

Heatex AB & Lund University faculty of engineering

The Heatex-Model

Multi-Cultural Business Process Development

Sebastian Persson
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Abstract

Title

The Heatex Model – Multi-cultural business process improvement

Author

Sebastian Persson

Supervisors

Dag Näslund, Associate professor, engineering logistics at Lund University

Jonas Bengtsson, global operations manager at Heatex AB

Purpose

The purpose of this study is to develop a model for business process improvement that integrates national culture aspects to achieve sustainable performance improvement.

Research questions

- How can national culture aspects be combined into a business process management model?
- What is the difference between mapping methods?
 - How do they relate to each other and their intended scope?

Research procedure

This project takes place from September 2014 to March 2015. During this time the researcher spent October – mid December at Heatex subsidiary in Shanghai, looking at the order to delivery process for the rotor production line. By first conducting a literary review of business process management, and development with a specific focus on business process mapping. This study has compared different business process mapping techniques into a business process management model that was applied to the case company.

As an attempt to further understand a foreign process the Hofstede framework was also integrated into the business process management model. The idea was to better be able to predict the process reaction to changes and be able to develop a suggestions that could create sustainable change and improve overall performance.

Results

The implemented improvements in the production process at Heatex Shanghai are:

- A KPI system for measuring performance
- A new and more efficient layout for the spinning line
- Tool-belts and –carts

Based on the experience and research procedure used in this study the Heatex model for multi-cultural process improvement were developed. It is a ten step model that combines

previously established process management models with Hofstede's model for culture dimensions:

1. Identified goal, opportunity or problem
2. Assemble team
3. Draw boundaries
4. Examine process
5. Evaluate issues
6. Find cause
7. Culture analysis
8. Develop solutions
9. Implement
10. Evaluate process

Conclusions

The purpose of this study is to develop a model for business process improvement that integrates national culture aspects to achieve sustainable performance improvement. It is a growing need for companies to develop their processes that cross national and cultural borders. The Heatex model presents a suggestion for how the Hofstede culture research can be applied to gain knowledge about a foreign culture. This can help to extract trustworthy data as well as be used as a tool to achieve sustainable process change. This study conducted a literary review over different mapping methods in order to further deepen the knowledge about process mapping. Based on this theory a theoretical model was developed for how to apply different process mapping techniques. By applying these mapping methods to Heatex Shanghai further conclusions could be drawn about how process mapping should be conducted. By answering the research questions this study provides an explanatory result between culture analysis and business process management, and within business process mapping.

Keywords

Process, Business process management, Process mapping, Culture, Culture dimensions, Hofstede, Case-study, make-to-order manufacturing

Acknowledgement

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Lund 2015-04-01

A handwritten signature in black ink, appearing to read 'Sebastian Persson', is written over a horizontal line.

Sebastian Persson

Table of contents

1. Introduction	1
1.1 Background	1
1.2 Case.....	3
1.3 Purpose	4
1.4 Research questions.....	4
1.5 Limitations	4
1.6 Target audience	5
1.7 Important terms and abbreviations	5
1.8 Report structure	6
2. Method.....	7
2.1 Types of studies	7
2.2 Research strategies.....	8
2.3 Approach.....	8
2.4 Data source, type, analysis & authenticity	9
2.5 Data collection strategies	10
2.5.1 Interviews	10
2.5.2 Observations	11
2.6 Ethics & integrity	12
2.6.1 Protect the participants interest.....	12
2.6.2 Avoid pretenses and incorrect representation	12
2.6.3 Any participant should give their informed consent	12
2.7 Method for this study	13
2.7.1 Literary review.....	13
2.7.2 Boundaries.....	13
2.7.3 Current-state analysis	14
2.7.4 Culture analysis	14
2.7.5 Improvements and implementation	15
3. Theoretical framework	17
3.1 Business process management	17
3.1.1 Business Process.....	18
3.1.2 Business Process Development.....	20
3.2 Process mapping.....	26

3.2.1	SIPOC	26
3.2.2	Value stream Mapping	28
3.2.3	Flowchart.....	32
3.2.4	Spaghetti diagram	33
3.2.5	Relationship between process mapping methods.....	34
3.3	Tools for analysis and improvement	36
3.3.1	Pareto-principle.....	36
3.3.2	The 5 Whys	38
3.3.3	Continuous flow	38
3.3.4	FIFO.....	39
3.3.5	The 5 S	39
3.3.6	Poka Yoke – Error proofing	40
3.3.7	KANBAN	42
3.3.8	SMED	42
3.3.9	Kaizen	43
3.4	The Hofstede Model	43
3.4.1	What is Culture?.....	43
3.4.2	National culture.....	44
3.4.3	The Hofstede model applied to China and Sweden.....	45
3.4.4	Organizational Culture according to Hofstede.....	47
3.5	Synthesis of the theoretical framework	49
4.	Results.....	53
4.1	Empirical findings.....	53
4.1.1	Step 1 – Define boundaries	53
4.1.2	Step 2 - Current-state and identified issues.....	58
4.1.3	Step 3 and 4 – Evaluation of identified issues and Find the root cause	64
4.2	Analysis of the empirical findings and implementation of improvements.....	70
4.2.1	Step 5 – Culture evaluation	70
4.2.2	Step 6 – Developed suggestions.....	72
4.2.3	Step 7 – Action plan, implementation, and measured results.....	77
4.3	The Heatex model.....	80
4.3.1	Identified goal opportunity or problem	80
4.3.2	Assemble team.....	80

4.3.3	Draw boundaries	81
4.3.4	Examine process.....	81
4.3.5	Evaluate issues	81
4.3.6	Find cause.....	81
4.3.7	Culture analysis	81
4.3.8	Develop solutions.....	82
4.3.9	Implement.....	82
4.3.10	Evaluate.....	82
5.	Discussion.....	84
5.1	Credibility.....	84
5.2	Business process management	84
5.3	Culture	85
5.4	Heatex model.....	85
6.	Conclusion and contribution.....	86
6.1	Answer to the research questions.....	86
6.1.1	How can national culture aspects be combined into a business process management model?	86
6.1.2	What is the difference between mapping methods? How do they relate to each other and their intended scope?	87
6.2	Practical contribution	87
6.3	Academic contribution	88
6.4	Future studies	88
7.	References	90
	Appendix A – Timetable	0
	Appendix B – Data collection Plan	3
	Appendix C – Interview guides.....	6
	Heatex Sweden	6
	Sale-support.....	6
	Global Purchasing Manager.....	6
	Production Planning.....	7
	Global quality manager.....	7
	Global operations manager	8
	Research and development	9
	Heatex Shanghai	9

Sale-support	9
Production Leader	10
Quality manager	10
Operations manager	11
Appendix D – Product Matrix at HSH	13
Appendix E – VSM-symbols	14
Appendix F – Found issues	16
Appendix G – Corporate culture evaluation	17
Means oriented versus goal oriented	17
Internally driven versus externally driven	17
Easygoing work discipline versus strict work discipline	17
Local versus professional	17
Open versus closed system	17
Employee versus work oriented	17
Degree of acceptance of leadership style a	17
Degree of indication with your organization	17
Appendix H – Improvement suggestions	19
Appendix I – Action plan	22
Appendix J – Theoretical future state map	23

Table of figures

Figure 1 presents the relationship between a company’s processes and the surrounding context.....	1
Figure 2 Describes the focus of the study is Order-to-delivery process for the product group “rotor”. RMW is raw materials warehouse and FGW is finished goods warehouse.	4
Figure 3 presents the culture analysis relationship to the business process development project.	14
Figure 4 framework used to answer the research questions	16
Figure 6 presents the horizontal organization chart for the core process from order to delivery. By breaking down the organization processes from the overall company strategy and goal it is possible to evaluate how the actual work is and should be conducted to achieve these goals.....	17
Figure 7 presents the relationship between business processes from overall organizational goal to implemented business processes. (Weske 2012).	19
Figure 8 the combination of continuous improvement and process innovation can look like an S-curve.	21
Figure 9 describes the process categories presented by DeToro and McCabe (1997)	22
Figure 10 relationship between intra-organizational and process choreographies (Weske 2012).....	23
Figure 11 business process improvement according to Weske (2012)	24
Figure 12 PDCA- cycle, Plan, Do, Check, and Act. (SIS 2009)	26
Figure 13, a SIPOC diagram over the juice making process. The process starts with the order processing of an order from a customer. The order then goes through mixing which requires ingredients, bottling which requires bottles and the final step is transportation which requires payment approval from the financial department.....	27
Figure 14 the first step in implementing a VSM at a facility (Rother, Shook 1999).....	28
Figure 15 shows commonly used metrics for VSM	29
Figure 16 A current-state value stream map that shows the production flow as well as information flow (Rother, Shook 1999).	30
Figure 17 One way divide the implementation plan is to look at the map as a series of pull-loops (Rother, Shook 1999)	32
Figure 18 a flowchart of the process of re-spray-painting a car (Meran, John et al. 2013)	33
Figure 19 spaghetti diagram of a warehouse, the green and red line are the movements of the forklift drivers, the yellow marked area is high-risk area due to the high traffic load.....	34
Figure 20 Model of the concluding relationship and scope for the presented maps.....	35
Figure 21 Pareto chart that shows the top ten causes of scrap defects and total weight of barrels.....	37
Figure 22 the cost of poor quality (Meran, John et al. 2013).	41
Figure 23 describes the Kanban process, a production Kanban card triggers the production process while a withdrawal Kanban card works as a shopping list (Rother, Shook 1999).	42
Figure 24 demonstrates the three main aspects of human uniqueness (Hofstede 2005)	44
Figure 25 presents the score for Sweden and China on each culture dimension in the Hofstede model (Hofstede 2014).....	47
Figure 26 shows four topics that commonly cover the.....	47

Figure 27 presents the framework for collecting, compiling, and structuring research used in this project.	50
Figure 28 describes the basic supply chain from Heatex' suppliers to end customer.....	54
Figure 29 presents the SIPOC analysis that identifies the process steps and the stakeholders to the process. For all production steps the purchasing are responsible to assure availability of material at the site while the warehouse are responsible for assuring that the material is available at the production line.	55
Figure 30 the left graphs shows the aluminum price over the last decade (Mundi 2015). The right graph shows the most aluminum consuming industries for 2013 (Rusal 2013).....	56
Figure 31 shows the analysis based on Porter's five forces.....	56
Figure 32 the goal for this process is not only to increase efficiency. Communication and visibility, Flexibility, and delivery performance are also of big importance.	57
Figure 33 shows delivered units from HSH, the most popular product is the G2. For G1 there is mainly one large order that increases the sold units.	58
Figure 34 show the production layout at Heatex Shanghai. The green line shows the production flow from spinning, inventory, welding, testing, mounting, final assembly and then transported to packing. The red lines shows component flow for spoke cutting (sc), sweep cutting, profile cutting (PC), and casing.....	59
Figure 35 shows the current state map of the VSM analysis. The cycle-time for planning is highly dependent on the order. A repetitive order can be planned within 1-2 hours while a new order require substantially more time to plan, up to two days.....	59
Figure 36 shows the operation times for the different product groups as well as the average cycle time "weighted CT".	61
Figure 37 Inventory data was collected by counting the number of units between operations each morning. This resulted in the following graph.	62
Figure 38 shows the process condition of the order to delivery process for rotors at HSH. ..	64
Figure 39 shows an estimated ranking between the issues made by the researcher and managers at Heatex to decide what to continue focusing on. Issues marked in green is the new focus for the study, the issue in striped green has been theoretically analyzed.....	65
Figure 40 shows the unnecessary transport that is built up by where the work is located "workplace" and how the work is executed "work procedure". The workplace is of course affected by the overall layout but it also have a large impact on the tools-handling for the assembly operation which of course effects the work procedure. The work procedure is for the welding and assembly area mostly built up by small individual tasks that have limited dependencies and offers frequent interruptions.	67
Figure 41 shows the layout for the welding and assembly operation. The welding operation has fixed machines such as the welding table, spoke cutting (SC), and sweep cutting that are located on different sides of the assembly area. The assembly operation have no fixed location for casing- or final-assembly.	68
Figure 42 presents the recommended action plan.....	74
Figure 43 shows the old layout at HSH	74
Figure 44 shows the new layout for HSH spinning line.....	75
Figure 45 shows the new KPI's for HSH spinning line and are updated weekly. The left graph shows the production rate, and the bottleneck capacity (currently the welding operation).	

The graph on the right shows the throughput time compiled into waiting time in red and operating time in green. The green dotted line shows the fastest throughput time and the dotted red shows the slowest. 77

Figure 46 shows the measured results from the KPI system from 2014-12-01 - 2014-12-30. 78

Figure 47 presents the average throughput time and shows both waiting time and operation time. 78

Figure 48 shows the current process condition based on Davenport's (1997) framework (1). It also shows the potential process condition based on the quality improvement project (2) and the if a planning and inventory project is launched (3). The X marks where the process was before. 80

Figure 49 The Heatex model, multi-cultural business process development, from root-cause analysis 83

Table of tables

Table 1 Different scientific approaches for scientific studies (Arbnor, Bjerke 2009).	9
Table 2 describes three interview approaches.	11
Table 3 Unstructured, Participation and structured observations.	12
Table 4 Product matrix based on Rother and Shook (1999). By listing all products, and operations it is decided that product A and D are in the same product family, and B and C are in the same.	29
Table 5 matrix for ranking of improvement of issues	37
Table 6 description and translation of the 5S tools (Ho 1999).	39
Table 7 Examination methods in the poka-yoke tool (Meran, John et al. 2013).....	41
Table 8 is collected directly from the Hofstede culture webpage. It describes the similarities and differences between Swedish and Chinese culture (Hofstede 2014).....	46
Table 9 presents the potential improvement of changing the production layout. Minimum improvement is calculated based on the reduced walking time for the welder, expected improvement is reduction of walking time and interruptions due to the walking. Long-term benefits are achieved if the welder is helped by either the spinning operator or an assembly worker.	75
Table 10 by implementing tool-carts and belts for pre-assembly the following improvements could be achieved. The results are calculated based on timed observations.	76
Table 11 by implementing tool-carts and belts for pre-assembly the following improvements could be achieved. The results are calculated based on timed observations	76
Table 12 presents a comparison between the average CT that the researcher calculated in the current-state analysis and the numbers presented by the KPI system. Since the measuring were not done in the same way or by the same people the data is hard to compare.....	79

1. Introduction

The introducing chapter starts by setting the premise for this case-study both from an academic and a case perspective, section 1.1 and 1.2. This is followed by the purpose, research questions and deliverables in section 1.3 - 1.5. The limitations for this study is discussed and evaluated in section 1.6 as well as the target audiences and important terms and abbreviations in section 1.7 and 1.8. This chapter finishes by presenting an overall research structure for the reader to gain an understanding of how the report is structured in section 1.9.

1.1 Background

Business process management has over the last decades manifested itself as a key tool for organizations to improve their performance. By visualizing information, financials, goods, people, actions e.tc in a measurable way business process management aims to develop and improve overall performance. To keep track of all actions required to produce a product from raw material to life-end (destruction/recycling) is almost impossible and would require a substantial amount of resources. So much resources in-fact that the researcher argues that it is not necessary. However, by identifying critical interfaces where output from one process becomes input to the next process, part of a puzzle can be laid, see Figure 1. This puzzle shows the relationship between a company and its immediate stakeholder, and the external surrounding context. By looking further into the case-company puzzle piece it becomes apparent that it is built up by smaller pieces. These represent how the company is built up from strategy to the operational daily work. By visualizing this it becomes possible to evaluate how small changes within the case company will affect the immediate stakeholders and in the end the environment. The revolutionary about business process management is not the recognition of processes itself but the recognition of cross-functional activities that add customer value and increase flexibility. Instead of having a chain of command where information flows upward to senior functional managers who evaluate the data, make decisions, and deploy policy and communication downward, the organization is viewed as a series of functional processes linked across the organization which is how the work actually gets done (DeToro, McCabe 1997).

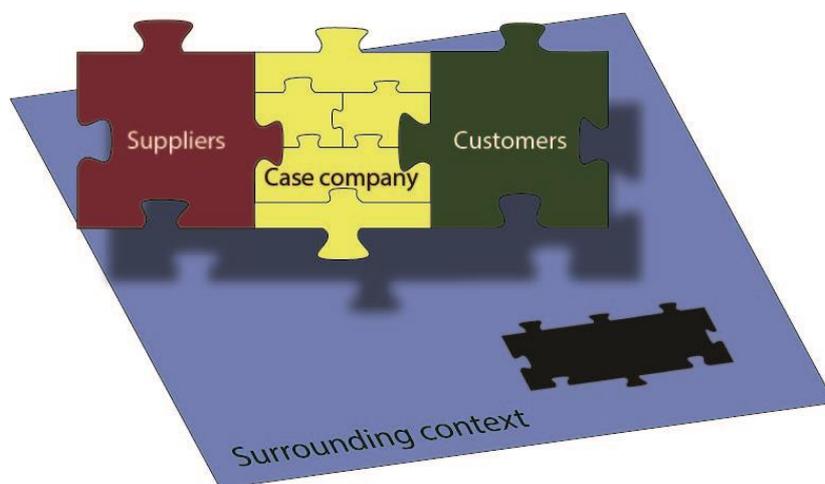


Figure 1 presents the relationship between a company's processes and the surrounding context.

The European standard EN ISO 9001:2008 defines a business process as *“An activity or set of activities using resources, and managed in order to enable the transformation of inputs into outputs, can be considered as a process. Often the output from one process directly forms the input to the next”* (SIS 2009). This means that a process should have a beginning and an end, it should receive and process input to provide a pre-specified output. This is of course done every day everywhere, literary every string of actions can be viewed as a process. Business processes however focus around creating value for customers. Processes exist on all levels of an organization. It is clear that business processes today are a strategic asset not unlike patents, copyrights, trademarks e.tc. (DeToro, McCabe 1997). To further classify business processes it is possible to draw the distinction between organizational and operational business processes, as well as intra- and inter-organizational business processes (Weske 2012). Organizational business processes are high-level, often core, processes that grasp over large parts of a company and more or less defines the structured for how the company should achieve its goals. These organizational processes are built up by operational business processes that specify all the required activities and their relationships. Just as it sounds intra-organizational business processes are processes that are conducted from input to output within the same organization. To understand business processes that interact between organizations is often more complex. Not only is the communication more difficult and time consuming. There is also need for additional negotiation, legal matters and technical specifications. The relationship between companies are typically determined by contracts such as sales orders that define ownership hand-off and delivery date e.tc

The main focus of business process management is not just to identify and classify its processes. Having a business process management approach will help to keep track of the processes that directly affect the organizations performance. The idea is to improve overall efficiency and effectiveness. Business process management is a well-defined field of research and there are plenty of business process development models to choose from. Despite this none of the models, the researcher encountered, had a clear description of how the process mapping should be conducted. Business process mapping is an essential part of business process management and while the potential of business process management is widely understood by organizations today there seems to be a lack of understanding for how different mapping methods should be used, at what level of the company should they be applied, their intended scope and level of detail. How can they create an overall improvement without sub-optimization? *“Every detail of a process is more or less affected by every other detail; therefore the entire process must be presented in such a way that it can be visualized all at once before any changes are made in any of its subdivision”* (Gilbreth, Gilbreth 1921). Visualization of processes is key to understand how the current work is actually conducted and compare it to the ideal workflow. If the current way of working is not visualized and understood properly the performance metrics may not tell you what you think and trying to improve them might not give the expected results. This study has therefore conducted a literary study of different mapping techniques and developed a framework for how different mapping techniques should be used based on their scope versus level of detail. Four mapping techniques were then applied to the case company

through a business process management model that was developed based on the literary review.

In order for companies to adopt and maintain competitiveness in globalization and today's fast pace changing environment, the need has arisen to become more efficient through process and cost optimization and knowledge from a globally dispersed talent pool (Vagadia 2012). It is common for organizations today to look overseas as a strategic choice to expand their growth and reach new markets, knowledge, and/or labor. With today's information technology and wide selection of alternatives for instant communication, process output can instantly become process input on the other side of the globe. To understand and visualize these flows is a complex task not only because they cross international borders but cultural borders as well. While different business units within the same organization may have similar corporate culture, this is not necessarily the case for national culture. The people working in global organizations have to work, learn and develop together. This study has therefore looked into how culture differences can affect the work within business process management. By integrating and acknowledging the Hofstede framework (de Mooij, Hofstede 2010, Hofstede, Hofstede et al. 2010) into the business process management model this structure can be used as a basis for mutual understanding i.e. a common goal.

1.2 Case

Heatex manufactures and sells air-to-air heat exchangers for industrial cooling, heating, and ventilation to a globally spread customer base located on all continents. The total number of employees is just below 200 (2014) located at the Headquarters and production unit in Sweden (HAB), and the production units in China (HSH), Czech Republic (HCR), and United States of America (HINC). The reason for having four production units is because all orders are manufactured to order and the lead-time to customer is one of the most crucial order winners. This study takes place within HAB located in Malmö Sweden and HSH located in Shanghai China.

A few years back managers at Heatex started to implement a LEAN initiative to reduce cost and increase flexibility. This initiative has proven effective in Sweden but it does not seem to stick at HSH. HAB has also heard complaints from customers about faulty products and not arriving on the requested date, yet this is never shown in the KPI's presented by HSH. HAB has realized the need better monitor and control their subsidiary. They think this can be achieved by developing their process orientation and having a uniform model for how to work with process improvements. By working in a similar way makes it to easier communicate on how and what the different production units are working on to improve as well as being able to send people for example from HCR to HINC to help dealing with a specific issue that was already solved at HCR. Having the same model for process improvement implemented at all production units can also help to increase visibility to better be able to assess performance and set goals.

By applying different mapping techniques as well as developing a business process management model that takes culture aspects into consideration it could provide Heatex with increased visibility and control to their subsidiary, as well as help to understand how change initiatives can be conducted at all their sites.

1.3 Purpose

The purpose of this study is to develop a model for business process improvement that integrates national culture aspects to achieve sustainable performance improvement.

1.4 Research questions

- How can national culture aspects be combined into a business process improvement model?
- What is the difference between mapping methods?
 - How do they relate to each other and their intended scope?

1.5 Limitations

This study has exclusively been looking at the order to delivery process for a one product-group that is already on the market with a built up demand. The process start from the point where a firm sales order is entered in to the ERP-system and end when the finished product is placed on the truck bound for the customer. Figure 2 below describes the scope of the project. Supporting processes will not be evaluated further than the acknowledgement of their existence. However supporting processes that are essential to the order to delivery process and have a direct effect on lead-time, quality, or customer satisfaction are measured in time, for example getting specific material or a minor drawing changes e.tc. HSH has extra testing operations implemented in the process in contrast to the other production units. These testing operations are so much faster than the other production operations that they have not been evaluated further than acknowledgement of their existence.

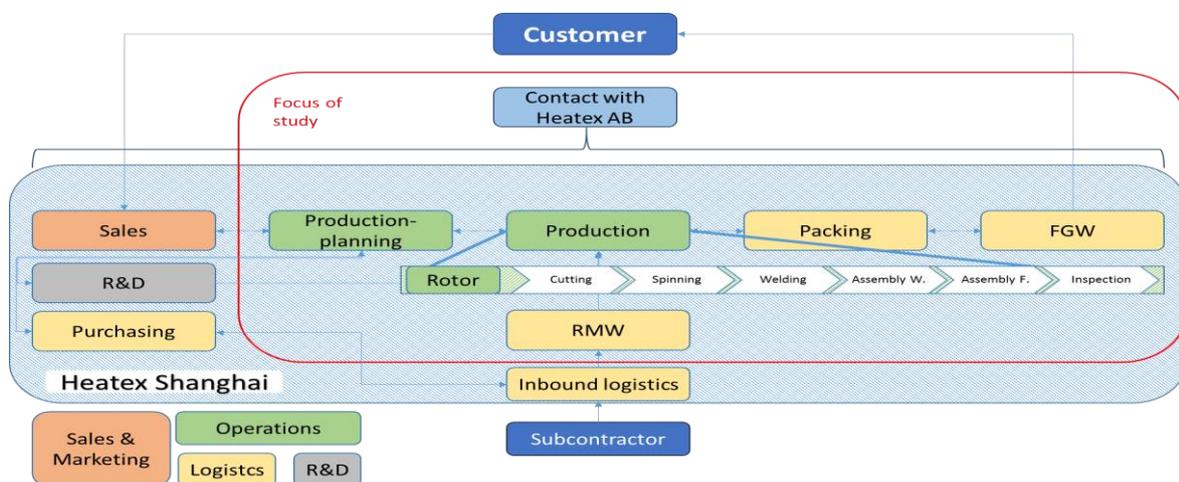


Figure 2 Describes the focus of the study is Order-to-delivery process for the product group "rotor". RMW is raw materials warehouse and FGW is finished goods warehouse.

The process was observed in intervals, of minimum one week during the 11 weeks the researcher spent in China. Due to low customer demand not all operations were not run all the time, this meant that the presented result in the value stream map are based on observed data as well as estimated analysis from previously collected data by HSH. Actual data was thus compared with internal documents for operation times for previous

processes. During the monitoring the shift-leader was not present in the facilities. This may have an effect on efficiency and structure on the production floor.

There are several frameworks and models for examining the culture within groups, companies and nationalities. The present study is not a cultural study but rather a study examining the possibilities to combine process based business development and cultural research. The Hofstede model is one of the most well-known and largest frameworks for cultural analysis and is therefore chosen to be applied to this study.

The data collection in this study has been affected by the language and cultural barriers between the researcher and the people working at Heatex Shanghai. This has been time consuming and required patience from both the researcher and the interviewee. The questions have in most cases been repeated several times to assure that the interviewee understands what he/she is answering to.

1.6 Target audience

The idea for this report is to develop a model for process improvement that Heatex can implement throughout their company. This makes personnel from Heatex that are linked to process development the primary audience.

This report is also targeting scientist, researchers, as well as people working with or interested in process based business development and/or cultural research.

The audience is assumed to have basic knowledge about business processes as well as process development tools e.g. LEAN, Six Sigma, Quality 7, e.tc.

1.7 Important terms and abbreviations

Abbreviation	Meaning
HSH	Heatex Shanghai
HAB	Heatex AB
HINC	Heatex in Corporate (USA)
HCR	Heatex Czech Republic
Effectiveness	How well output meets customer demands
Efficiency	How well output meets internal requirements
FPA	Forward piece pick area
SIPOC	Supplier, Input, Process, Output, Customer
VSM	Value state map
RMW	Raw materials warehouse
FGW	Finished goods warehouse
CT	Cycle-time
LT	Lead-time
FIFO	First-in-First-Out
SWOT	Strengths, Weaknesses, Opportunities, and Threats analysis
BCG-matrix	Boston consulting group model for classifying the product portfolio
WIP	Work in progress

1.8 Report structure

Chapter two presents common procedures for conducting research and finishes with the methodology for this study.

Chapter three presents the theoretical framework that is the foundation for this study.

Chapter four presents the results of the study. Starting with empirical findings

Chapter five discusses the results.

Chapter six draws conclusions where the research questions are answered as well as the practical and academically contribution is presented.

2. Method

This chapter presents and explains common theories for conducting research. These are analyzed, and discussed to establish a proper research procedure that assures a credible result. Section 2.1 – 2.6 presents theories for different types of studies, research strategies, how to collect and analyze data, ethic aspects, e.tc. In the final paragraph for each section conclusions about this study is presented. The final section, 2.7, presents the method for this study, more explicit for how the work has been conducted.

The timetable is presented in Appendix A, the data collection plan in Appendix B, and the interview guides in Appendix C.

2.1 Types of studies

Most projects have a limited amount of available resources e.g. time, money. To better achieve the goals and purpose of the study researchers and scientist have to evaluate what method to use. A method does not tell what to do and when to do it; it provides a framework of how you can get from an issue to a better understanding of the subject with the available resources (Höst, Regnell et al. 2006). The previous research and available information within the specific area covered by the study can also be a factor when choosing method (Björklund, Paulsson 2012). Björklund and Paulsson (2012) provide 4 different kinds of studies:

1. Explorative studies is usually done within fields that have limited or no research
2. Descriptive studies is often used within areas with available basic research in an attempt to understand the basis of the field
3. Explanatory studies is usually done when you want to deeper knowledge within a field
4. Normative studies aims to give guidance and suggest improvement for an already established field of studies, this is to create new theory and further deepen the knowledge
5. Problem solving studies purpose is to find a solution to a pre-identified problem (Höst, Regnell et al. 2006).

Business process management is a well-established field of research, however the use of business process development are different from company to company, and culture to culture. Business process management is field within business process management that has not been fully understood by organizations today. National culture research is also a well-established field of research however research combining business process development drawing benefits from national culture research seems to be very limited. Articles related to the subject mostly discuss what cultural aspects can help/hinder compliance. This study therefore provides an explanatory result for how national culture research can be integrated into a business process development model and business process mapping.

2.2 Research strategies

There are different strategies to gathering data, examine a problem and increase knowledge. The following are short descriptions of common research strategies (Bell, Nilsson 2006, Denscombe 1998, Höst, Regnell et al. 2006):

- Action research is to reach conclusions about how to deal with a specific problem and how to implement changes for a specific problem.
- Case studies offer the possibility to explore, in depth, a well-defined issue within a limited time frame. It is mostly used for studying a specific phenomenon that has been identified and conclusions that are drawn are often case specific.
- Surveys usually provide a current state answer to a broad question. By asking a representative part of the population you can draw conclusions about the entire population i.e. election studies.
- Experiments are usually conducted to compare two or more options. While keeping all parameters as constant as possible except for one, testing and evaluation of the different options can provide conclusions about the different options.

Based on this study's the well-defined scope between business process management and culture as well as culture being a collective phenomenon and best learned from experience a case study is the most suitable for this type of study. It would of course have been interesting to look into several cases and compare both how different corporate cultures affects as well as different culture models. Having that said a single case-study is sufficient enough to draw conclusions of whether business process management can benefit from culture differences. This in combination with available resources the decision was made to focus on a single case.

2.3 Approach

Arbner & Bjerke (2009) discusses three approaches to scientific studies; analytical-, systemic- and actors view. Table 1 presents an overview of the three approaches that are further discussed below.

The analytical view assumes that reality can be explained by sum-able independent causes (variables) that together form an effect. Essentially all the different causes could be broken down and studied as individual elements and the sum of all the elements would represent the whole (Arbner, Bjerke 2009). Data collection is controlled by hypotheses that have not been proven false, as more and more of the hypotheses in a theory are verified, the theory is considered to be a better and better representation of reality (Arbner, Bjerke 2009).

Much like the analytical view, the systemic view assumes the existence of a fact based reality; however this reality is built up of components that are mutually dependent on each other. In the systemic view synergies between the different components are just as important as the components itself (Björklund, Paulsson 2012).

The actors view assumes that reality is a social structure that is affected by and effects the people that are in contact with this structure (Björklund, Paulsson 2012). The actors view

attempts to prove inner and outer constitutional factors, inner factors helps the actors to understand their situation better and the outer factors is new knowledge and understanding (Arbnor, Bjerke 2009).

Table 1 different scientific approaches for scientific studies (Arbnor, Bjerke 2009).

	Analytical View	Systems View	Actors View
Prerequisites	<ul style="list-style-type: none"> Existing analytical theory Verified/falsified hypotheses 	<ul style="list-style-type: none"> Existing systems theory Analogies (homologies) 	<ul style="list-style-type: none"> Meta-theories Constitutional factors General pre-understanding
Explaining/- Understanding	Causality Case-effect (explanation)	Finality Producer-product (explanation or understanding)	Dialectics Thesis-antithesis-synthesis (understanding)
Results	Cause-effect relations (as an ideal)	Classifications <ul style="list-style-type: none"> Structural representative models Representative interpretations 	Descriptive languages <ul style="list-style-type: none"> Situational interpretive models Institutional models Process models
	Logical models	Classification mechanisms	Ideal-typified language <ul style="list-style-type: none"> Ideal-typified cases Constitutional ideals
	Representative cases	Typical cases Partly unique cases	Emancipatory interactive action <ul style="list-style-type: none"> Creative action Direct action

The adopted view for this study for business process management is systemic, different components are assumed to influence and effect each other based on their relationship and context. Changes in one component can and probably will affect the adjacent components and so on. However since culture is a social phenomenon the experiences of the people involved has to be taken into consideration. The overall view on reality is therefore between systemic and actors view.

2.4 Data source, type, analysis & authenticity

The source of the data is of high relevance when conducting scientific research; it is divided between primary and secondary data. Primary data is defined as information that is directly gathered by the researcher and is obtained from the source via observations, interviews or surveys. Secondary data is interpretations of primary data (Bell, Nilsson 2006).

Quantitative data is data that can adopt a numerical value and are therefore good to use for comparison. Qualitative data is more often used when the goal is to create a deeper understanding within a certain field (Björklund, Paulsson 2012)

Induction, deduction and abduction describe the relationship between general theory and concrete empirical data (Björklund, Paulsson 2012). Induction is evaluating empirical data to find patterns that can be summarized in to models and framework, induction can be done without studying existing theory of a subject (Björklund, Paulsson 2012). If so, all theory is developed through gathered empirical data. When conducting deduction, extensive theory is the basis for making prediction about the empirical data. By then gathering facts from the empirical data you can verify your predictions and draw conclusions (Björklund, Paulsson 2012). When a study contains both induction and deduction alternating it is called abduction.

Triangulating means that you are examining from more than one perspective (Denscombe 1998). This is to increase the accuracy of the study and create a more complete picture by using different sources and references, different analytical methods to examine and evaluate the data. Reliability is about repeatability and whether the outcome of the study would be the same if it was repeated. Validity is to assure that the correct data has been collected.

Data has been collected through both theoretical and empirical studies and both quantitative and qualitative. Due to the language and cultural barriers extensive triangulating and reliability assurance has been conducted by asking several people the same question, questioning of given answer, and participating in the activities when possible. The researcher also sent e-mail check-ups to make sure the subject had understood the question as well as the researcher had understood the answer correctly. This study has aimed to achieve abduction. The project started with a deduction phase by conducting a literary review that was compiled into a framework that describes how the theory should be applied to the case. The second phase is an induction phase by using the framework to collect and evaluate data. Lastly the empirical and theoretical data is compared into an evaluation of the framework, which is why this study considers that abduction has been used.

2.5 Data collection strategies

2.5.1 Interviews

An interview is a direct questioning of a person about a specific subject. It can provide a deeper knowledge than a survey and a skilled interviewer can also draw conclusions from the response given by the person who is interviewed (Bell, Nilsson 2006). Interviews can be used to gather easy factual information, however it is when studying complex and subtitle phenomenon the full potential of an interview is released (Denscombe 1998). If researcher wants to gather easy uncontroversial facts a survey is probably better suited however interviews are best for data collection of (Denscombe 1998):

- Opinion, perceptions, feelings and experiences, this kind of information usually requires further description than a few words also sign language can be a big tell
- Sensitive information, by handling a matter gracefully and respectfully it is often possible to get interviewees to speak openly and honestly about sensitive matters
- Privileged information, for example via direct contact to key people such as established researchers within a field or management of a company

An interview can be either a personal- or a group interview, Table 2 below, describes three different interview approaches that are compatible with both personal and group interviews.

Table 2 describes three interview approaches.

Interview-type	Description
Structured	<ul style="list-style-type: none"> • The researcher holds a tight grip over the agenda • It is more or less face to face survey • Gives the researcher standardized replies • Replies are heavily dependent on the questions which is dependent on the researchers knowledge of the subject
Semi-structured	<ul style="list-style-type: none"> • The researcher has a pre-made list of selected topics • The agenda is somewhat set by the replies of the interviewee • The interviewee is given more time to explain and develop their replies than in a structured
Unstructured	<ul style="list-style-type: none"> • Is almost entirely built up on the interviewees thoughts • The interviewer sets the agenda by addressing a topic • The interviewer tries to intervene as little as possible to get the most out of the interviewee

While using interview as a data collection method has the advantage of flexibility and the possibility of adding follow up question unlike for example a survey, interviewing people is time consuming and, if only a few people are interviewed, can provide a subjective perspective. To create the questions is difficult, time consuming and if not done properly will make it hard to analyze the answers. If done properly an interview can provide a lot of good primary data.

In this study semi-structured and unstructured interviews has been conducted with key personal in both Heatex AB in Sweden and HSH. This has provided both perspectives from parent-company and subsidiary. During the data collection it also became clear that Chinese’s English pronunciation is different from British, American or Scandinavian; however the written language is the same which is why for some more descriptive questions e-mail conversations were more suitable together with meetings.

2.5.2 Observations

Observational data collection is common in scientific studies and can be performed in different ways depending on the situation. Observations offer the researcher the benefit of the doubt, instead of rely on what people are saying or say that they are thinking it catches the direct actions of a subject. Bell (2006) describes three types of observations, see Table 3 below. Based on what the researcher wants to evaluate the observed people can be told in advance or be observed in the unknowingly.

Table 3 unstructured, Participation and structured observations (Bell, Nilsson 2006).

Interview type	Description
Unstructured observation	Unstructured observations are suitable when the researcher have a well-defined purpose of the observation but not sure of the details. Enough time and resources must be set in to the studies to be able to gather and analyze enough data to be able to find frameworks to describe the studied object/reality.
Participant observation	Just like an unstructured observation the researcher studies an individual, group or organization, however it may require the researcher to take part in the work, to be able to access data or be accepted by the group. The participant observation has a greater risk to be biased and influenced by the feelings or friendship to the observed people it can also affect the researcher. This is something that needs to be acknowledged and it may be helpful to get an outside person to review the observed material.
Structured observation	In a structured observation you start from a pre-determined focus. Structured observation can just as well be criticized for being subjective and biased since you have already have a purpose of the observation it is important to be aware of this and both observe facts that speak both for and against the hypothesis.

This study has used both unstructured and structured observations and when appropriate participating observations.

2.6 Ethics & integrity

While conducting research it is important to be ethical and a researcher is expected to respect the participant rights and dignity, avoid any injury or harm through participation in the study and use an honest work flow that respects the participant. Denscombe (1998) discusses three main principles to conduct ethical research presented in chapter 2.6.1-2.6.2.

2.6.1 Protect the participants interest

Participants should not be worse off after the study than what they were before. No physical harm can affect the participants as well as sensitive information should be handled in a confidential way.

2.6.2 Avoid pretenses and incorrect representation

Researchers should be honest and work openly and respectfully and provide an impartially and objective view of the matter. However being completely open about your result can jeopardize the study. For example many psychological experiments would be spoiled if the subjects knew what the researcher was studying.

2.6.3 Any participant should give their informed consent

The participation of everyone in the study needs to be voluntarily, no one can be forced to participate in a study. There are exceptions, for example large observational studies e.g. number of cars on a road during rush hour. For research that require a personal

commitment over a longer time period will of course require the informed consent of the subjects.

The researcher considers that this study has been conducted ethically correct. A note is that the observations in this study were somewhat uninformed, the workers were unaware of what data was collected; however the researcher being the only non-Chinese at the site, approximately 30 centimeter taller than everybody else and only blonde were hardly unnoticed. The idea of the study is not to keep the workers unknowing or in any purpose to hurt them, but to improve both efficiency and their working environment. If they would have known what data was collected then the observed data would have been further compromised.

2.7 Method for this study

A graphic demonstration of the working procedure is presented in Figure 4 on page 16. It shows the three stages of theoretical data collection, empirical data collection, and the empirical analysis. It demonstrates HSH as a martini glass where the width of the glass represents the depth of the project. The work procedure is presented from the top down starting with the theoretical framework that supports the entire study. The study then looks at external aspects affecting all of Heatex as well as specific aspects to HSH and finally the order to delivery process for the spinning line. By doing this the overall purpose of the order to delivery process can be established and provide input to what to focus changes on. By then looking at the actual root-cause and try to implement changes the idea is to achieve improvements that spread through the supply chain. This type of working procedure to start by working wide and then continuously narrowing it down is reflected in the method in the following sections.

2.7.1 Literary review

This study started by conducting an extensive literary review in the area of Business process management, mapping and development, and culture evaluation. The researcher used databases and libraries provided by Lund University to find articles, journals, and research writings as well as corporate research to create this literary review. This was to gain insight to existing theories, and previous work conducted within the area as well as give input to what data to collect, how it could be collected as well as how to analyze it. Based on the theoretical framework a synthesis was developed for how the research should be conducted.

2.7.2 Boundaries

Based on previous business process management and development research it became apparent that applying an outside in approach by first looking at the bigger picture and then breaking it down into smaller pieces, like the puzzle presented in Figure 1, can create an understanding of how small changes can affect the bigger picture. This study is primarily focused within HSH as the main process in focus is the order-to-delivery process. By first examining competitors, suppliers, and customers and the general behavior in the construction supply chain and discussing it during interviews with the quality, sales, and purchase manager at both HSH and HAB. Knowledge about Heatex market position and competitiveness were gained. This information together with Heatex strategy could then be

translated, via discussions with the global operations manager, for its effect on the order to delivery process at HSH.

2.7.3 Current-state analysis

When the boundaries and environmental aspects was identified the shift focused towards the process itself. By interviewing the production planner and global operations manager at HAB as well as the operations manager, sale-support, production leader, and purchaser at HSH conclusions could be drawn of both external effects that are specific to HSH as well as how the work differs according to the employees at HSH. By then conducting extensive observations of the process at HSH and comparing it to the researcher’s previous knowledge of how work is conducted at HAB conclusions could be drawn about how the employees say that they work and how they actually work. This helped to understand how results from the current-state analysis should be interpreted.

The current-state analysis identified several issues. Based on discussions with the global operations manager at HAB and the operations manager at HSH the issues that would benefit the process the most were further evaluated. This meant conducting further observations primarily within the sub-processes or operations steps called welding, and assembly. For the planning operation this analysis was done with both interviews with sale-support and planning as well as observing them retrieve requested information.

2.7.4 Culture analysis

A business process development project can roughly be explained in two steps. The first step is to collect information from the process, and the second step is to put improvements back into the process based on this information. The culture analysis can in the beginning be viewed as a separate project from the business process development project that intertwines with the project at the point where the business process development project goes from collecting information to provide improvements. Figure 3 illustrates the relationship between the order to delivery process, business process development project, and the theory.

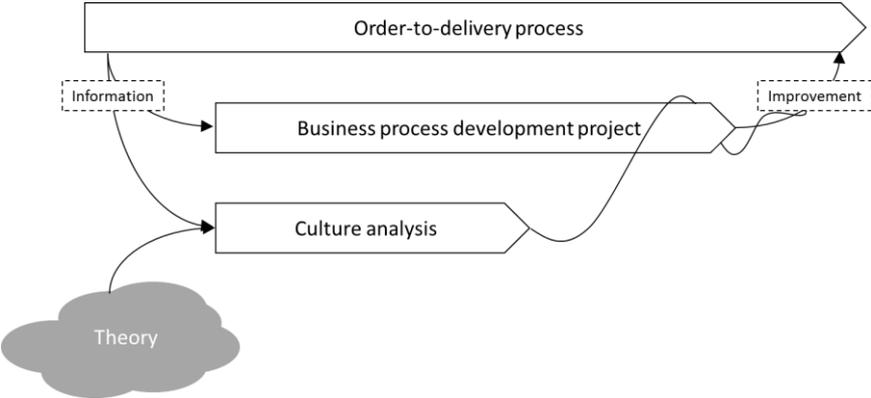


Figure 3 presents the culture analysis relationship to the business process development project.

The culture analysis started by examining current theory regarding common culture frameworks and methods. Since this is not a culture study but rather a process development project trying to draw benefits from culture differences. Scope was therefore limited to

focus on a major model called the Hofstede model (Hofstede 2014, de Mooij, Hofstede 2010, Hofstede, Hofstede et al. 2010).

Gained with the theoretical knowledge the researcher then examined the cultural setting at HSH by interviewing staff in Sweden that have frequent contact with HSH a Swedish view on Chinese culture developed. At HSH interviews were held with staff that has frequent contact with HAB about both Swedish and Chinese culture and their differences and similarities. These interviews were held at both employee and managerial level of the company so that the results were not affected by who is the boss. This was combined with observations of the actual work conducted in China.

The idea was to have enough understanding of the culture, when the researcher first landed in China, to be able to extract good and trustworthy data from the process both for the process development project and the culture analysis. This is why the culture analysis started already in Sweden. However the best way to understand a culture is to experience that culture. Extracting data and coming up with suggestions to improve it is easy compared to creating sustainable and successful change. This is why the comparison between theory and empirical data was conducted at the point when the project switched from extracting information from the process to developing and implementing solutions. By having a deeper understanding of the culture and its effects on the process, ideas and suggestions can be developed to fit in the environment. It can also provide input to how the people and process will react to change and how this can be used as an advantage to create change. The culture analysis was compiled based on the interviews and unstructured observations and compared to the theoretical findings.

2.7.5 Improvements and implementation

The focus of this study is within process mapping and culture analysis. The idea of a process map is not just to identify issues, by applying process maps changes can be evaluated based on their effects on the overall system. The order to delivery process at HSH is a manufacturing process which is why common manufacturing improvement tools were studied in the literary review, for example LEAN, quality seven, e.tc. Improvement suggestions were then developed based on the culture analysis to fit in the context. and with the objective to improve overall performance. Some of these suggestions that were developed were also implemented with an action plan developed with the operations manager, and production leader at HSH.

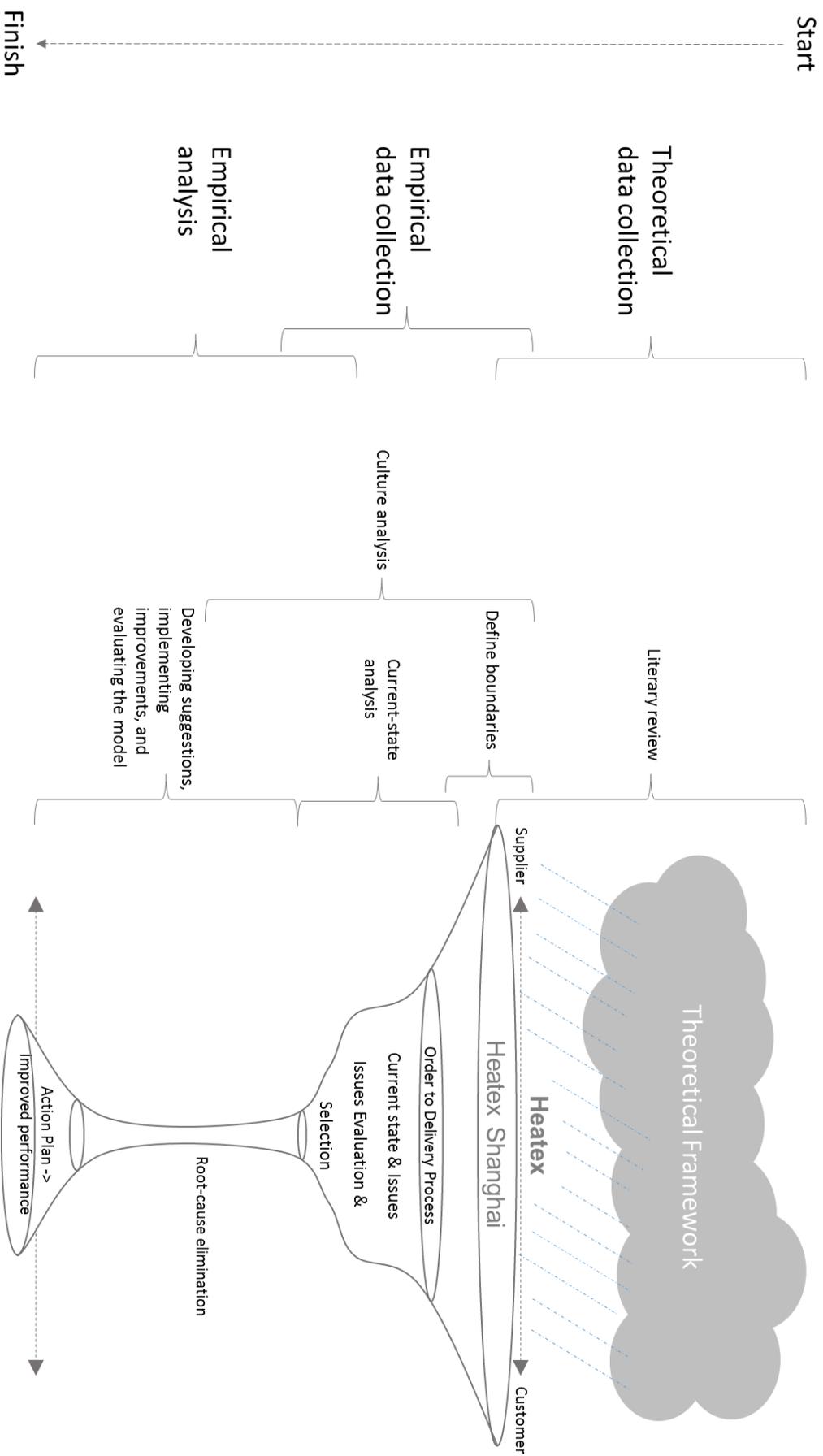


Figure 4 framework used to answer the research questions

3. Theoretical framework

The theoretical framework starts by defining business processes management, business processes and business process development in section 3.1. Sections 3.2 discuss how business processes can be visualized and help to identify issues by using different mapping methods. Section 3.3 addresses common tools for business process improvement and analysis. In section 3.4 the Hofstede model for culture research and culture evaluation are presented and section 3.5 presents a synthesis of the theory is presented and how it has been applied to this study.

3.1 Business process management

It is more or less impossible for one company to keep track of all actions required to get its products from raw material to life-end (destruction/recycling), or even end user of their products. However by keeping track of its input from supplier, actions and output to customer the company is able to assess their value to customer and identify opportunities, risks as well as areas to improve. Business process management can be viewed as a tool for companies to organize measure and evaluate the string everyday actions to produce value. The revolutionary about business process management is not the process itself but the recognition of cross-functional activities to add customer value and increase flexibility. Unlike *“The traditional organization is managed hierarchically; there is a chain of command where information flows upward to senior functional managers who evaluate the data, make decisions, and deploy policy and communication downward. Cross-functional issues are rarely addressed effectively and consequently, the performance of the organization is sub-optimized”* (DeToro, McCabe 1997). Organizations today have to a greater extent understood the importance of business process management and what is known as the horizontal organization, an example is presented in Figure 6. By using horizontal management the organization is viewed as a series of functional processes linked across the organization, which is how work actually gets done (DeToro, McCabe 1997).

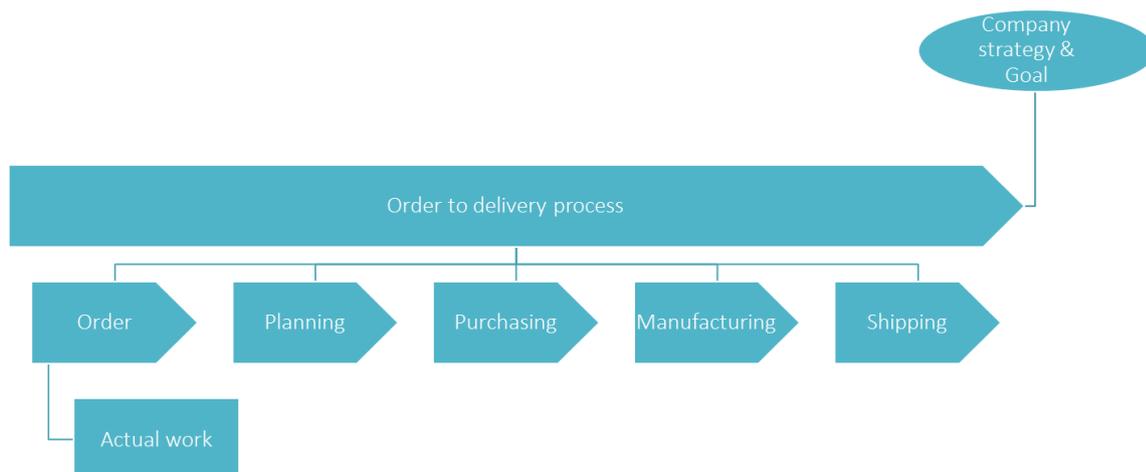


Figure 6 presents the horizontal organization chart for the core process from order to delivery. By breaking down the organization processes from the overall company strategy and goal it is possible to evaluate how the actual work is and should be conducted to achieve these goals.

3.1.1 Business Process

The European standard EN ISO 9001:2008 defines a business process as *“An activity or set of activities using resources, and managed in order to enable the transformation of inputs into outputs, can be considered as a process. Often the output from one process directly forms the input to the next”* (SIS 2009). This means that processes should have beginning and an end, receive and process input to provide a pre-specified output, this is of course done every day everywhere, literary every string of actions can be viewed as a process. Business processes however focus around creating value for customers. Processes therefore exist on all levels of an organization. It is clear that business processes today are a strategic asset not unlike patents, copyrights, trademarks e.tc. (DeToro, McCabe 1997). However not all process in an organization creates hands-on actual value to the customer and it is common to list business processes under the following three types:

1. Operational or core processes are processes of high strategic importance and high impact on customer satisfaction
2. Management processes are processes designed to process information from internal processes and external factors in order to evaluate strategic planning, risks e.tc.
3. Supporting processes support the operational and management processes with information or material e.g. IT, Accounting, HR e.tc.

Core processes are of most strategic importance to a company, they are essential for business get done and have an ability to archive the company’s vision, goals, objectives, and mission. They are usually cross-functional, produces an output, have a high impact to the organizational success, and customer satisfaction (DeToro, McCabe 1997). The core processes demonstrates how work gets done at the company. In small companies and companies that grow rapidly these processes is usually developed ad-hoc when they suddenly are required. This often seems like a good idea at the time but will most often require substantial fire-fighting to deliver the specified output. This can often be related to the process being unclear and the supporting and management processes not being in place to assist the core process. Management processes are the control program for both supporting and core processes. The output of management processes is often quantitative such as a KPI. But it can also be reports, presentations and discussions, and any type of communication of suggestions and actions for how to create improvement and highlight good performance. The management processes therefore have a high impact on the core processes. Not only because it is impossible for them to measure every aspect of a process which means that the process responsible of course will optimize the process to give good values on what currently is being measured. Management processes are often the basis for the rewards and incentives. By stimulating workers with various monetary material and psychological rewards the employer can enhance productivity, quality, knowledge, collaboration, leadership, and other positive qualities in the company (Soffer, Sadiq et al. 2012). This can have the opposite effect as well if the incentives and measurements are poorly set up. Gardner (2002) suggests acknowledging activities but reward results. By this he means that change for the sake of change is not necessarily good and that results that generates measured improvement is what counts in the end. Supporting processes are generally all processes that are required to keep the core processes operational. For

example staff to run the machines, material to put into the machine, dispensing of paychecks e.tc. The performance of these processes will also highly effect the overall effectivity and effectiveness of the core processes and there through the organization.

All types of processes have a direct effect on each other. Information is important between functions and departments. If changes are made in either process this must be acknowledged early on so actions can be taken to assure performance. A company that continuously works with its processes has a better chance to catch disturbances early on, and therefore have a better chance of dealing with it in the best way. Figure 7 presents the relationship between business processes and the strategy and overall business goals set for the organization. To better be able to understand business processes Weske (2012) presents the following classification:

1. Organizational versus operational
2. Intra-organizational processes versus process choreographies
3. Degree of automation
4. Degree of repetition

Organizational business processes are high-level processes that are typically specified in textual form by their inputs, outputs, expected results, and their dependencies on other organizational business processes (Weske 2012). An example can be how to manage raw material from a set of suppliers. The organizational business processes more or less defines the structured and boundaries for how the company should achieve the organizational goal. These organizational processes are built up by operational business processes that specify the activities and their relationships. Implemented business

processes are how the actual work is executed. This can be exemplified by the building of a skyscraper, let's say that a company wants to build the world's tallest sky scraper than this would be the business goal. The architectural drawing that shows the building, how high it should be, and number of floors represents the organizational business processes. The technical specification and drawings for where plumbing, beams and all components that requires for the building to work is similar to the operational business processes. The implemented business processes will tell you how and who will put it together, as well as where and when.

Just as it sounds intra-organizational business processes are processes that are conducted from input to output within the same organizational, and the focus should therefore to be to make the process as efficient as possible. For business processes that interact between organizations and form choreographies it often get more complex. Not only is the

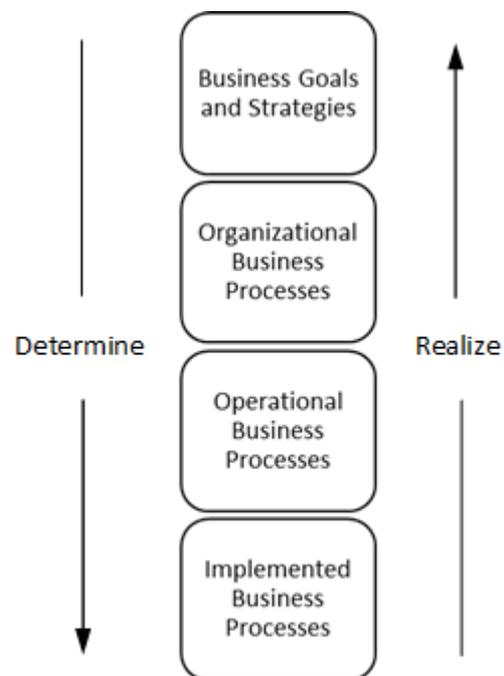


Figure 7 presents the relationship between business processes from overall organizational goal to implemented business processes. (Weske 2012).

communication (often) more difficult and time consuming. There is also need for additional negotiation, legal matters and technical specifications.

Automated business processes are processes with no or very limited human interaction while operating. Most online purchases are directly linked to a warehouse, once a purchase is approved a pick list is printed for the workers in the warehouse. All automated processes require some kind of manual trigger for them to start and are usually developed for processes with high degree of repetition.

As discussed about the automated business processes a process can be classified according to its degree of repetition. For some years now in Sweden groceries stores have introduced automatic scanners for customers to scan their own groceries. Before leaving the grocery store customers simply connect their scanner to a computer and pay the amount shown on the screen. This has been a large investment during a long time for the companies to make this work but because of this they have been able to reduce labor cost and expect to make money in the long run. Processes with less repetition for example designing and building custom luxury yachts or other industries with the low quantity and large amount of selections would make an automated process too expensive.

To understand a business process there are several aspects to consider. Take a management process that gathers and compares data from a production process can be viewed as intra-organizational. However to further analysis it is probably of high interest to try and draw conclusions and compare it to the competition. The idea of having a business process approach is to visualize relationships, understand how disruptions and changes will affect the bigger picture and from there draw conclusions to how goals can be achieved or discovers new opportunities.

3.1.2 Business Process Development

The main focus of business process management is not just to identify and classify its processes. The idea is of course to improve efficiency and effectiveness. In order for companies to adopt and maintain competitiveness in globalization and fast pace changing environment, the need has arisen to become more efficient through process and cost optimization (Vagadia 2012). While there are plenty of business process development models to choose from. Before picking a model and hope for dramatic improvement it is important to think through what's actually being improved. In his article Gardner (2002) presents several business improvements tips to be able to achieve sustainable process change. He also addresses the importance of having a goal in mind, not only to reduce the risk of sub-optimization but also to set up a clear purpose, goal, and a framework for how to work. The idea is to develop a clear view of the project, how much will have to change, what effects it will have, and what resources in time and knowledge it require.

Within business process development there are two main factors that separates process improvement projects between each other; time and expected results. The time or pace of change can be either rapid, normally one day to a few months, or continuously ongoing. The degree of change can either affect an incremental or substantial part of the organization. Both process innovation and improvement require significant organizational and behavioral

change to be successful (Davenport 1993). They also require substantial efforts and investment in time. Continuous improvement require time consuming training and cultural change, process innovation typically require time for construction of new information systems and organizational structures (Davenport 1993). The expected results for continuous improvement might be 10-20 percent improvement per year while process innovation aims for up to tenfold this result. As shown in Figure 8, process improvement and process innovation can work together to create an S-shaped curve. This curve does however tell very little about when it is time for a new business innovation project. To determine that is dependent on the organizations own strategy and market position as well as the competition. DeToro and McCabe (1997) provide a 5 level framework for rating a process based on its effectiveness and efficiency see Figure 9:

1. World class – the organization is recognized as a functionally superior by customers and competitors. Often benchmarked by other organizations.
2. Best in class – the output exceeds customer expectations as well as the processes outperform the competitors.
3. Competitive – The organization meets all the customer requirements and internal requirements such as cost quality, return on asset, and cycle time. Since the company is competitive improvement paths can be either continuous improvement or process innovation.
4. Noncompetitive – This organization does not satisfy customer or internal requirements, a possible improvement path would be to redesign or replace the processes.
5. Unhealthy – The organization is ineffective, inefficient, and at risk of failing. An improvement path would be to replace its processes.

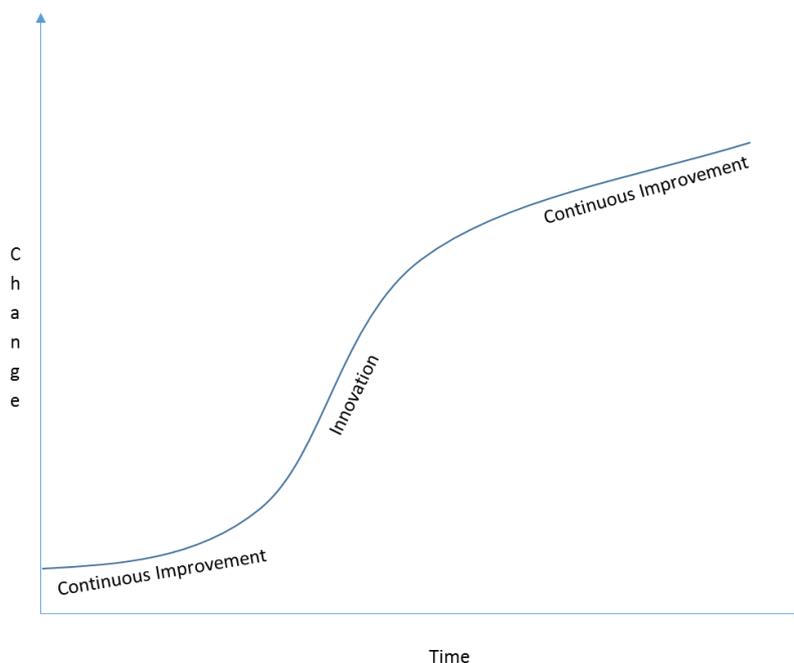


Figure 8 the combination of continuous improvement and process innovation can look like an S-curve.

Efficiency	Process condition				
Process is defect free there is low unit cost, short cycle time, no waste, and low cost of pro quality					World class
Process is efficient, costs are low, waste is low and cycle time has been reduced					Best in class
Process is operating fairly efficiently, but has room for improvement in cycle time and unit costs					Competitive
Process is inefficient and needs improvement					Non competitive
Process has major problems with defects, waste, long cycle time, high unit costs, staffing and procedural issues, and high cost of poor quality					Unhealthy
	Outputs do not meet customer requirements	Outputs meet some customer requirements	Output meet customer requirements	Outputs exceed some customer requirements	Outputs exceed most customer requirements
	Effectiveness				

Figure 9 describes the process categories presented by DeToro and McCabe (1997)

A company that strive to remain as the market leader by providing world class manufacturing needs to constantly re-innovate itself and its processes. This comes with the high risk of losing track of what changes actually translates into results and it is also expensive. Companies that have a more cost leadership strategy on the other hand run a larger risk of being non-competitive due to outdated processes. There are several other models for determining process maturity, the framework presented above was chosen based on the well-defined steps that create a 20 square matrix that easily shows, and compare processes and process improvements.

3.1.2.1 Models & Modeling

As discussed in section 3.1 it is currently impossible for companies to keep track of all actions required for its products to go from raw material to end customer and finally destruction/re-cycling. However by having a business process management approach, it will help to keep track of the processes that directly affect the organizations performance. Figure 10 presents the relationship between processes with internal and external stakeholders. As we can see the intra-organizational process, business process 2, is still influenced by external requirements such as customer demand and supplier performance. The relationship between companies is typically determined by contracts such as sales orders that define ownership hand-off and delivery date e.tc. For the internal process they are mostly regulated through policies and performance measures that are descending from the overall business strategy.

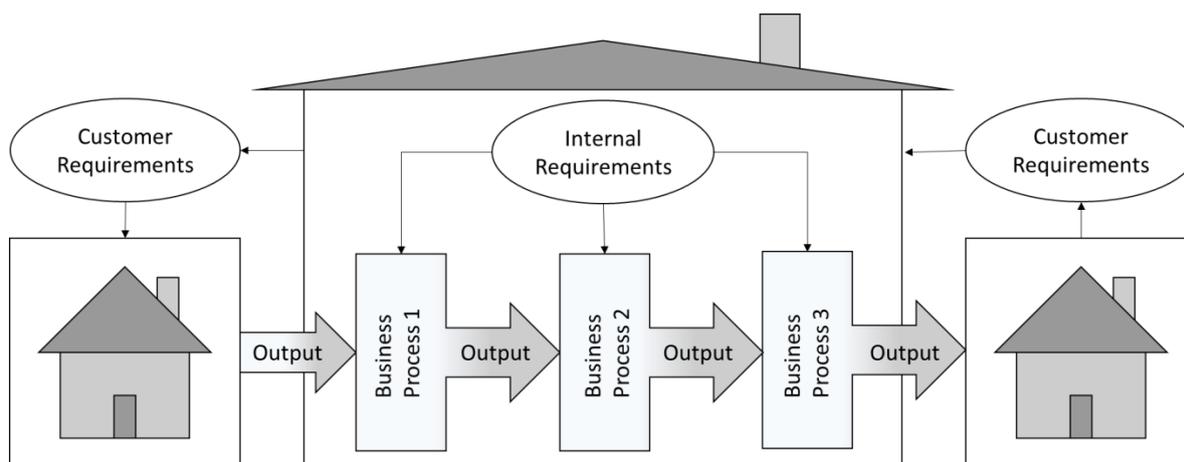


Figure 10 relationship between intra-organizational and process choreographies (Weske 2012).

In reality it is a lot more complex than presented in Figure 10. In most cases there are several suppliers involved as well as several customers that all compete to outmaneuver each other. But Figure 10 illustrate that in order for the final customer to get the required output, the entire string of events needs to take place. The customer itself is mostly interested in the product itself and when it can be delivered. To achieve high performance all actions and processes must fall into place to achieve customer requirements and company goals. By actively working and visualizing the value chain will increase a company's flexibility to not only streamline the internal operations but be ready and able to handle disturbances.

There are several models for process development and improvement available today. Especially have management consultancy firms realized the lucrative opportunity to sell process improvement project. However improvement competence must be grown organically (Gardner 2002). This means that while it can be helpful to get an outsiders perspective an organization cannot just hire consultants that implement some tools and expect dramatic improvements. Process improvement requires time, knowledge and understanding from everybody involved. Depending on the scale of the project effects will not be shown until the people working in the process has gotten accustomed to their new roles. Not all people are happy to change which is why it may require substantial management push. Since there are a vast amount of models to choose from conclusions can be drawn that there is no model that fits all. Companies have unique processes, culture and employees each company has to develop its own way of working with its processes. To get the width of different process development methods this study will present three different frameworks for process development. The first framework, see section 3.1.2.1.1, is developed by Weske (2012) it is actually more a framework for how processes should be designed to develop other processes. It does however in a good way encapsulate the different levels of process improvement and how changes at different levels affect each other. The second framework has a more hands-on approach and is developed by Rummler and Brache (1991). This model is a bit more directed towards manufacturing companies and is built up by ten steps of working procedures. For several companies certification is an order qualifier and ISO 9001 is for many companies a requirement, including the case-company, which is why this study also examines how they suggest companies work with process

development. The ISO framework is not directed towards a specific set of processes but according to them can be applied everywhere.

3.1.2.1.1 *Weske Methodology (2012)*

Rather than presenting a formal method for describing development processes we use an informal notation, in which phases are presented by boxes and dependencies between phases by arrows (Weske 2012), see Figure 11. His methodology starts from the strategy and organization phase when high level officials identify the key processes for achieving a particular business goal. For each required process a process owner should be determined that together with a team are responsible to improve the performance of the process.

The process landscape is very similar to Figure 10 by identifying the key relationships between processes, customers and suppliers a set of dependencies can be identified to assure that no sub-optimization is allowed.

From phase three all remaining phases should be conducted for each identified business process and should start with the process design. In this step it is important to look at the process itself. The controlling operations are a good start but how the actual work is being conducted and the effects of it also need to be understood. When designing the process it is important to take customer value into consideration and focus on the activities that produce customer value. In this phase a set of metrics should be designed based on suggested changes in order to evaluate whether the implementation was a success.

The process implementation is not just about going out and implementing the changes. To be able to evaluate the changes and make sustainable change this must be done with consideration to organizational aspects as well as technical aspects of the project. It is important not to forget the implementation of measures from the previous phase as well.

The daily business of the organization is conducted during the operations and controlling phase by executing business processes (Weske 2012). The measures provided from the operational processes are evaluated by the process team. Disturbances and negative results are assessed by the team that comes with suggestions to improve performance.

3.1.2.1.2 *Business process improvement according to Rummler and Brache (1991)*

To better get an understanding of how business process improvement can be conducted as well as what steps that need to be in place, already in 1991 Rummler and Brache presented this hands on model for business process improvement:

1. Identify a critical business issue – senior management has identified a current or potential problem or opportunity with measurable goals.
2. Select critical processes – identification of one or more cross-functional processes that have the greatest potential to resolve it.

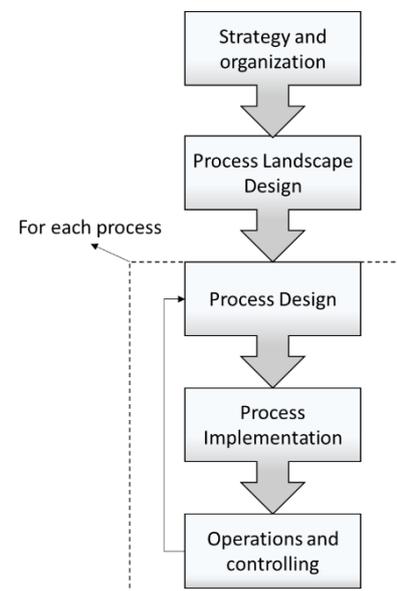


Figure 11 business process improvement according to Weske (2012)

3. Select a leader and team – dividing responsibilities is a key goal for process improvement and to be able to easier achieve sustainable process improvement, change (and the preferably the leader) should come from within the company.
4. Train team – the team members need to have a basic understanding of process improvement tools.
5. Develop “is”-map – develop a map that describes the current situation
6. Find the disconnects – a disconnect is a missing or illogical factor that could affect the critical business issue.
7. Analyze the disconnects – find the cause of these disconnects and develop suggestions for how these causes can be handled
8. Develop “should”-map – create a map that describes the how the process can achieve its goals.
9. Establish measures – develop a measurement system to know if the goal has been met.
10. Recommend changes – create an action plan for how this can be implemented.

Looking at both models from Rummler and Brache, and Weske it is easy to see similarities such as they stem from a high-level decision within the organization, propose that improvements should be led through a team with required competence, and highlights the importance of measurement. While Wreske keeps a more general approach to the improvement itself Rummler and Brache is focused on the cross-functional gaps to improve hand-offs. To be able to approach inefficiencies within process development they advocate the use of two maps; “Is”-map and “Should”-map. An “Is”-map is not a map that can be drawn by managers in a board room. It requires observations to draw the actual current situation of how the work is conducted. This is to identify not only functional gaps but also gaps between the actual work and the policies stating how the work should be conducted. A “should”-map is then a map drawn based on the “is”-map that shows changes in order to improve the overall system.

3.1.2.1.3 ISO 9001:2008

Depending on the industry for an organization to be allowed to sell or even manufacture their products it is not uncommon that different certificates are required. This can for example be to show that the products are of high quality or manufactured in an ethical way. This can be required not only by customer but legislation as well. A typical industry that requires a lot of certification is the pharmaceutical supply chain. For the manufacturing industry ISO 9001 is a common requirement. ISO 9001 is the requirements for ISO certification within quality management systems. This is not a study that examines how companies can achieve ISO certification therefore the focus is on their method for process development.

The international standard promotes the adoption of a process approach when developing, implementing and improving the effectiveness of quality management system, to enhance customer satisfaction by meeting customer requirements (SIS 2009). They propose the PDCA-Cycle that as they claim can be applied to any process, see Figure 12. The different steps of the cycle are described as follows:

- Plan – Establish the objectives and processes necessary to deliver results in accordance with customer requirements and the organizations policies
- Do – implement the processes
- Check – monitor and measure processes and product against policies, objectives and requirements for the product and report the results
- Act – take actions on continually improve process performance

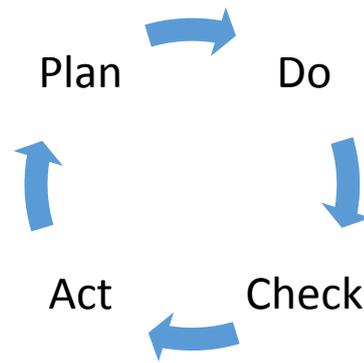


Figure 12 PDCA- cycle, Plan, Do, Check, and Act. (SIS 2009)

There are of course further descriptions for how process development should be conducted according to the ISO regulation. However as rather neatly presented in Figure 12 this four step model does encapsulate all steps from both Wreske, and Rummler and Brache. Starting from a high-level decision based on a hoped future result, to implementation, measure results and proposing changes to improve further.

3.2 Process mapping

As discussed all through chapter 3.1 identification and visualization of processes is key to business process management and the easiest way to understand a complex environment is of course to draw a map. Process mapping is a crucial step within process development to understand how the current work is conducted. Process mapping can also work the other way by creating an understanding for how the work should be conducted. Just because an executive at a company has decided that a product should be manufactured a certain way does not mean that the workers actually are working accordingly. If the current way of working is not visualized and understood properly the performance metrics may not tell you what you think and trying to improve them might not give the expected results. As business process management stretches through all levels of a company, different mapping methods have been developed with different goals in mind and to describe different levels of the company. Presented below are four different mapping methods with different scopes. A common mistake when using mapping today is the use of the wrong mapping tool at the wrong level.

3.2.1 SIPOC

SIPOC Stands for Supplier, Input, Process, Output, and Customer. Suppliers and customers can be both internal and external. It is a high-level map for visualizing large processes and its processes steps of interests and all of its stakeholders. Stakeholders can be actual customers and suppliers to the company but also functions such as purchasing, logistics, production, sales e.tc. By doing this it becomes easier to understand what types of knowledge is required within the process development team as well as it shows the boundaries from where an output from one process becomes an input to the next. Presented below are five statements/goals for why a SIPOC map can help in business process management:

- Determine the relevant process outputs and identify their recipients/customer (Meran, John et al. 2013)
- Guarantee a uniform understanding of the process to be improved (Meran, John et al. 2013)
- Understand what inputs are required to attain the correct output (Parkash, Kaushik 2011)
- Develop team purpose or mission (Parkash, Kaushik 2011)
- Select a core process to redesign (Parkash, Kaushik 2011)

By examining the five statements presented above it becomes apparent that while the process is the basis the actual focus of the SIPOC map is not to look at the process itself but rather the environment that it is operating in. Even if a SIPOC can help to create well-defined boundaries and scope for a project it cannot change the fact that all processes operates in a larger context and is affected by it. The SIPOC map is conducted to understand how the context might respond to changes done in the process itself.

To create a SIPOC map, start by defining the “start and stop signal of the process” and mark them as events (Meran, John et al. 2013). In Figure 13 this is defined by the squares marked “Order processing” and “Transport”. As shown in the Figure both internal and external customers are identified. This is to see both inter-company interaction as well as cross-functional activities is identified. The main process should be described in about five to seven steps for not going in to too much detail, and match the input and outputs. Suppliers and customers are defined as “whos”, input and outputs are “what’s” and the processes are “how’s” (Parkash, Kaushik 2011).

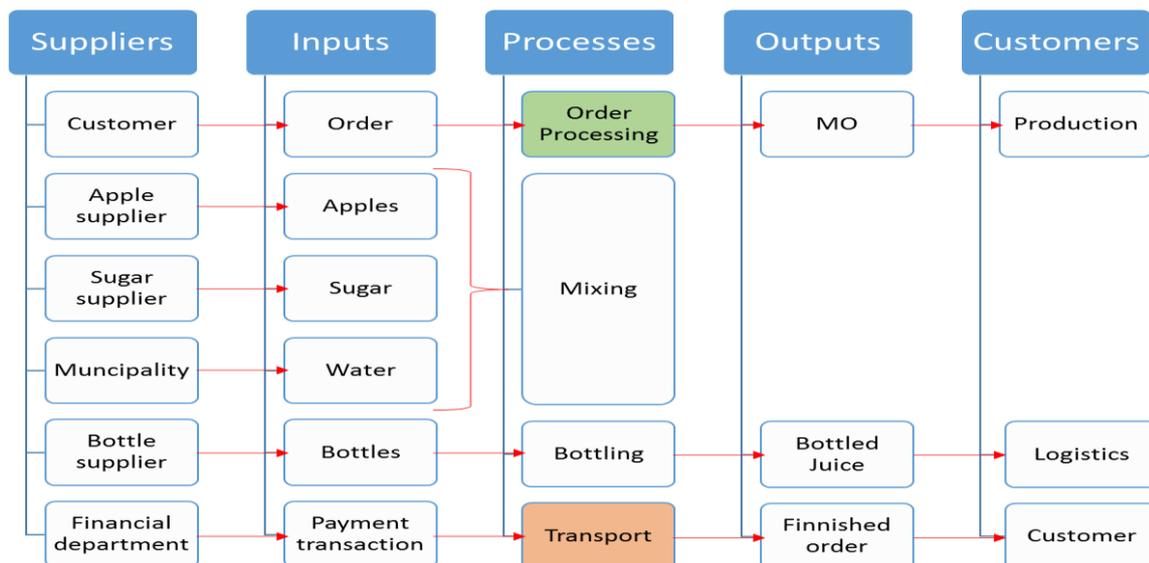


Figure 13, a SIPOC diagram over the juice making process. The process starts with the order processing of an order from a customer. The order then goes through mixing which requires ingredients, bottling which requires bottles and the final step is transportation which requires payment approval from the financial department.

When evaluating the SIPOC map, start by evaluating the customers, “Who are they?” and “What do they want?” by doing so it is possible to assess the outputs and whether they

meet the specification and are competitive. It is the customer requirements that should focus the improvements of the processes. SIPOC is commonly used to develop a list of processes, and then select one or more to improve (Parkash, Kaushik 2011). If drawn on a wall with post-it notes it offers the opportunity to see a clean pictures as well as easy to change, it also allows for the entire team to see the same picture. By coloring or red-flagging processes that need improvement it is easier to see how the different elements effect each other.

3.2.2 Value stream Mapping

As discussed about the SIPOC map in the previous chapter the focus is rather the surrounding context than the actual process. To link information between the process and the context there is need for a map that still visualizes external stakeholders but also provides information about the process itself. The Value Stream Map (VSM) was developed by Toyota as an essential part of their Toyota production system and is an extensive mapping technique. In addition to illustrating the material flow it visualizes the information flow within the same map (Erlach 2013). The underlying idea of a value stream map is to reduce and avoid waste or non-value adding activities. A value stream is all the actions (both value added and non-value added) currently required to bring a product through one of the two main flows essential to every product (ASME 1947, Rother, Shook 1999):

- The design flow from concept to launch.
- The production flow from raw material to customer

The focus of this study is products that already are on the market. The theory in this chapter will therefore focus on the flow from raw material to customer. However to follow a product from the source of raw material to the final customer is in most cases impossible. This is why VSM usually is focused within in a facility. The answer to the question “*What does your factory look like?*” is generally answered with a photograph and a map of the factory layout (Erlach 2013). This tells us nothing about the quality of the factory and is where the VSM comes in handy.

A VSM is a medium to high-level of mapping, the focus is on product families with similar processing steps instead of individual products, and each of the different product families has a separate VSM. According to Rother and Shook (1999), a VSM project usually follows the steps shown in Figure 14, once a product family is selected the mapping of the current-state begins. Based on the current-state you can formulate a future-state map with improvements and solutions to found issues. When the future-state is decided, an implementation plan should be actively used, however since the current-state and future-state are overlapping, it means that this requires actively working on a

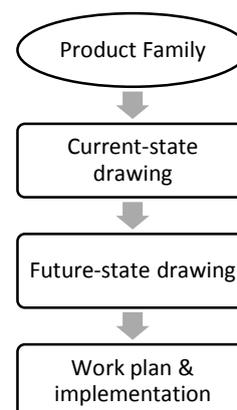


Figure 14 the first step in implementing a VSM at a facility (Rother, Shook 1999)

continuous basis, the goal is a seamless pull production with no waste and minimum lead-time.

The first step of any VSM project is to identify what product family to focus on. If the product family contains products that only share a few processing step the map will be hard to read, however choosing to map individual products is not ideal either since similar products may be produced in similar production processes from mostly similar raw materials and the production procedures are better joined in one value stream (Erlach 2013). A product matrix can help categorizing the products, see Table 4. By listing all the products on the X-axis and all the processing steps on the Y-axis it makes it easier to group products with similar processing steps together.

Table 4 product matrix based on Rother and Shook (1999). By listing all products, and operations it is decided that product A and D are in the same product family, and B and C are in the same.

Manufacturing and assembly steps

		1	2	3	4	5	Product Family
Products	A	X		X	X	X	PF I
	B	X	X	X		X	PF II
	C		X	X		X	PF II
	D	X			X	X	PF I

3.2.2.1 Current state map

Once a product family is chosen it is time to draw a current-state map. Rother and Shook (1999) suggest that this is best done by hand on an A3 sheet of paper as you walk-the-flow, door-to-door. Walking the flow is not just about visualizing the flow but also to collect primary data straight from the process itself. In order to know what data to collect it is important to have a purpose for the project. Rother and Shook (1999) presents standardized symbols to describe the different activities, see Appendix E. By placing the Supplier in the upper left corner and the customer in the upper right corner of the paper, there is room for planning and production activities in the middle of the paper. This will also give you a structured overview of the information flow travelling from right to left and the material flow from left to right, see Figure 16.

<ul style="list-style-type: none"> • Cycle time • Change over time • Uptime • Production batch size • Working time 	<ul style="list-style-type: none"> • Number of operators • Number of product variations • Pack size • Scrap rate
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Figure 15 shows commonly used metrics for VSM

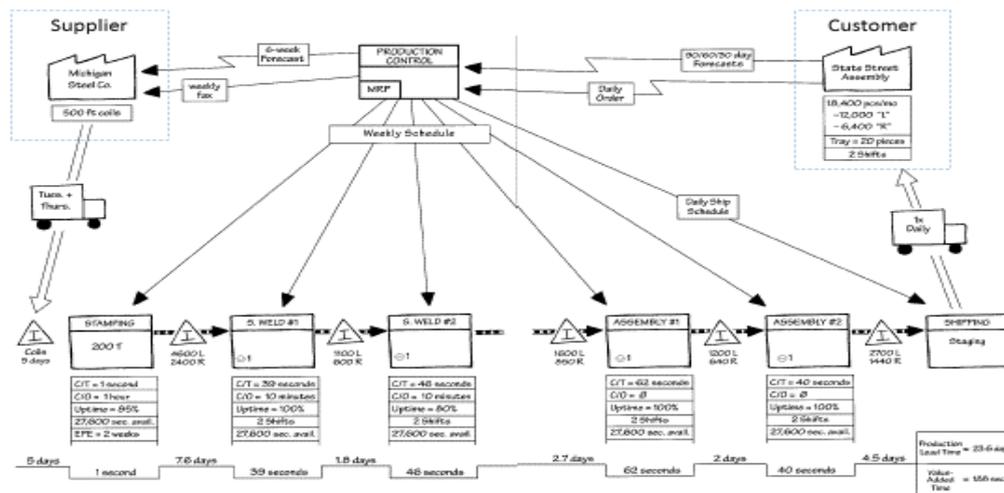


Figure 16 A current-state value stream map that shows the production flow as well as information flow (Rother, Shook 1999).

Figure 16 describes a current-state VSM presented by Rother and Shook (1999). Since the point of a VSM is to improve performance by identifying value adding activities as well as non-value adding activities. Traditionally the idea is to remove the non-value adding activities. However one could of course argue that a process with only value adding activities still can improve by developing the value adding activities. To be able to identify non-value adding activities or waste Figure 15 presents common metrics that can help and identify waste in a production process. For example change over time is non-value adding time, different cycle time for operation steps will create bottlenecks and unnecessary inventory e.tc. Based on the process environment and the objectives for the project different metrics needs to be compiled. To help understand what metrics is necessary for a project Erlach (2013) lists the following eight common waste issues:

1. Overproduction – In value stream mapping, it is about the balance of the production process. Over production is related to all production conducted, earlier, in larger amounts, or faster than required. Overproduction is a common result of poor line balancing.
2. Stockpiling – While the cost of high amount of inventory should be reason enough to consider a just-in-time approach. The main problem with stockpiling is that it hides the problems in the production and therefore prevent the elimination of the problems.
3. Conveyance – An inefficient layout may increase the length and frequency of transport routs as well as interruptions of partially finished orders may increase the transport efforts.
4. Rejections – Waste through production of rejections are among the most expensive to deal with. This is not just non-value adding but value destroying. If the source of the issue is not identified immediately all value adding activities that are following may also be ruined. Goods that are rejected by a customer may affect the company’s reputation.
5. Motion – Inappropriate motion can result in efficiency loss.

6. Processing – Adverse processing procedures are common in production today. Machines having to be prepared or set-up before production as well as unsuitable technology/equipment.
7. Waiting time – There are two types of waiting time, lack of material, and operators with no specific task. In these situations it is important prevent activities covering the efficiency issues.
8. Order processing – Is not directly related to production processes, however most VSM clearly points out possible deficiencies in order processing, materials management, production planning, e.tc. This is often related to intercompany software being unable to speak to each other.

Finding issues in a production process is generally speaking easy. But to construct and develop the ideal production is of course extremely difficult. Just to get production and purchasing conducted just-in-time without any safety stock is almost impossible. There are too many factors to consider for example elimination of unscheduled downtime, perfect forecasting as well as fast response time to inventory. This is just for production, there is no guarantee that the manufactured products will sell. In reality there will always be a need for some safety stock. But with the right tools and planning that safety stock can be limited. The point where planning is scheduled is called the pacemaker process, because how production is controlled at this process sets the pace for all the upstream processes (Rother, Shook 1999). In order to keep a constant lead time all process downstream of the pacemaker process need to be as a direct flow.

3.2.2.2 *Future state map*

Based on the analysis of the current-state map it is now time to draw the future-state map. Rother and shook (1999) provides the following key questions for drawing the future state map:

1. What is the tact time, based on the available working time of your downstream processes that are closest to the customer?
2. Will you build to a finished goods supermarket from which the customer pulls or directly shipping?
3. Where can you use continuous flow processing?
4. Where will you need to use supermarket pull systems in order to control production of upstream processes?
5. At what single point in the production chain will you schedule production?
6. How will you level the production mix at the pacemaker process?
7. What increment of work will you consistently release and take away at the pacemaker process?
8. What process improvements will be necessary for the VSM to flow as your future-state design specifies?

Understood from the questions above VSM is about creating a seamless flow from where an order comes from the customer and the order being released to manufacturing with just enough time to get it done and shipped to the customer at the delivery day. The process should be scheduled at one point and all process steps before and after should respond to

this process. When drawing the future state map it is important that it is drawn similar to the current state map so relationships can be understood. This can help to understand what actually needs to change but also save resources in demonstrating what can be preserved.

3.2.2.3 Work plan and implementation

“VSM is only a tool, unless you achieve the future state that you have drawn, and achieve parts of it within a short period of time, your value stream maps are nearly worthless” (Rother, Shook 1999). In most cases it is not possible to implement all changes to achieve the future state immediately. One way to look at the future state map is as a series of loops, see Figure 17. These loops can be implemented one by one, the most downstream loop is the pacemaker loop it affects the flow of all upstream loops between pull-systems. This is a continuous process; a VSM should be followed by a clear action plan with measurable goals that sets a path for future improvements.

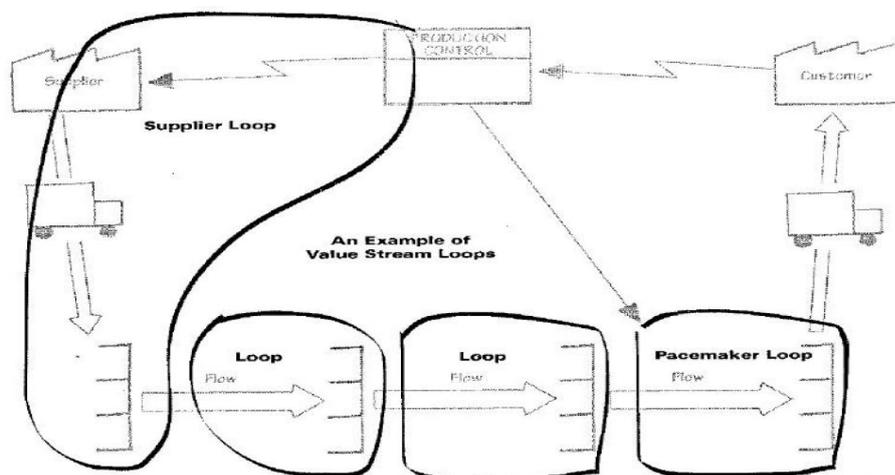


Figure 17 One way divide the implementation plan is to look at the map as a series of pull-loops (Rother, Shook 1999)

3.2.2.4 Limitations

A VSM analysis does not, despite its name, consider the value of the products nor the price. Different purchasing strategies can for example give economies of scale which the VSM does not take in to consideration. In order to get a sense of the actual value of the products a VSM could be combined with a total-cost-of-ownership analysis. When comes to choosing what improvement projects to focus on an activity-based-costing analysis could give away some low hanging fruit. To choose what product families to focus on a SWOT analysis or the BCG-matrix can give input from the market perspective.

3.2.3 Flowchart

A process flowchart is a graphic representation of the sequence of all operations, transportations, inspections, delays and storages occurring during a process or procedure (ASME 1947). It is a device for visualizing a process as a means of improving it. To further compliment the VSM and the SIPOC that presents the process in a series of high-medium-level steps a flowchart visualizes the actual work. For example a VSM doesn't necessarily consider replenishment levels or quality approval procedures. These are two types of procedures that a flowchart can assist the VSM. A flowchart is therefore a map that should

be used for a narrow and precise scope. To conduct a flowchart Meran, John et al. (2013) describes the following steps:

1. Determine start and stop points by using a high-level map
2. Identify the process steps with the help of brainstorming before drawing up the actual chart
3. Sort the process steps according to their actual sequence and include any information gained from process inspections or walk-throughs with respect to the process steps
4. Include decision steps, branches and any loops
5. Mark known weak points (waste)

These steps confirms that just like a VSM or a SIPOC map a flowchart requires specific boundaries, however the narrow scope is what separates this map from the other. Figure 18 presents a typical flowchart map. A flowchart can also be used as a control diagram to monitor that the current work is done in the right way., for example by setting up decision points or control points along the way. When it comes to implement change and/or describe change the flowchart can provide an easy and assessable way of communicating the changes throughout an organization.

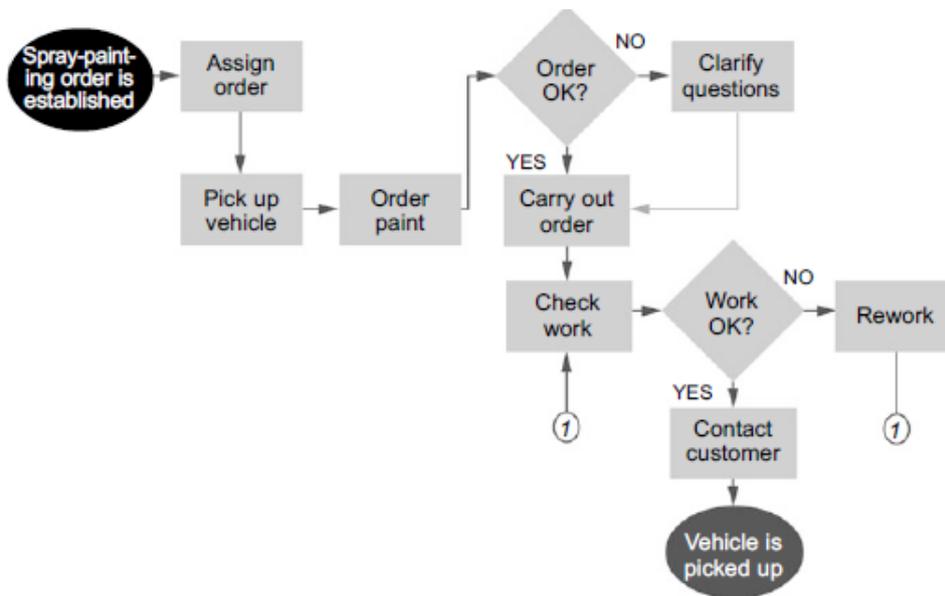


Figure 18 a flowchart of the process of re-spray-painting a car (Meran, John et al. 2013)

3.2.4 Spaghetti diagram

A spaghetti diagram is a map that illustrates actual movement for example within a warehouse in contrast to a flowchart that describes the actions. By plotting the actual movement gives a deeper understanding of how the actual work is conducted. Based on the situation the scope can vary for example being the overall material flow, following the movement of a truck driver for a shift e.tc. The goal is to identify suboptimal motion as well as optimize the layout in order to optimize value adding activities (Meran, John et al. 2013).

A spaghetti diagram can also help to illustrate how changes will work in reality and gives a direct understanding of how the new system is going to work physically and show the changes it in a familiar environment (e.g. the production layout).

Meran, John et al. (2013) provides the following procedure for making a Spaghetti diagram:

1. Draw the layout of the relevant area including all objects
2. Draw all movements of material, tools and employees and mark them in different colors
 - a. This step is not supposed to be drawn at a desk thinking “it should-be like this”, it is crucial to draw the actual movement of the object that is in focus
3. Already recognized weak points (waste) are to be marked, routes which are critical with respect to efficient procedure, e.g. because of intersections of foot paths and traffic ways, traffic jam or dangers are to be highlighted

As the procedure above suggest, much like the VSM, the idea with a spaghetti map is to examine how the actual work is conducted in reality and identify are bottlenecks and other issues. Visualizing the physical flow of the process gives input to how the company is organized. If operators have to go around looking for the right tools during a change-over it can be derived to a fault in the tool management system. It can of course also be related to a careless operator but if the issue is observed for several operators then this can probably be ruled out. Another example can be seen in Figure 19 that shows the movement of two forklift drivers. By looking at the map it is easy to identify the risk for conveyance at the door, striped in yellow. By looking at the actual movements it shows that the truck drivers has to go around a lot in the warehouse. It might therefore be interesting to look at the different components in the warehouse and compare how often it is picked with distance from the door. This can dramatically improve efficiency.

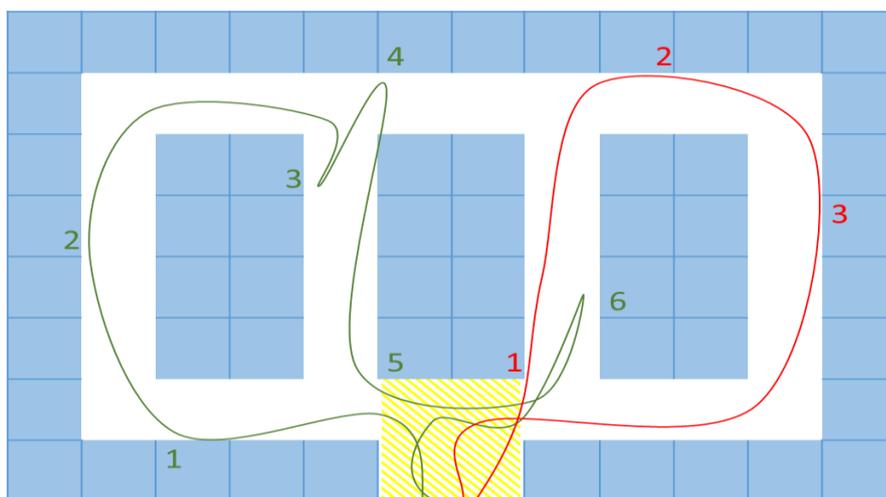


Figure 19 spaghetti diagram of a warehouse, the green and red line are the movements of the forklift drivers, the yellow marked area is high-risk area due to the high traffic load.

3.2.5 Relationship between process mapping methods

This section is an analysis of how the different mapping methods presented in this chapter relates to each other, their intended scope, and level of detail. An overview is presented in Figure 20 that illustrates a company’s organizational process from supplier to customer. By

examining Figure 20 it becomes apparent that a process map either has a wide scope or a high level of detail.

A wide scope is useful when the goal is to examine the larger picture, in this case from supplier to customer. This will give input to how the process works on an overall basis and help to set up goals and larger problems to handle. It does not tell anything of what specific issues needs to be handled to achieve these goals.

Mapping with high detail will provide deeper understanding about the issues within the process. However if this is attempted with a wide scope it will require huge amounts of data. Having a lot of data is difficult to structure and analyze as well as to evaluate whether the data is trustworthy which can further compromise the analysis. Another problem with mapping a large process with high detail is that it becomes difficult to understand the relationship between the changes and the overall process. If this is not understood properly it is impossible to evaluate if the changes will improve overall efficiency or just sub-optimize the process. This is why Figure 20 was developed to increase the understanding of when to apply a certain mapping method.

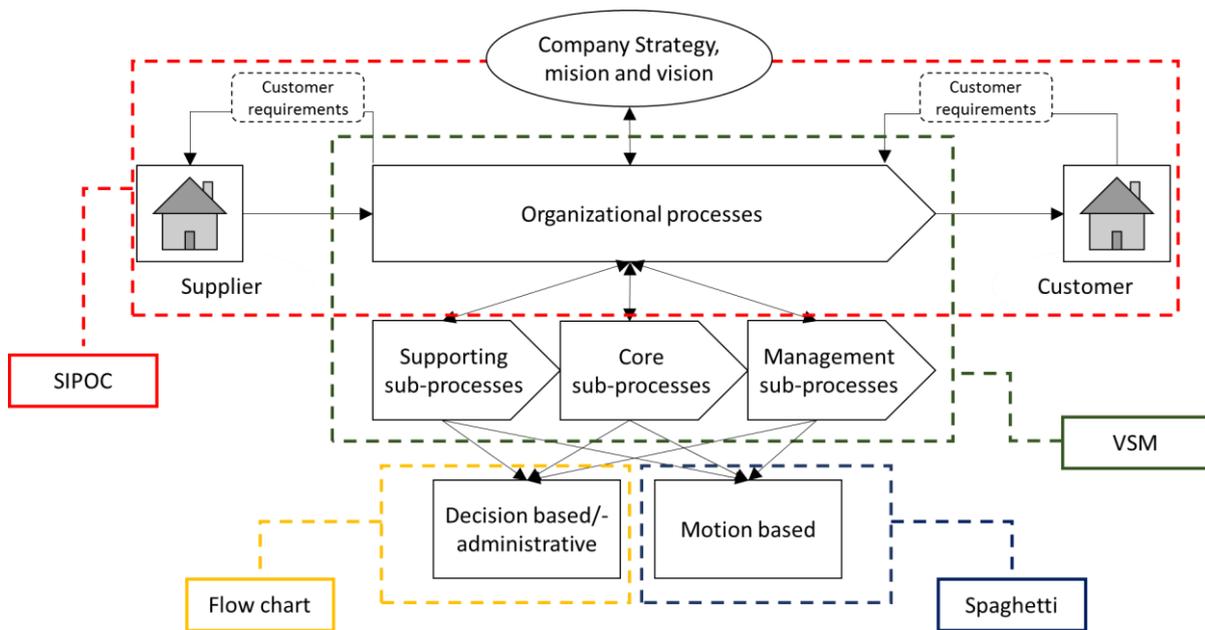


Figure 20 Model of the concluding relationship and scope for the presented maps.

Out of the four process maps presented in section 3.2 the SIPOC has the widest scope and therefore also the lowest level of detail. It is more a visualizing tool that identifies the different stakeholders as well as the very important hand-offs between stakeholders. It has the advantage to take qualitative information from external factors as well as the process itself and structure it in a way that makes it easy to overview. The SIPOC map also identifies the endpoints for the process, in Figure 20 supplier and customer, which makes it possible to examine their interest in the process. It also helps to set the premise for another mapping tool that can further focus on the process, for example a VSM. Everything in-between the endpoints is the scope for the VSM.

A VSM can be viewed as a bridge between the wide scope low detailed maps and the narrow scope high detailed maps. It has the advantage of a wide scope by being able to visualizing large processes. And by grouping similar products it can give a higher level of details than a SIPOC. The underlying idea with a VSM is to identify and highlight issues. By developing a future-state map and connecting it via the endpoints from the SIPOC analysis it becomes possible to understand how the entire system can benefit from suggested changes.

A future-state map is easy to create but hard to realize in reality. The better understanding of how the actual work is conducted the easier it becomes to understand what changes needs to be made and in what sequence. The idea with a model or a map is to describe reality in a comprehensive way. It will therefore always be a gap between maps and models, and reality. By applying maps with high level of details to the identified specific points that have a large effect on the issue in focus can help narrow the gap between theory and reality and give input to how and when changes should be made. This study presents to different types of mapping methods for these narrow scope. The spaghetti map is focused on physical movement while a flowchart maps information and decisions.

Based on the literary review it has become apparent that the idea of a process map is not to visualize the process in its entirety all at once. This would probably result in a process development team figuratively drowning in information. By combining different process mapping methods and step by step breaking the process down a relevant amount of information can be compiled and improvements can be implemented with an overall goal in mind.

3.3 Tools for analysis and improvement

By identifying and visualizing the relevant business processes presented in chapter 3.2 it is almost impossible not to stumble upon several issues that needs attention. In this section, common tools for selecting, analyzing, and handle issues are presented.

3.3.1 Pareto-principle

The Pareto-principle is named after Vilfredo Pareto (1842-1923) who in 1906 discovered that 80 percent of Italy's wealth was owned by 20 percent of the population. The principle is also known as "the vital few" or "the trivial many". It is a well-established empirical guideline. However the rule is still often largely ignored by business, it is in fact one of the basic tools of total quality management (La Rooy 1999). Ever since its introduction, the principle has been found workable in many other scenarios presented below are examples of where the rule can be applied:

- 80 percent of quality related problems are caused by 20 percent of the sources (Murugaiah, Benjamin et al. 2010)
- 80 percent of total sales of a company are originated from 20 percent of its customer (Murugaiah, Benjamin et al. 2010)
- 20 percent of the items in a warehouse stand for 80 percent of the value (La Rooy 1999)

If similar tendencies as stated above can be drawn for issues found within a production process it can give guidance of where to focus the improvements. It can also be used as a framework for what developed suggestions should be implemented first.

The Pareto-principle is usually presented in graphs with bars sorted according to severity, frequency, nature, or source and displays them in order of size to show which problems are the most important. Figure 21 is presented by (Murugaiah, Benjamin et al. 2010) shows an example of the Pareto-principle. In their study they used the Pareto rule to evaluate the vital few and drew the conclusion to focus on the top problem of scraps related to last pieces material scratches. If an exact numerical value cannot be calculate Table 5 presents a framework for how a team can discuss evaluate the relationship between suggestions. The idea is to use a 2x2-matrix that compares estimated potential and required resources. Suggestions that require low resources and high improvement potential are off course the most interesting while opportunities that require a lot of resources and only promise a low potential improvement should be avoided. Rating the improvements must be done with caution to avoid favouritism especially from dominant team-members

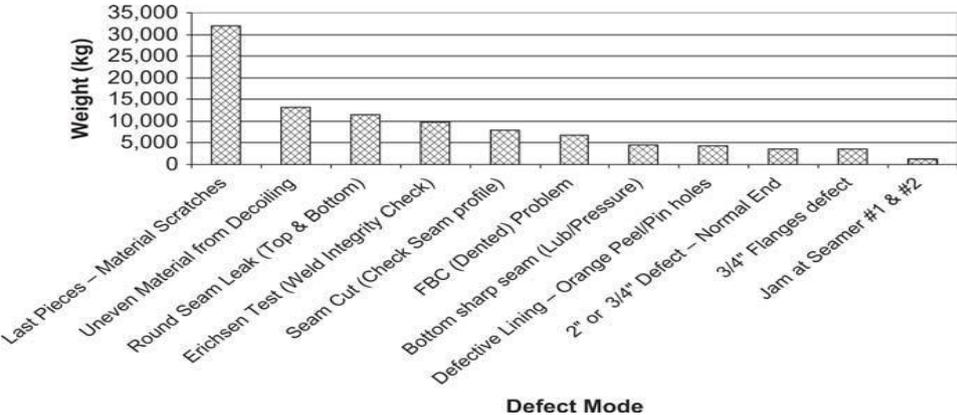


Figure 21 Pareto chart that shows the top ten causes of scrap defects and total weight of barrels

Table 5 matrix for ranking of improvement of issues

Potential improvement	High	The improvements that offer high improvement potential for little resources should be implemented first.	Further analysis is needed to assure the improvement is worth the cost.
	Low	Evaluate the effect it will have on softer aspects as well.	Look for other solutions for the issue.
		Low	High
		Resources needed	

In process development just like product development ideas and suggestions pop out throughout the process. It can be hard and difficult to compile and examine the required data and put together a proper Pareto analysis. The framework in Table 5 can therefore, based on the team’s earlier experiences, produce an estimation of what the project should continue focusing on. For example this study is a master thesis with one responsible student that have weekly meetings with supervisors from Heatex. In this project there is not enough

time to develop suggestions for all issues and completely redesign the production process. So in consensus with managers at Heatex suggested issues were grouped in this type of matrix to determine the continued focus. A Pareto diagram itself was then used for comparing the developed changes.

3.3.2 The 5 Whys

Process development is not about treating symptoms but to find the cause of these symptoms and eliminate it. By eliminating the root-cause instead of symptoms it prevents the symptoms from popping up again (Adams 2008). To identify the root-cause of an issue, a five why analysis is commonly used within LEAN manufacturing. It may sound trivial but by asking the question “why...?” five times the problem itself unfolds and can be treated. The use of five why can be explained by Ohno’s (1988) example:

Q1. Why did the robot stop?

A. The circuit is overloaded, causing a fuse to blow

Q2. Why is the circuit overloaded?

A. There was insufficient lubrication on the bearings, so they locked up.

Q3. Why was there insufficient lubrication on the bearings?

A. The oil pump on the robot is not circulating sufficient oil

Q4. Why is the pump not circulating sufficient oil?

A. The pump intake is clogged with metal shavings

Q5. Why is the intake clogged with metal shavings?

A. Because there is no filter on the pump

“This may seem easy and obvious however business issues do not always have a simple answer and answers can be difficult to find. Root-cause analysis is a topic as old as the hills, but it is not always done. And even when it is done, it is not always done thoroughly, with depth and breadth. And even when a thorough analysis is done, it is not always followed-up effectively” (Pylipow, Royall 2001). The application of the five whys analysis provides a fact based and structured approach to problem identification and correction that focuses on not only reducing defects but also eliminating them (Murugaiah, Benjamin et al. 2010). In this study business process development has been described from supply chain level down via functions, processes, process steps and issues all the way down to the root-cause of the issue. The idea is that by visualizing this path changes can be examined on how it will affect the big picture. Just by finding the root-cause of the problem will not solve the problem. Presented in section 3.3.3-3.3.9 are tools to handle with the root-cause itself.

3.3.3 Continuous flow

If stock keeps piling up at one station it means that the balance in the line is not right. Stockpiling is a typical bottleneck scenario and is basically the process steps before the stockpile are too fast, and at least the process immediately after the stockpile is too slow. A

continuous flow prevents stockpiling by directly linking the two process steps together, prohibiting the leading processes to produce more stock than the lagging station can handle. Each item passes immediately from one person to the next without stagnation (Rother, Shook 1999). If stock piles up at one station, this is visualized and the lagging station can be aided by the leading one. To be able to create a continuous workflow it does require for all process steps to take approximately the same amount of time.

3.3.4 FIFO

FIFO stands for First-In-First-Out and is just like the continuous flow a common production level tool within LEAN as well as warehouse management. Whichever part reaches the production process first must also be the first to leave, and not let other parts overtake (Erlach 2013). FIFO is often used between production lines that cannot be linked with a continuous flow. It is a common method to be used for goods with short expiration dates, i.e. perishable goods such as milk. Consider yourself in a grocery store and you are about to purchase some milk, do you take a package from the front or do you reach in and grab one from the back? The milk packages in the back tend to have longer expiration date because it has just arrived from the dairy. This is an example of the FIFO principle not working properly

3.3.5 The 5 S

Unlike the FIFO and continuous flow tools the Five-S is an organizational technique to establish and maintain a quality work-environment in an organization. The technique has been practised in Japan for a long time. Most Japanese’s five-S practitioners consider the 5-S useful not just for improving their physical environment but for improving their total quality management processes as well (Ho 1999). Table 6 shows the different 5S in Japanese as well as translated into English. The logic behind the five-S principles at the workplace is that these principles are the basic requirements for high efficiency in producing better quality products and services with little or no waste (Low 2001).

Table 6 description and translation of the 5S tools (Ho 1999).

Japanese	English	Meaning	Example
Seiri	Structure	Organization	Throw away rubbish
Seiton	Systematize	Neatness	30-second retrieval of documents or tools
Seiso	Sanitize	Cleaning	Individual cleaning responsibility
Seiketsu	Standardize	Standardization	Transparency of storage
Shitsuke	Self-discipline	Discipline	Do 5-s daily

3.3.5.1 Seiri – Organization

Seiri is about separating the things that are necessary from those that are not (Low 2001). The necessary things for the process should be kept as low as possible as well as keeping them close to where they are needed. It should be emphasized the importance of a principle of organization called “one-is-best”. Examples of application include one set of tools/stationery; one-page form/mem; one day processing e.tc (Ho 1999).

3.3.5.2 *Seiton – Neatness*

To quickly retrieve information, tools or material at the time when it is needed can of course effect efficiency. The time it takes to put back the information, tool, or material into place also has to be taken into consideration. If this is not done properly waste is easily created by searching for the right information, tool or material. An arbitrary decision on where things go is not going to make you any faster (Ho 1999). Instead the arbitrary should be based on who, where, and how the things are used. A tool being used once a week does not need to be at as a convenient location as a tool used every 15-minute.

3.3.5.3 *Seiso – Cleaning*

Keeping it clean is the responsibility of everyone in the organization. By having all the people in the organization responsible for daily cleaning for marked up areas will not only make the organization more clean, it will be more effective as well. However all the responsibilities must be clear with procedures that make it easy to know what is expected as well as see what needs to be restocked and missing. Throwing out things that are unnecessary will uncover areas for inspection. Discarding unwanted items will make the area clear and uncluttered (Low 2001). This goes for information and data as well, instructions should be up to date, and each staff is responsible for their personal files.

3.3.5.4 *Seiketsu – Standardization*

Standardized conditions on site must be achieved so that work can be done quickly (Low 2001). By having standardized work procedures and processes the organization will become more transparent. If everybody in the organization knows and understands the standardized workflow it will not only increase the understanding of the entire process, it can also increase the flexibility of the workforce.

3.3.5.5 *Shitsuke – Discipline*

The focus of discipline is to create a bad-habit free workplace. By having the people in the organization understand what needs to be done and having everyone practising it bad habits are broken and good ones are formed (Ho 1999).

For five-S to work it is imperative that the entire organization embraces and follows the five-S. It should also be implemented systematically and visualized throughout the organization. An example for this is to have a five-S champion. A five-S champion could led the whole organization towards five-S implementation, step-by-step (Ho 1999).

3.3.6 *Poka Yoke – Error proofing*

Poka-yoke is a device at production level that either prevents or detects abnormalities, which might be detrimental either to product quality, or to employees (Saurin, Ribeiro et al. 2012). The goal with poka-yoke is 100 percent quality performance. This is done by having quality control integrated in the process for not passing on defects and recognizing them as early in the process as possible. The preventive-mechanisms is used to ensure optimal conditions before a process is initiated. Should a defect occur, the tool uses detection-mechanisms to find the cause of the defect and not pass it along for further processing. Table 7 shows that the required cost and effort will increase with each step towards defect prevention. However as shown in Figure 22 the cost for processing or damaging a unit in the

end of the process is more expensive than in the beginning. Naturally should resources be placed to not damage a unit at the end of the process.

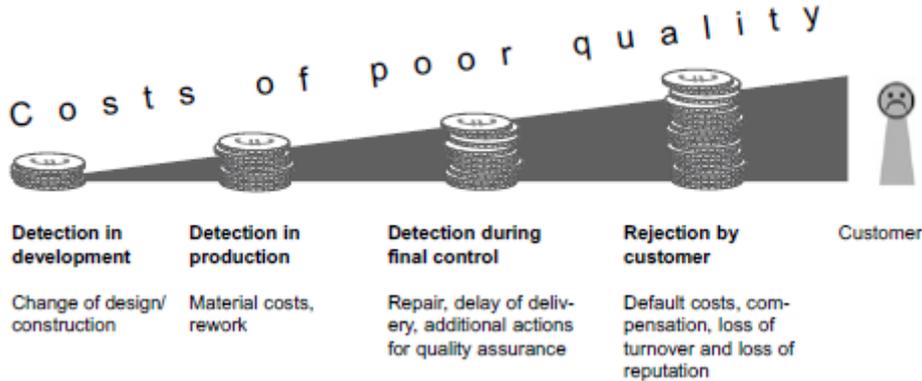


Figure 22 the cost of poor quality (Meran, John et al. 2013).

Table 7 Examination methods in the poka-yoke tool (Meran, John et al. 2013)

Examination	Layout	Comment
Traditional		<ul style="list-style-type: none"> • Distinction between good part and scrap and/or rework • Reduces the defective parts delivered to the customer • Doesn't prevent error production • Slow feedback on scrap and rework
Statistical		<ul style="list-style-type: none"> • System for reduction of examination costs • Doesn't prevent error production, does not ensure non-defective parts • Errors can be passed through due to examination of samples • Slow feedback on scrap and rework
Continuous		<ul style="list-style-type: none"> • Each process step controls the quality of the previous process • 100% of the parts are examined • Doesn't prevent error production • High effort/expenses of examination – efficient only for small amounts
Self-examination		<ul style="list-style-type: none"> • Each process step controls its own quality • Immediate feedback and corrective actions • The further processing of the defective part is stopped • High effort/expenses for examination – 100% of the parts examined
Complete examination		<ul style="list-style-type: none"> • Each process step controls its own quality and that of its supplier • Problem detection before finishing the process step • Immediate feedback and corrective action • The further processing of the defective part is stop • High effort/expenses for examination – 100% of the parts are examined

3.3.7 KANBAN

The Kanban system is a production level tool for managing the supply of a process. By having replenishment systems built into the process itself the system becomes pull-based. Figure 23 describes the Kanban system from production via safety-stock to assembly. The Kanban cards can be either physical or electronic. When a certain pre-specified level of inventory is hit it triggers a production Kanban to replenish the unit. A withdrawal Kanban can be seen as a shopping-list for units to withdraw (Rother, Shook 1999).

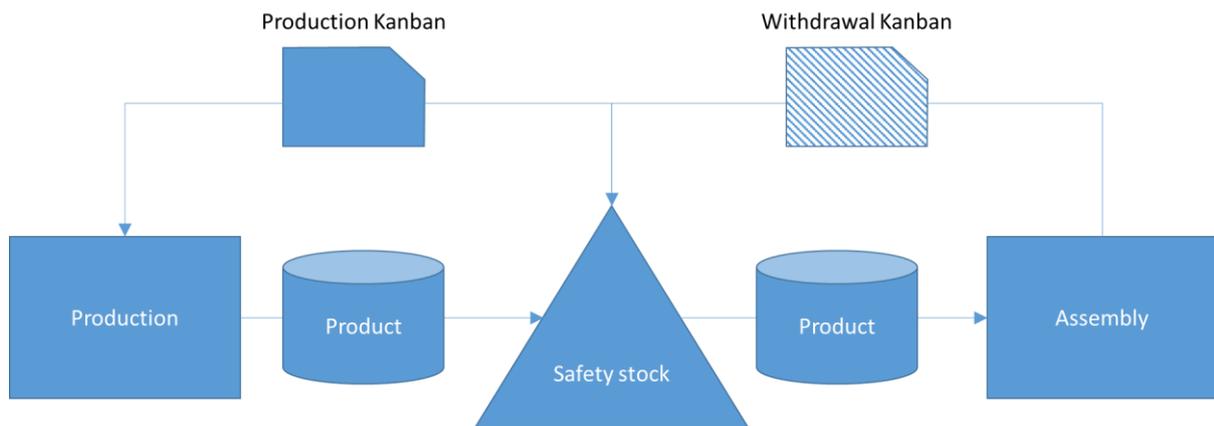


Figure 23 describes the Kanban process, a production Kanban card triggers the production process while a withdrawal Kanban card works as a shopping list (Rother, Shook 1999).

3.3.8 SMED

Single Minute Exchange of Die (SMED) is a tool that focuses on the set-up time for production machinery. By reducing set-up time the organization is actually freeing up capacity, increasing flexibility as well as reducing working capital. SMED differentiate between internal and external set-up time. External set-up is settings that can be done while the machine is still running and internal set-up is settings that need to be done when the machine is stopped. Merna, John et al. (2013) provides the following procedure for working with SMED:

1. Document setup process and divide individual activities into internal and external activities
2. Convert internal into external activities
 - a. Focus primarily on delaying and disrupting activities
 - b. Find the cause of the disruptions
3. Streamline remaining internal activities
 - a. Evaluate if steps can be eliminated
 - b. Reduce or eliminate the need for hand tools, nuts bolts and screws
 - c. Enable quick change systems
4. Eliminate adjustments and test runs
 - a. Eliminate intuition and estimates from adjustments and replace them with facts and fixed settings
 - b. Use visual control mechanisms to reduce adjustment times caused by inaccurate alignments

3.3.9 Kaizen

“Kaizen translated from Japanese is composed of kai “change” and zen “good”. Together these two words imply “incremental, continuous improvement” (Womack, Jones et al. 2006). Kaizen is an event based development tool and recognized as an essential part of lean thinking. Kaizen can help to streamline and align processes in production (Wronka 2013). When waste is identified it needs to be discarded it can be done with a Kaizen event that is the connection between theory and reality. The main principle about Kaizen is that improvements should evolve over time; if something doesn’t happen as intended or new problems arise along the way, employees should take their time to understand why the problem is happening (Hailes 2012, Feldman 2014) . A Kaizen event should therefore not be rushed, it should neither be so long that it loses focus on the achievement. Stone (2010) argues that a typical Kaizen event should be spread over 5 days. The team often consist of 4-8 people, one team leader accompanied by several engineers. The success of the team’s work depends not only on how well they can produce performance measures but also on the members’ attitude and behavior (Stone 2010). Kaizen is to some extent seen as a philosophy or an organizational culture where employees are involved and continuously search and implement improvements.

3.4 The Hofstede Model

The idea of applying culture research into business process is just as Hofstede, Hofstede et al (2010) describes the objective of their book, “to help dealing with the differences in thinking, feeling, and acting of people around the globe”. The Hofstede model is a framework that present structures found in all cultures and by acknowledging this structure it can be used as a basis for mutual understanding i.e. a common goal. Just think of all confrontations between people, groups, and nations around the globe today. Whether it is an issue with bad delivery performance from a supplier or ending world hunger it requires cooperation to find a solution.

Geert Hofstede has actively worked within research in culture since the late 1960. In 1980 he published his first book “cultures consequences” with ground breaking analysis that cast doubts of previously established theories. In 1991 he published the first edition of “Cultures and Organizations: software of the mind” and is more focused towards a combination of research and business use. Due to the changing cultural environment in the world in 2001, 2005 and 2010 new editions were released with updated models. This study will focus on the national culture between Sweden and China as well as draw conclusions about the organizational culture within Heatex.

3.4.1 What is Culture?

Culture is of course difficult to explain and to define. In this study culture is defined as a collective phenomenon that visualizes itself in the interactions between people. Culture consist of the unwritten rules of the social game (Hofstede, Hofstede et al. 2010). Figure 24 demonstrates the three main aspects of human uniqueness. The human nature is the basis for all human beings, what separates us from other animals and defines us as a species. It is inherited in our genes and is for example our ability to feel, associate with others, play and exercise. The way these abilities is expressed is highly affected by the culture surrounding us

not just now but during our upbringing as well. The personality of an individual is based on the specific genes as well as learned behavior from the collective-behavior e.g. culture and the life experiences of the unique person.

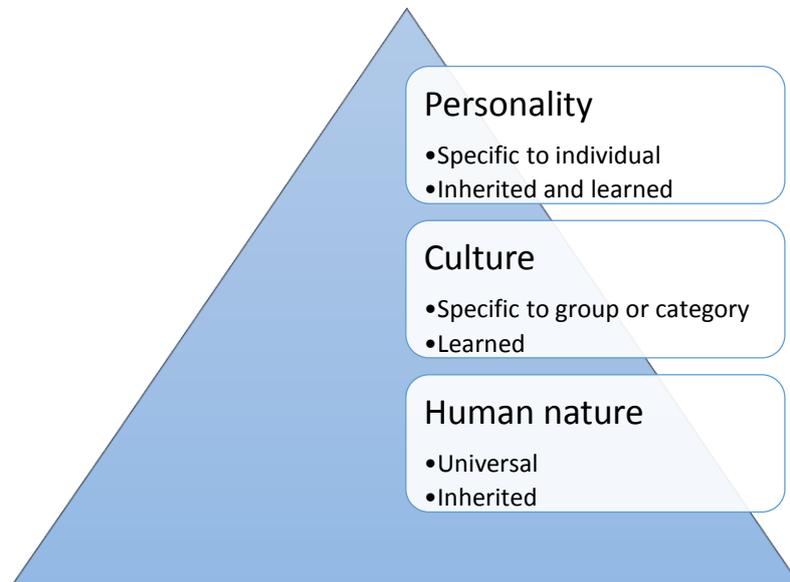


Figure 24 demonstrates the three main aspects of human uniqueness (Hofstede 2005)

3.4.2 National culture

The Hofstede model is a framework for cultural evaluation between countries. It is developed by Geert Hofstede and called “*The Hofstede model*”. 93 countries has been assigned values on a scale from 0-100 for 93 countries on six dimensions, and each country has a position on each scale or index relative to other countries. The six dimensions are:

1. Power distance
2. Individualism/collectivism
3. Masculinity/femininity
4. Uncertainty avoidance
5. Long-/short-term orientation
6. Indulgence versus restraint

The power distance is related to “*the extent to which less powerful members of a society accept and expect that power is distributed unequally*” (Hofstede, Hofstede et al. 2010). Cultures with low power distance are often associated with flat organizations, while in large power distance cultures the social status and rightful place are highly related to hierarchy and needs to be shown/understood to show proper respect. An indication of high status can be the use of luxury articles and global brands.

Individualism/collectivism can be defined as “*people looking after themselves and their immediate family only, versus people belonging to in-groups that look after them in exchange for loyalty*” (Hofstede, Hofstede et al. 2010). The individualistic behavior is “I”-focused and often connected with the belief that the values within the culture apply to the

whole world. Individuals within individualistic cultures strive towards self-actualization. Communication is done low-context with explicit verbal communications. Collectivistic cultures are more “we”-focused, individuals feel a strong connection to their social system as well as the avoid losing face. De Mooij and Hofstede (2010) uses the example of a sales process; in an individualistic culture both parties want to get to the point fast, while in collectivistic cultures trust and relationship between the parties must be built first.

Masculinity/femininity is defined by Hofstede, Hofstede et al. (2010) as *“the dominant values in a masculine society are achievement and success; the dominant values in a feminine society are caring for others and quality of life”*. Masculine societies tend to acknowledge and also demonstrate achievements; a typical factor in feminine societies is the sharing of household work between husband and wife.

Uncertainty avoidance is defined as *“the extent to which people feel threatened by uncertainty and ambiguity and try to avoid these situations”*. In general do people in societies with high scores in uncertainty avoidance dislike change and structure their life by rules, formalities and belief in experts.

Long-/short-term orientation is *“the extent to which a society exhibits a pragmatic future-orientated perspective rather than a conventional historic or short-term point of view”*. Cultures with a long-term orientation tend to value investments in the future and the focus is on perseverance, ordering relationships by status, and having a sense of shame. Short-term orientation includes steadiness and stability and respect for tradition.

Indulgence stands for *“a tendency to allow relatively free gratification of basic and natural human desires related to enjoying life and having fun”*, its opposite *“restraint reflects a conviction that such gratification needs to be curbed and regulated by strict social norms”* (Hofstede, Hofstede et al. 2010). Indulgent cultures tend to have a higher approval of foreign music and films, sharing of household task between partners, higher percentages of obese people, smiling as a norm, freedom of speech are viewed as relatively importance e.tc. As opposed to restrained countries.

3.4.3 The Hofstede model applied to China and Sweden

According to current statistical and economic evaluation conducted by IMF China has this year (2014) surpassed U.S.A. as the world’s largest economy. For global firms the Chinese market is too big to ignore and are for many companies a cornerstone in their annual revenue. For foreign companies doing business in China it is more difficult than just overcoming language barriers. Relationships and networks are of high importance in China. Networking connects the individual to a social network of “friends” who can be called upon for favors when needed (Feldman 2014). Each member of the network has a status and a reputation, face. Based on this status the member expects certain treatment and courtesy. For western businesses trying to establish in China it is often confusing and almost impossible without specialist help. Figure 25 below demonstrates the results of Hofstede’s culture research between Sweden and China. Just by looking at it is clear that there are large cultural differences in all categories except for uncertainty avoidance, the different characteristics for Sweden and China according to Hofstede is presented in Table 8 below.

Table 8 is collected directly from the Hofstede culture webpage. It describes the similarities and differences between Swedish and Chinese culture (Hofstede 2014).

	Sweden	China
Power Distance	Sweden scores low on this dimension (score of 31) which means that the following characterizes the Swedish style: Being independent, hierarchy for convenience only, equal rights, superiors accessible, coaching leader, management facilitates and empowers. Power is decentralized and managers count on the experience of their team members. Employees expect to be consulted. Control is disliked and attitude towards managers are informal and on first name basis. Communication is direct and participative.	At 80 China sits in the higher rankings of PDI – i.e. a society that believes that inequalities amongst people are acceptable. The subordinate-superior relationship tends to be polarized and there is no defense against power abuse by superiors. Individuals are influenced by formal authority and sanctions and are in general optimistic about people's capacity for leadership and initiative. People should not have aspirations beyond their rank.
Individualism	Sweden, with a score of 71 is an Individualistic society. This means there is a high preference for a loosely-knit social framework in which individuals are expected to take care of themselves and their immediate families only. In individualistic societies offence causes guilt and a loss of self-esteem, the employer/employee relationship is a contract based on mutual advantage, hiring and promotion decisions are supposed to be based on merit only, management is the management of individuals.	At a score of 20 China is a highly collectivist culture where people act in the interests of the group and not necessarily of themselves. In-group considerations affect hiring and promotions with closer in-groups (such as family) are getting preferential treatment. Employee commitment to the organization (but not necessarily to the people in the organization) is low. Whereas relationships with colleagues are cooperative for in-groups they are cold or even hostile to out-groups. Personal relationships prevail over task and company.
Masculinity	Sweden scores 5 on this dimension and is therefore a feminine society. In feminine countries it is important to keep the life/work balance and you make sure that all are included. An effective manager is supportive to his/her people, and decision making is achieved through involvement. Managers strive for consensus and people value equality, solidarity and quality in their working lives. Conflicts are resolved by compromise and negotiation and Swedes are known for their long discussions until consensus has been reached. Incentives such as free time and flexible work hours and place are favored. The whole culture is based around 'lagom', which means something like not too much, not too little, not too noticeable, everything in moderation. Lagom ensures that everybody has enough and nobody goes without. Lagom is enforced in society by "Jante Law" which should keep people "in place" at all times. It is a fictional law and a Scandinavian concept which counsels people not to boast or try to lift themselves above others.	At 66 China is a masculine society –success oriented and driven. The need to ensure success can be exemplified by the fact that many Chinese will sacrifice family and leisure priorities to work. Service people (such as hairdressers) will provide services until very late at night. Leisure time is not so important. The migrated farmer workers will leave their families behind in faraway places in order to obtain better work and pay in the cities. Another example is that Chinese students care very much about their exam scores and ranking as this is the main criteria to achieve success or not.
Uncertainty avoidance	Sweden scores 29 on this dimension and thus has a very low preference for avoiding uncertainty. Low UAI societies maintain a more relaxed attitude in which practice counts more than principles and deviance from the norm is more easily tolerated. In societies exhibiting low UAI, people believe there should be no more rules than are necessary and if they are ambiguous or do not work they should be abandoned or changed. Schedules are flexible, hard work is undertaken when necessary but not for its own sake, precision and punctuality do not come naturally, innovation is not seen as threatening.	At 30 China has a low score on uncertainty avoidance. Truth may be relative though in the immediate social circles there is concern for Truth with a capital T and rules (but not necessarily laws) abound. None the less, adherence to laws and rules may be flexible to suit the actual situation and pragmatism is a fact of life. The Chinese are comfortable with ambiguity; the Chinese language is full of ambiguous meanings that can be difficult for Western people to follow. Chinese are adaptable and entrepreneurial. At the time of writing the majority (70% -80%) of Chinese businesses tend to be small to medium sized and family owned.
Pragmatism	With an intermediate score of 53 Sweden is seen to not express a clear preference on this dimension.	China scores 87 in this dimension, which means that it is a very pragmatic culture. In societies with a pragmatic orientation, people believe that truth depends very much on situation, context and time. They show an ability to adapt traditions easily to changed conditions, a strong propensity to save and invest, thriftiness, and perseverance in achieving results.
Indulgence	A high score of 78 in this dimension indicates that Swedish culture is one of indulgence. People in societies classified by a high score in indulgence generally exhibit a willingness to realize their impulses and desires with regard to enjoying life and having fun. They possess a positive attitude and have a tendency towards optimism. In addition, they place a higher degree of importance on leisure time, act as they please and spend money as they wish.	China is a restrained society as can be seen in its low score of 24 in this dimension. Societies with a low score in this dimension have a tendency to cynicism and pessimism. Also, in contrast to indulgent societies, restrained societies do not put much emphasis on leisure time and control the gratification of their desires. People with this orientation have the perception that their actions are restrained by social norms and feel that indulging themselves is somewhat wrong.

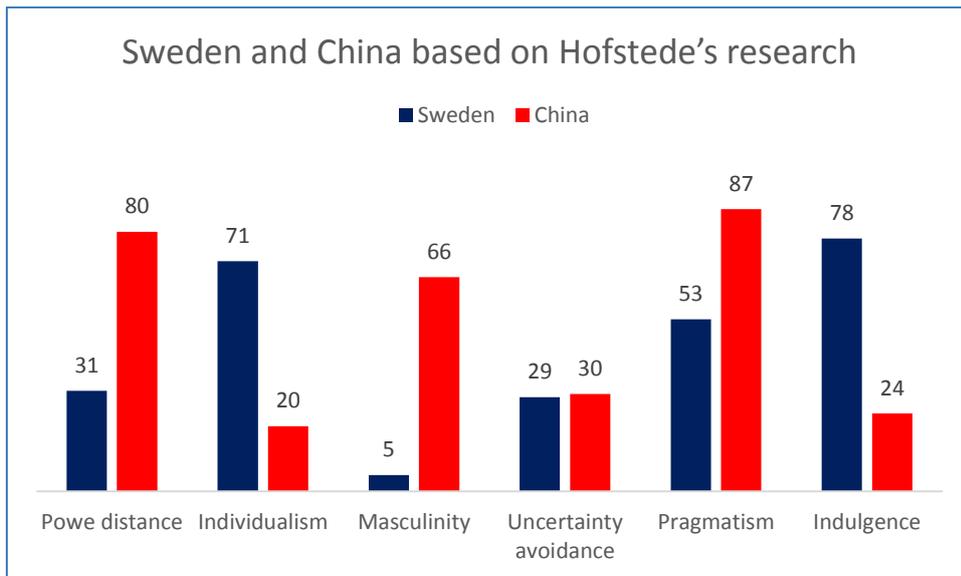


Figure 25 presents the score for Sweden and China on each culture dimension in the Hofstede model (Hofstede 2014).

3.4.4 Organizational Culture according to Hofstede

Culture can be expressed in an endless set of ways, however according to Hofstede, Hofstede et al. (2010) the following four cover the concept rather well; symbols, heroes, rituals, and values, see Figure 26. Symbols are words, gestures, pictures, or objects that are shared and perceived in the same way in the same culture. Heroes are persons with qualities that are valued within the culture, these persons does not have to be living nor real. Rituals are activities that take place for their own sake, such as greeting, and ceremonies. Business meetings are often full of rituals, for example for leaders to assert themselves e.tc. Symbols, Heroes and rituals have been subsumed under the term practices; it means that they are visual to an outside observer. "The core of the culture is the values. Values are feelings with an added arrow indicating a plus and a minus side." Values can be exemplified as follows:

- Evil versus good
- Dirty versus clean
- Dangerous versus safe
- Moral versus immoral
- Unnatural versus natural
- Normal versus abnormal
- Irrational versus rational

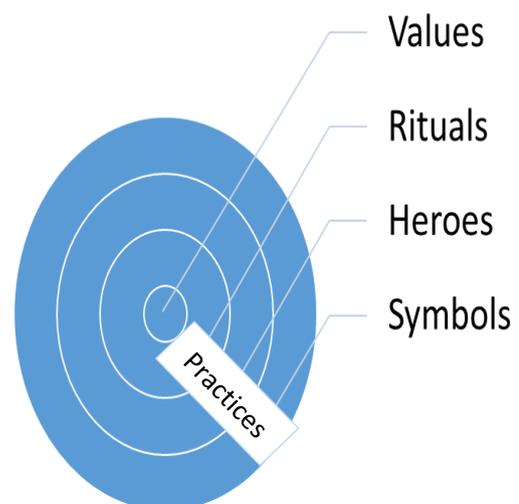


Figure 26 shows four topics that commonly cover the

One could argue that national culture in the modern world is becoming more unified, Hofstede has the example of people dressing the same, having the same products and use the same fashionable words (symbols), they see the same television shows and movies (heroes), they engage in the same sports and leisure activities (rituals). This is however just superficial levels of culture. Research that digs in to the deeper underlying values often shows differences between cultures. The Institute for Research on Intercultural Cooperation conducted a research focused on practices vs. values in internal organizational culture. The IRIC study found the roles of values versus practices at the organizational level to be exactly the opposite of their roles at the national level (Hofstede, Hofstede et al. 2010). People with similar job descriptions in different organizations could have different rituals, heroes and symbols, but were surprisingly similar in values.

In organizational culture the national dimensions that tend to be viewed of most importance are power distance, and uncertainty avoidance. That is because within organizations two questions needs to be determined, who has the power to decide that? And what rules or procedures will be followed to attain the desired ends (Hofstede, Hofstede et al. 2010). The performance of a business is highly dependent on the people working towards a common goal. Monitoring the performance of subordinates is common for companies. At some level in global companies the monitoring takes place across national borders and will require adaption. To discuss culture within companies, a six autonomous dimension and two semi-autonomous dimension model has been developed. In their book Hofstede, Hofstede et al. (2010) discusses the terminology for the organizational culture dimensions as an ongoing discussion so the names not suggest a good or bad pole for each dimensions. The dimensions described below are therefore collected from his homepage (Hofstede 2014) and differ somewhat from what is described in his book. Whether a score is good or bad is decided if the score match the intended purpose of the managers responsible. The dimensions are: means oriented versus goal oriented, internally driven versus externally driven, easy going work discipline versus strict work discipline, local versus professional, open system versus closed system, employee oriented versus work oriented, degree of acceptance of leadership style, and degree of indication with your organization.

3.4.4.1 Means oriented versus goal oriented

This dimension can be related to the effectiveness in an organization. A means oriented organization is more focused on how the work is carried out than a goal oriented which are more focused on the result. Employees in a goal oriented organization tend to be more focused on achieving internal goals even if I come with large risks. Employees in a means oriented organization tend to be avoiding risk and limiting the amount of effort in to their job.

3.4.4.2 Internally driven versus externally driven

An internally driven organizational culture rely on the fact that they know what is best for the customer while an externally driven organization focus on achieving customer requirements. The internally driven organization tends to have a focus on business ethics and honesty while the opposite focuses on results and pragmatic attitudes is more

important than ethics. This dimension is focused on customer satisfaction and therefore differ itself from the previous one which is focused on personal achievements.

3.4.4.3 Easy going work discipline versus strict work discipline

This dimension relates to the control used to both monitor and perform the process. An easygoing culture has more improvisation and loose internal structure. The limited discipline leads to surprises and lack of predictability. The opposite strict work-environment is more cost-conscious, punctual and serious.

3.4.4.4 Local versus professional

In local company there is a social atmosphere and the employees put effort in to being liked by everybody else, they are short term directed and identify with the boss and/or the unit where they work. The opposite, a professional culture the employees identify with his/hers profession and/or the content of the job. A professional culture tends to be more long-term directed and not necessarily focused on being liked.

3.4.4.5 Open system versus closed system

An open organization is accessible to both outsiders and insiders. New employees are welcomed with open arms and there is a belief that almost anyone would fit in the organization. In a closed organization it is more skepticism about outside people, a new employee has to prove that he/she fits in the organization.

3.4.4.6 Employee oriented versus work oriented

This dimension is highly affected by management philosophy. In employee oriented organizations the personal problems of the employees are taken into consideration. Decisions are made by groups or committees. A work oriented organization is more result oriented and the focus is more on performing task, even at the expense of the employees.

3.4.4.7 Degree of acceptance of leadership style

This dimension evaluates if the leadership style from the boss is in line with the workers preferences. It should be noted that culture measures central tendencies and that people may have different bosses doesn't play a part at the level of culture.

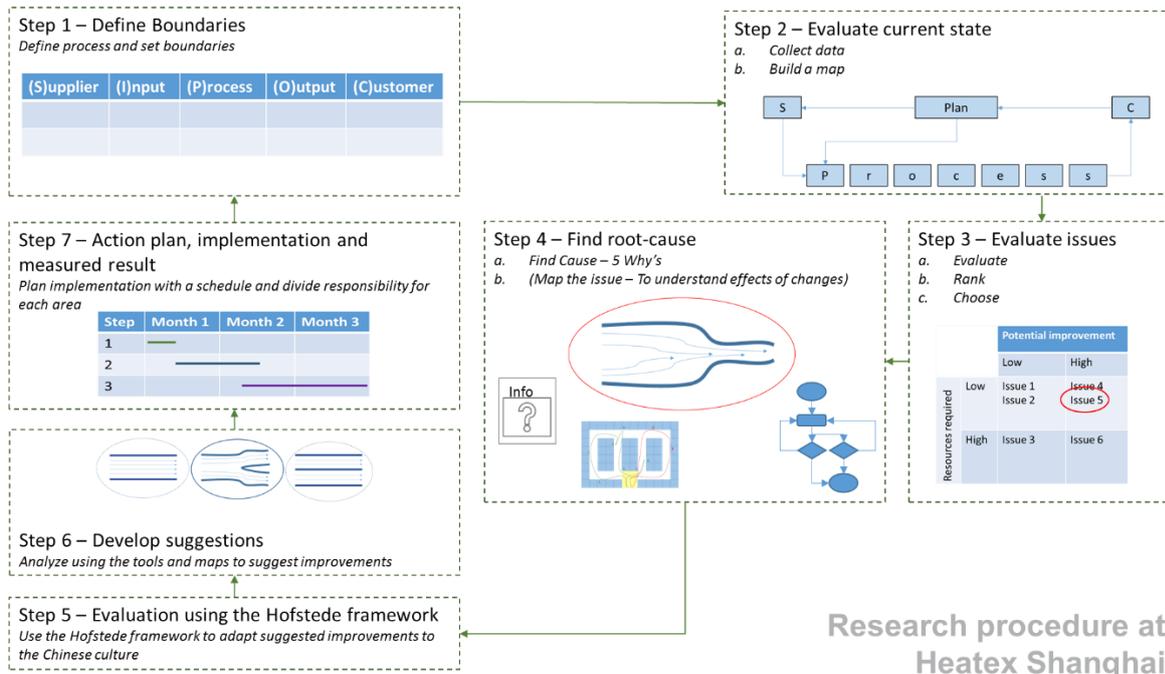
3.4.4.8 Degree of indication with your organization

This dimension measures whether the employees identify with the organization or not. An employee can identify with different parts of the organization, clients, a close working group, boss, and/or the whole organization. It is also possible that one does not identify with any or just some of those aspects.

3.5 Synthesis of the theoretical framework

After researching business process management it becomes clear that to succeed with business process development is a complex. Without a proper framework that can compile and structure cross-functional data from all levels of the organization it is easy to lose track half way through. In order to stay on track all through the project a draft model or framework for this project was developed based on the research presented in Chapter 3. This model is just as the literary review suggested, molded by an outside-in approach. Figure 27 presents a graphical representation of the model with the following steps:

- Step 1 – Define boundaries
- Step 2 – Evaluate current state
- Step 3 – Evaluate issues
- Step 4 – Find root-cause
- Step 5 – Evaluation using the Hofstede framework
- Step 6 – Develop suggestions
- Step 7 – Action plan, implementation and measured result



Research procedure at Heatex Shanghai

Figure 27 presents the framework for collecting, compiling, and structuring research used in this project.

Since this study have pre-specified goals presented, in short, to increase visibility between HAB and HSH, and assess and improve performance. These goals serve as correlation between the organizational strategy of Heatex and this project. It therefore makes sense for this study to start by understanding the premise for the process or as Weske (2012) presents is as the process landscape. This is where a SIPOC map comes in handy by not only establishing the beginning and end of the process it will also identify the input and output as well as all stakeholders. By doing this conclusions can be drawn regarding specific input, supplier and customer relationships, premise for the final product. All this information makes it possible to evaluate response to changes, as well as effects on stakeholders. By defining the beginning and end in a SIPOC map will also give hints of where and what kind of measures can be set up to assure that changes actual effect the overall performance and not just sub-optimization. The whole point is basically to draw the outline and surroundings of the process to be able to understand and assess different perspectives of the process and its problems.

Step two starts when the boundaries and outline of the process are defined. It is now possible to shift the focus to the process and its main sub-processes. The goal is to assess the overall performance and condition of the process. A VSM is designed for performance

assessment and is chosen because of the methods high-level approach, but also evaluates the different process steps individually. This project has a pre-specified product family to focus on, see Appendix D. The data collected and analyzed in the VSM can then be used to assess the process condition based on efficiency and effectiveness the framework for presented by DeToro and McCabe (1997).

Step three begins by examining the current-state analysis and applying the 8 common wastes presented by Rother and Shook (1999) issues can be identified. By grouping similar and smaller issues together larger goals for the process can be established. These grouped issues should then be compiled together to be able to evaluate them between each other. If a proper Pareto diagram cannot be conducted a model as presented in Table 6 can come with sufficient input. To help evaluate the data the following questions can also provide input for new more narrow focus:

- Is this issue inside of the scope?
- Will this issue affect the goal?
- Can we affect this issue with the available resources?
- What departments are responsible for this issue?

Evaluation especially based on limited quantitative data should always be done with caution and keeping an objective mind is of highest importance. The risk of favoring preferred alternatives can lead to missed opportunities and limit the actual result. For large process development projects it is important to already in this step evaluate the potential improvements and whether the requested changes are enough to achieve them. For this project it is important to narrow the scope down already in this step because of the limited time aspect and the fact that the researcher is working more or less alone.

In step 4 it is once again required to step back into the process and collect data. However this time the scope of data collection should be narrow and focused, on just the issues. By applying the five why technique, root causes can be identified, spaghetti maps, pictures and flowcharts are tools to can further help understand the cause.

The idea to conduct the culture analysis in step 5 between the identification of the root cause and development improvement suggestions is because at this point all development project goes from instead of extracting and analyzing information from the process the project now has to start putting information back into the process to make changes. This changes does off course effect the people working in the process. Culture is an unavoidable collective phenomenon affecting all groups of people and most people working in global companies are aware of that cultural differences exist. Another aspect of why the culture analysis is conducted now is because the easiest and best way to learn about a culture is to experience that culture which is why the evaluation is conducted some time into the project, when the researcher has been accustomed to the culture. This is to minimize the risk of just looking at the previous research and actually draw conclusions from the case. By analyzing the culture dimensions further, find examples for when they are correct and not correct a deeper understanding of what suggestion can and cannot work in this environment. By discussing the Hofstede corporate culture dimensions can also give further understanding of

how ideas and suggestions will be perceived by the process. Another important aspect of conducting a culture evaluation is the fact that while managers from different countries and cultures who work together will develop a mutual culture between each other. The employees of the managers does not share or partake in. If improvements are implemented at the employee level then the implementations should be adapted to their culture.

In step 6 it is now time to use the different tools to develop improvement suggestions. Based on the collected data the theoretical improvement can be calculated and the idea is that by applying the cultural analysis, sufficient insight has been gained to modify the suggestions and get an understanding for how this can be implemented in reality. It is also in this point that all business development projects start to become expensive. To be able to implement certain improvement may require production stops, purchases or other investments. It is therefore important to evaluate the suggestion thoroughly and in a comparable way. Decision authorities must be aware of and understand the required actions and resources as well as both expected short term and long term improvement. To help with this, diagrams and presentations are useful but once again mapping can be used not only to explain suggested ideas and how they will improve. They can also give input to what actually is required. For example a layout map that shows both the old and new layout will increase the understanding of what production equipment has to be moved or can remain. It can also give input to in what order should the movements take place.

In step 6 it is time to create an action plan. There are many different ways to prioritize an action plan. Rother and Shook (1999) presents the possibility of using pull loops for implementation or one could go for some low hanging fruit in the beginning. It may sound trivial but two of the most important things to decide are a responsible person and a deadline for each action. This goes not only for the actions regarding the actual improvement implementation. It is equally important to establish a responsible person and deadline for the measuring of the project. Ideal should measures follow the SMART abbreviation; Specific, Measureable, Achievable, Relevant, and Time-Bound. This is a popular definition of how the measures should be designed.

By applying this model to HSH the idea is to be able to visualize all levels of the process. Understand what should be developed, compare it to the available resources and focus on what this project can achieve. By developing, implementing, and measure changes the project should be able to evaluate the changes itself. This study will of course also focus on the compatibility of applying culture aspects to business process development and whether it has given useful input in the development of suggestions as well as implementation.

4. Results

This chapter follows the synthesis of the theoretical framework presented in section 3.5. It starts with presenting the empirical findings in section 4.1 by:

1. Define boundaries
2. Evaluate current state
3. Identify and evaluate issues
4. Find root cause

Section 4.2 then analyzes these findings to develop improvements in the following steps:

5. Culture analysis
6. Develop and evaluate suggestions
7. Action plan, implementation and measured results

The model itself is evaluated in Chapter 4.3.

4.1 Empirical findings

4.1.1 Step 1 – Define boundaries

The actual SIPOC map for Heatex is confidential, however presented in Figure 29 is the basic information that the analysis is based on. Additional information are also presented in this chapter to give a further understanding of the boundaries and challenges facing the process.

The rotor heat-exchangers that Heatex manufactures and sells are mostly fitted in large buildings such as industrial premises, airports, office buildings, shopping centers e.tc. This type of ventilation is usually fitted through standardized components that are scaled based on the required airflow. The Heat-exchanger helps to preserve the energy by transferring heat between the exit and entry airflow. In warm climate it will block out the heat, in cold climates it preserves the heat inside. Adding a heat-exchanger will require additional energy, however if tuned correctly by not having to heat/cool the entry air as much the overall system will consume less energy. Heatex strongest selling point is their recognized expertise within calculating and tuning the system to minimize overall required energy. This means that Heatex are selling high-end equipment to the construction industry. An industry that is renowned for its sensitivity towards fluctuations, delays, and tough legal regulations. An example of legislations affecting Heatex in a good way is that some countries require that heat-exchangers is fitted in all new builds. It has provided Heatex with a bigger market but it has come with some drawbacks as well. By pushing heat-exchanger into every building it has opened up the market to low-cost competition that has gained substantial market shares over the last few years. This has mostly affected the plate heat-exchanger products and not yet the rotary products to the same extent. However currently there are similar tendencies shown for rotary heat-exchangers as when the low-cost plate heat-exchangers emerged, such as customer has started to produce their own rotors in-house, there are more and more manufacturers starting to produce rotors. Luckily Heatex is not only competing on price but a combination of price, performance, lead-time, flexibility, contractual compliance and cooperation willingness. Heatex does not only feel competition from low-cost manufacturers, there are of course high-end competition as well and they are all competing

in an industry with frequent delays, changes that require a lot of flexibility from the suppliers. This is demonstrated through Figure 28 that shows the typical supply chain for Heatex. If there is an abruption in one of the projects, the project manager will tell the contractor. The contractor will then evaluate the effects and inform the ventilation specialist that will finally contact Heatex and inform them. But it doesn't end there, since Heatex manufactures order specific units it means that they have no stock and only limited use of unwanted produced units, and most rotors are sold with order specific casing that are manufactured from a supplier. Heatex have a ten workday lead-time from when the order is sent by customer until the goods are shipped out of the factory, Heatex casing supplier have five days to produce the casings.

If there is an interruption at the final project that is acknowledged the same day as Heatex receives the order and it only takes an estimated half-day to transfer information from one company to the next Heatex receives the information on day two of their ten day lead-time. Heatex may not have started production yet however the order specific casing will almost certainly be under manufacturing. And this is just if the interruption occurs one day after Heatex receives the order, later will be worse. If the interruption only requires a later delivery date it is of course not as severe as drawing mistake or other changes that affect the product itself. This is a kind of lead-time bullwhip phenomenon that can have a large impact on the supply chain relationship. A prerequisite for short lead-time are good customer relationships, correct order placement and quick communication.

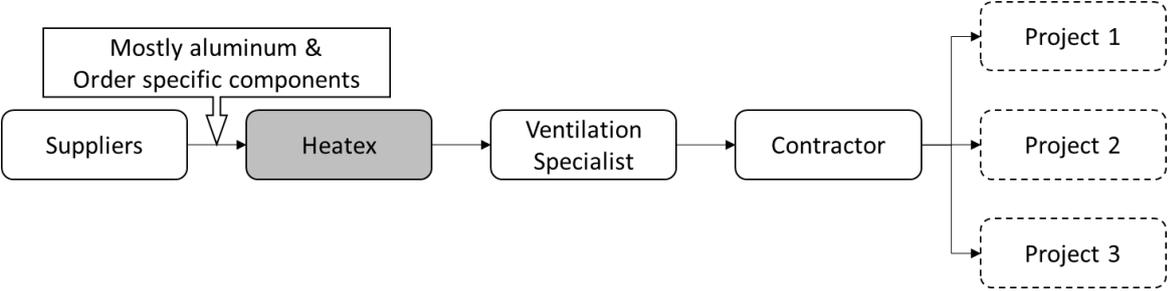


Figure 28 describes the basic supply chain from Heatex' suppliers to end customer.

The order to delivery process for the rotor production line is the focus of this study. A SIPOC map is presented in Figure 29. It starts with a customer confirming a sales order to Heatex' sales support. The information provided by the customer is then treated and handed over to the order planning department that creates a manufacturing order for the production. The manufacturing order specifies how the product should be produced, in what order and with what components. Based on this order the purchasing and warehouse department can prepare the required components for the production. Order specific components such as casings are provided straight from the supplier and handled directly by the purchasing department. Components that are kept in stock are handled by the warehousing department. There is a difference between the production process in China and it is the testing procedure. At the other facilities the products are tested by the operator and the operator at the following production step, not unlike a poka yoke - complete examination presented in section 3.3.6. In China all products are tested by the shift-leader. HSH has tried to implement the testing procedure into the process however it has not been successful. The

required time for the testing procedure is in comparison to the other observation steps so short that it has not been evaluated further in this study. Based on the contractual relationship with the customer before outgoing goods is released the customer may have to meet certain requirements such as finalized payment or arrange their own pickup.

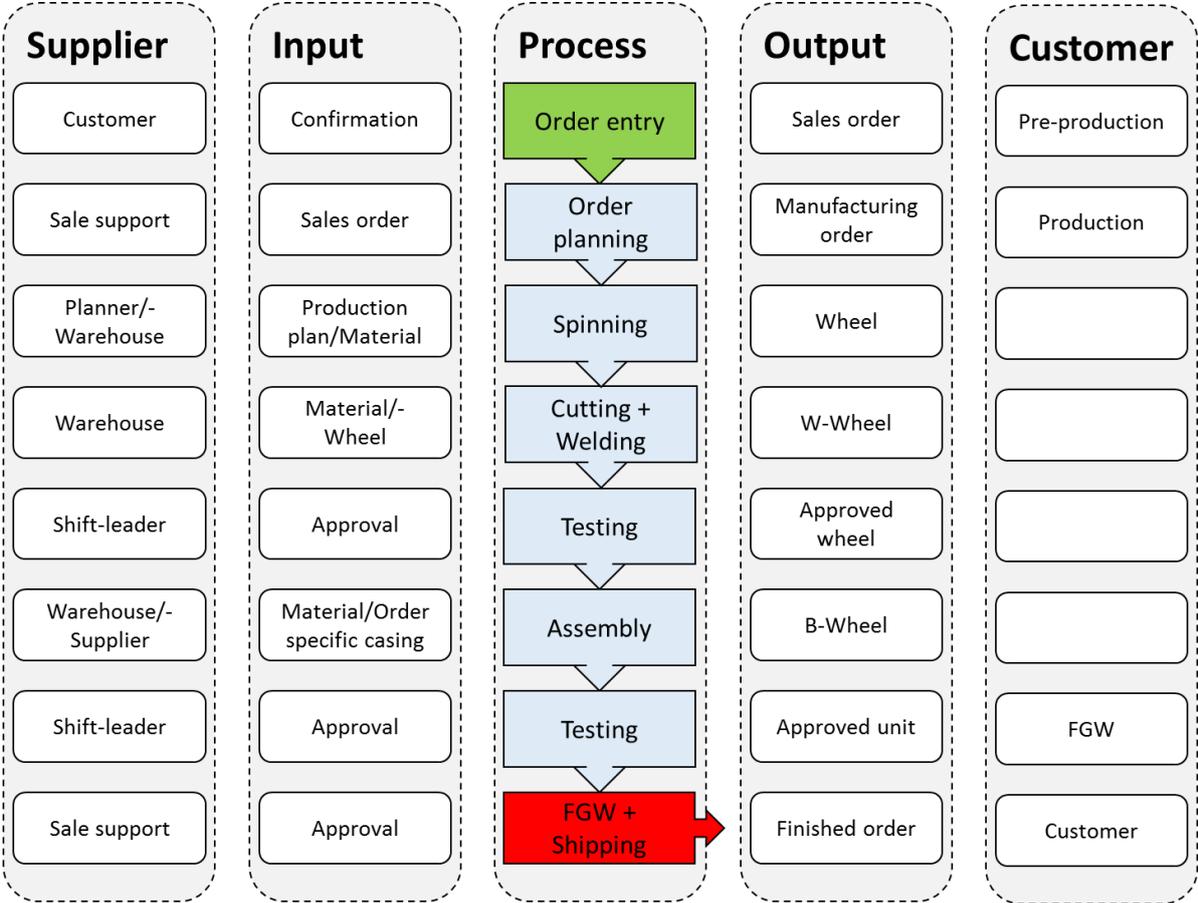


Figure 29 presents the SIPOC analysis that identifies the process steps and the stakeholders to the process. For all production steps the purchasing are responsible to assure availability of material at the site while the warehouse are responsible for assuring that the material is available at the production line.

The main components in the heat-exchangers that Heatex manufactures is aluminum which means that the direct material cost is affected by the price of aluminum. Over the last three years the aluminum price has remained rather stable with a slight tendency of decreasing. However historically we can see that the price has gone up and down a lot, see Figure 30. Aluminum’s strong and light-weight properties make it ideal for the transport industry. Figure 30 also presents, according to Rusal (2013) one of the largest aluminum producers, the top aluminum consuming industries in the world. As shown in the graph, the transport industry is by far the biggest and more than twice as big as the construction industry. Because Heatex buys coiled raw aluminum straight from these large produces one can only assume that their bargaining power is very limited.

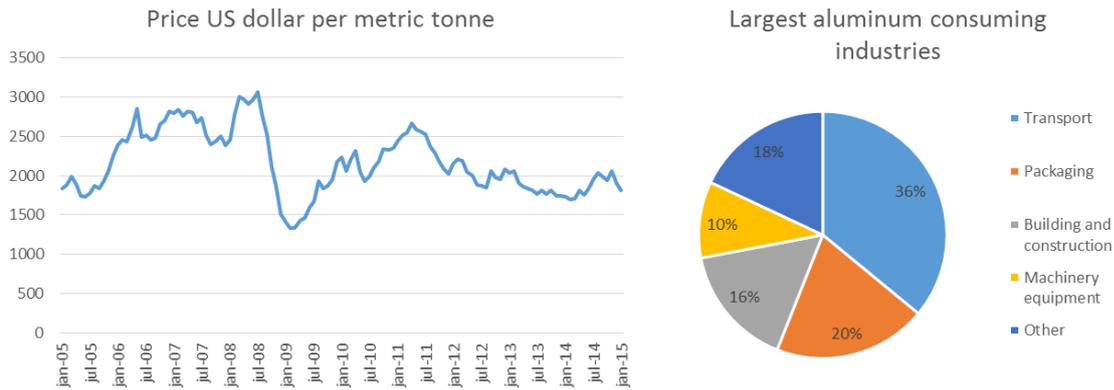


Figure 30 the left graphs shows the aluminum price over the last decade (Mundi 2015). The right graph shows the most aluminum consuming industries for 2013 (Rusal 2013).

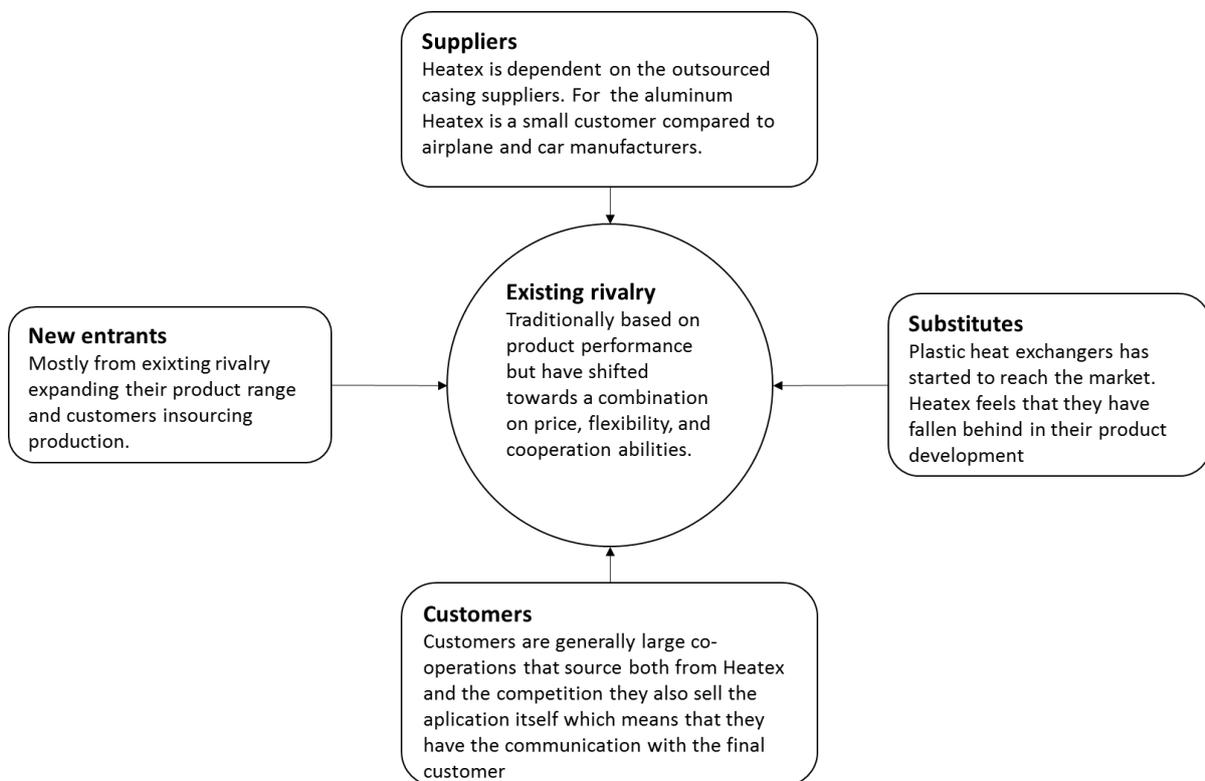


Figure 31 shows the analysis based on Porter's five forces.

To summarize how these different aspects affect Heatex the framework developed by Michael Porter's five forces has been used and are presented in Figure 31. This framework looks at the market based on the industry's internal rivalry, bargaining power of suppliers and customer, as well as threat of new entrants and substitutes. For Heatex all of these forces oppose a threat.

For suppliers, Heatex is dependent on order specific casings that to a large extent determine the lead-time that Heatex can promise to its customers. Negotiation with these suppliers is key for further improvements. For the aluminum which is the most vital component, Heatex sources from large suppliers which also supports demanding industries like automotive and

transport industry. Heatex are aware of that they are a small customer and that they have to work around it.

The customers, not unlike the aluminum producers, are in general considerably larger than Heatex and many of them also source part of their demand from Heatex, and part of their demand from the competition which of course puts Heatex in a tough position. However according to managers at Heatex in recent months customer has beginning to come back and placing orders at Heatex. Whether this is the market that has taken a turn for the better or the customers scrapping their own heat-exchanger manufacturing is not sure.

It is not really new entrants that are the problem but the existing entrants improving their product quality and widening their product portfolios. This can actually be viewed as intensified rivalry within the supply chain. Nevertheless this is a problem that Heatex must tackle head on. Their idea of doing it is not by price reduction but increased product performance and flexibility.

Of the five forces currently the substitute threat is the weakest. There has been some development in producing plastic heat-exchangers however it has not really caught on. But this could just be due to the fact that it is a slow market with few early adopters. If it catches on then it opposes a large threat to Heatex.

Stated in the Porters' five forces analysis are factors that affect all of Heatex. This information can now be translated down to how it will affect the order to delivery process and what kind of improvement is of most interest. Since Heatex strategy is not to exclusively compete in price but a combination flexibility, product diversity (customer adaptation), product performance, and compliance. This is a process development project; effectiveness is not related to product development. It is instead focused on delivery performance

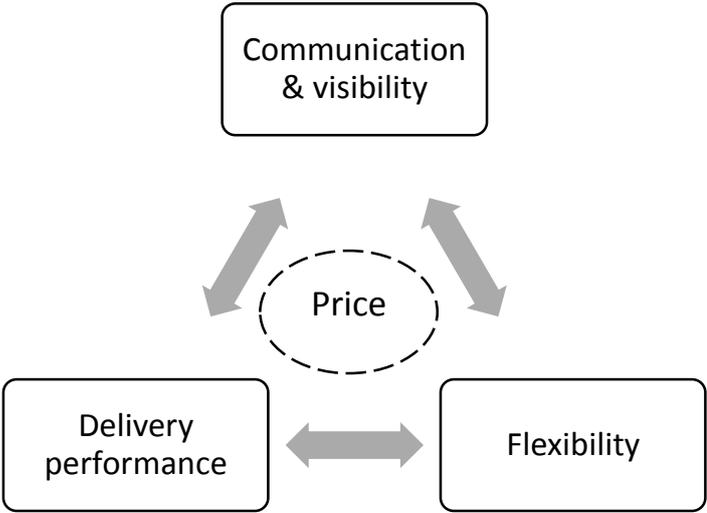


Figure 32 the goal for this process is not only to increase efficiency. Communication and visibility, Flexibility, and delivery performance are also of big importance.

such as on time, in the correct quantity and the right quality. The goal is neither just to increase efficiency as much as possible but also to improve visibility and communication to create an agile production that can handle disruptions, and assess and distribute information through the supply chain; the goals are illustrated in Figure 32. This could not only help with handling external forces but are also in-line with the internal factors for conducting this stud for example increased visibility between HAB and HSH. It is also important to understand that these factors illustrate what's important right now. If external changes happen such as the aluminum price a lot then these three boxes might be replaced with one, reduce cost.

4.1.2 Step 2 - Current-state and identified issues

With the boundaries laid out it is now time to shift the focus onto the process itself. To get an overview the current-state map is complemented with a map of the production layout and the contemplated product movement. The rotors are manufactured from diameter 500 mm to 3600 mm with 10 mm intervals, instead of looking at each size individually to and to easier identify patterns the products were grouped into seven groups with 300 mm intervals, see below:

1. 500 – 799 mm (G1)
2. 800 – 1099 mm (G2)
3. 1100 – 1399 mm (G3)
4. 1400 – 1699 mm (G4)
5. 1700 – 1999 mm (G5)
6. 1999 – 2299 mm (G6)
7. 2300 – 2600 mm (G7)

Before going into the VSM, the analysis will start by looking at what the process has achieved in delivered units from 2014. Figure 33 shows delivered units from January until end of October 2014. It shows a volatile demand with a quick ramp up and that in August the process was able to deliver twice as many units as any other month, however most of them are in a small diameter. This graph does however not tell anything of how well the process has been able to deliver these units in terms of over-time, faulty products, or production time per unit. According to the delivery performance KPI that HSH supplies they have had 100 percent delivery performance and 0 percent reclaims from customer, as mentioned before this is however unlikely.

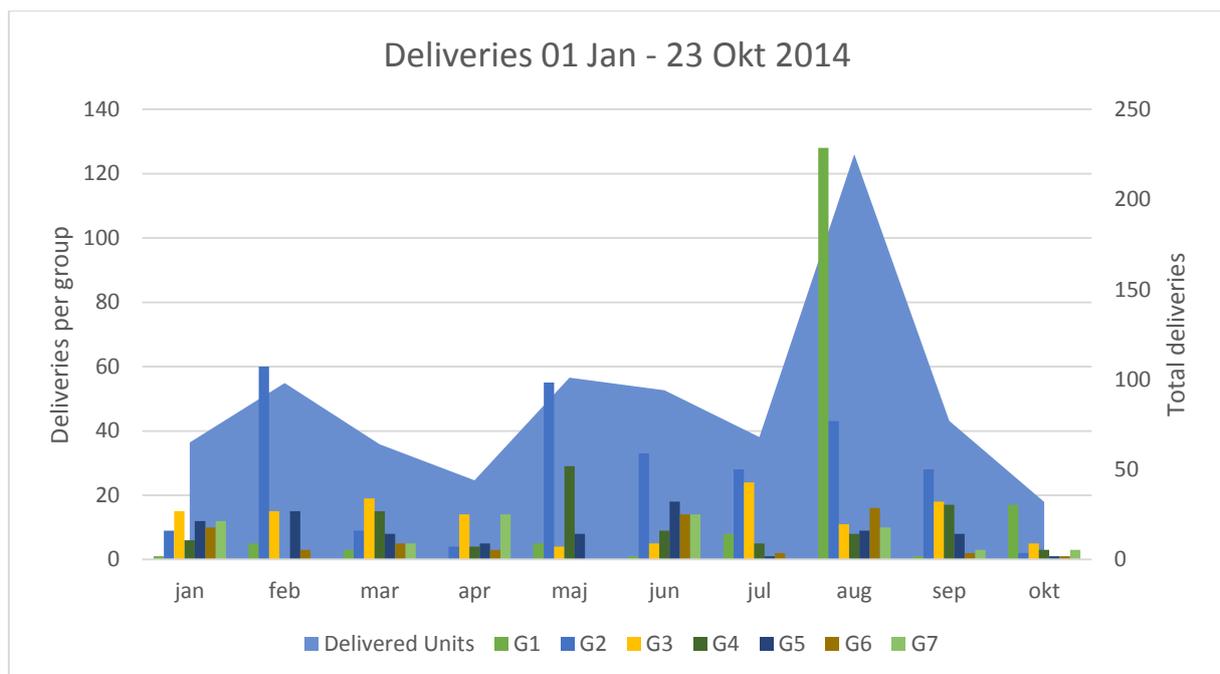


Figure 33 shows delivered units from HSH, the most popular product is the G2. For G1 there is mainly one large order that increases the sold units.

To better understand the VSM, presented in Figure 34 is the production layout. Marked with the thick arrow is the planned production flow and the thin arrows are component transport to the product flow. The production process starts with spinning, and is then placed in a temporary storage area before welding. The welding process requires a sweep and spoke that are cut on the opposite side of the assembly area and dragged to the welding table. This is done by the welder. After the rotor has been welded it is tested and mounted into a casing that has been assembled separately. The heat-exchanger then has to go through final assembly and packing before it is finished for shipment. This is further explained in the current-state analysis in section 4.1.2.1.

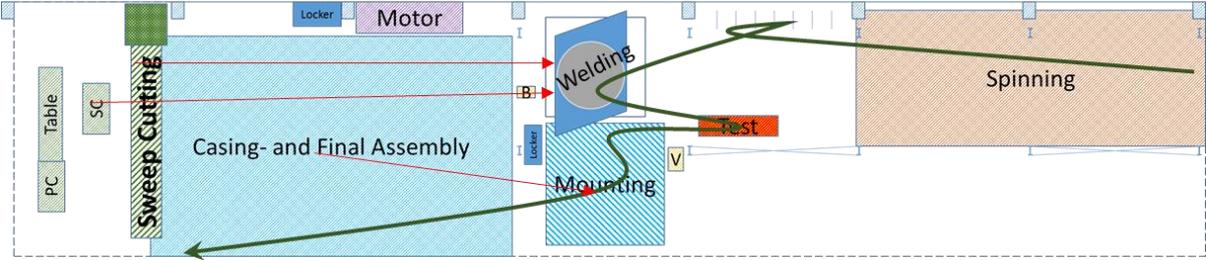


Figure 34 show the production layout at Heatex Shanghai. The green line shows the production flow from spinning, inventory, welding, testing, mounting, final assembly and then transported to packing. The red lines shows component flow for spoke cutting (sc), sweep cutting, profile cutting (PC), and casing.

4.1.2.1 Current-state value stream map

Presented in Figure 35 is the value stream map. It shows the order flow from the point when a customer confirms an order to Heatex until when the finished goods is placed on the truck bound for the customer.

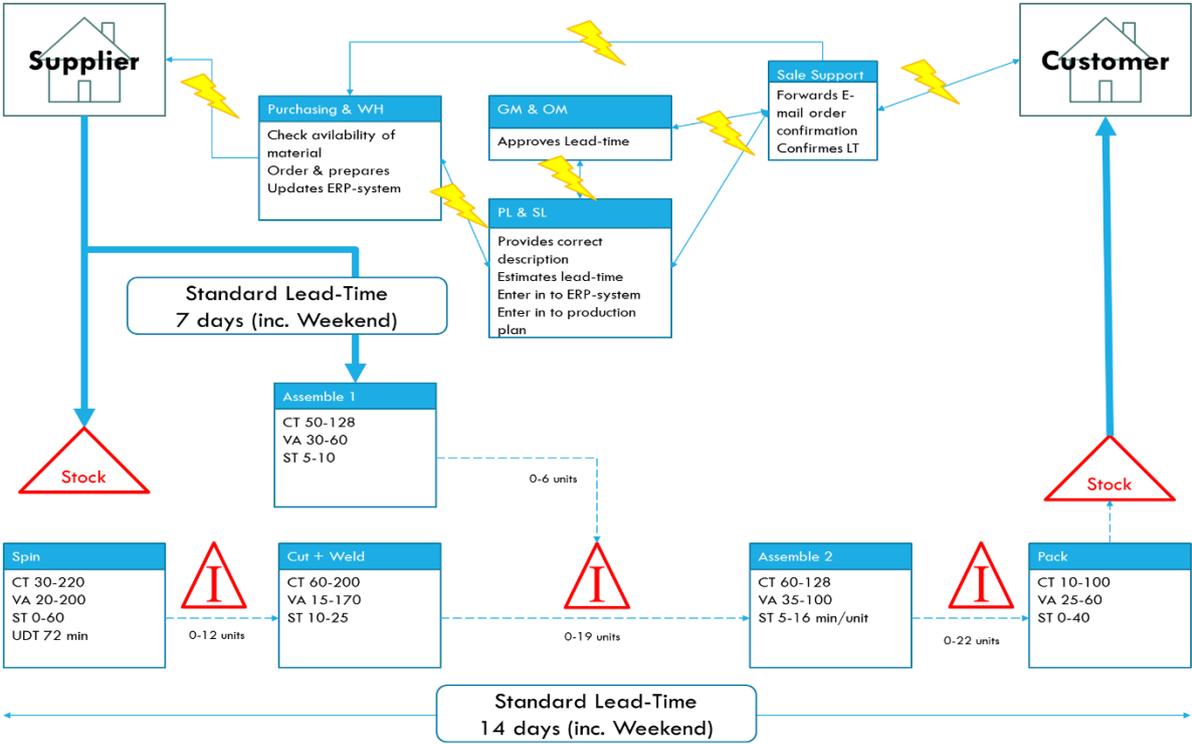


Figure 35 shows the current state map of the VSM analysis. The cycle-time for planning is highly dependent on the order. A repetitive order can be planned within 1-2 hours while a new order require substantially more time to plan, up to two days.

As we can see in the top right corner, the initiating sequence for the process is when a customer contacts the sale support at HSH with an order stating what type of heat-exchanger they want, and quantity. All Heatex products have a unique 34-sign description code that specifies all options available for the heat-exchanger. A customer can get this code either by software provided by HAB. In China however most customers have not learned to provide this code and send an e-mail with part of the description and a drawing for where the heat exchanger will be mounted. The people working in sale-support take this information and enter it into a standardized e-mail format that is then sent to the:

- General manager (GM) and operations manager (OM)
- Production leader (PL) and shift leader (SL) – Planning department
- Purchasing and Warehouse (WH) – Purchasing department

Sale support is also responsible for entering the order into the ERP-system, but this is in many cases done substantially later than the e-mail is sent out. The purchasing and warehouse department are together responsible for making the purchases and updating the ERP-system on component quantity level e.tc. The planning department is responsible for when and how the order should be produced. They plan this through the ERP-system which produces manufacturing order and schedule for the production. The lead-time to customer is set by the planning department but needs to be approved by the general manager or the operations manager; this separates the planning process from the Swedish production unit that instead uses a manager approved set of standard lead-times for each product. This system of communicating sales order via e-mail and not through the ERP-system results in that the purchase orders and manufacturing orders are not connected to the sales order in the ERP-system. This puts severe limitation on traceability and increases the risk of mixing components between orders as well as misunderstanding and miscommunication. All this has been grouped into one larger issue:

- The planning is time consuming, complex and hard to trace.

The schedule and manufacturing orders are handed out to the production in a stand between the spinning line and the welding table. But the schedule is also discussed during the morning production meeting to communicate changes and assure that everybody know what to focus on. The manufacturing starts with the spinning of the rotor. This is the only automated operation and is run with one operator. There is one spinning machine and one rotor can be spun at a time. Presented in Figure 36 is the operation cycle-time for the different operation steps. As shown in the graphs for the spinning line, the cycle-time is almost exclusively dependent on the rotor diameter; the largest rotors are also the most time consuming of all operation steps. Since HSH only have one spinning line this means that if demand exceeds one shift production they have to increase the working hours. In this figure the weighted cycle-time is also presented. This is the cycle time for the average produced wheel based on the delivered units presented in Figure 33. This shows that the spinning line is the second most time consuming operation step. The set-up time is dependent on three characteristics of the rotor; the two types of material and the well-height. To change both material and the well-height takes approximately one hour. But the planner tries to minimize the set-up time by producing similar rotors after each other which

reduces the set-up time. The spinning line is old and could benefit from some renovation. Not only could it increase efficiency it could also help standardize set-up time and minimize change-over time. In fact the spinning line is so old that it has been discussed that it should be scrapped altogether and build a new one. The largest issue for the spinning operation is:

- The spinning line is old and needs updating or replacement

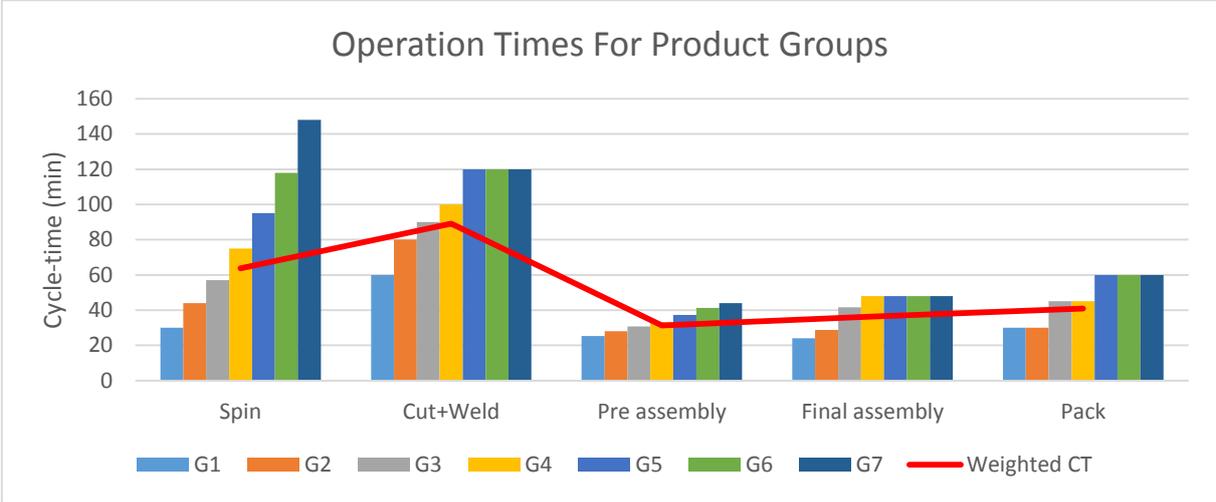


Figure 36 shows the operation times for the different product groups as well as the average cycle time "weighted CT".

Figure 37 presents the amount of WIP units between each operation step every morning. If there is inventory between the operations steps it means that the previous production step have produced more than the latter production step has been able to handle. When the monitoring started the production had been idle due to low demand for a while which means that they were only work in progress units in the assembly step. During the observation the process was also under low utilization however if both the spinning and welding operation is run at the same time, such as day zero and day one, it is common to have a few units waiting between the spinning and welding procedure. This is because the average rotor is faster to spin than to weld. The cycle-time for welding, presented in Figure 36, is not necessarily dependent on the size of the rotor. The welder is responsible for stabilizing the rotor by applying a sweep of thicker aluminum around the rotor as well as spokes diagonally across the rotor. Depending on the size of the wheel it requires between two to eight spokes for each side of each rotor. To do this the welder has to go across the assembly area to cut spokes and sweep in the right length and then carry it back to the welding table. The welder also has to cut sections across rotor for the spokes to sit in. So the welder who is employed, and paid, for his skills to weld aluminum is actually working 20 – 40 percent with other activities. The largest issues for the welding operation are:

- The welding is a bottleneck
- It builds up inventory between spinning and welding
- There is unnecessary transport in the operation
- Bad utilization of the welders skills
- Quality issues with the welding

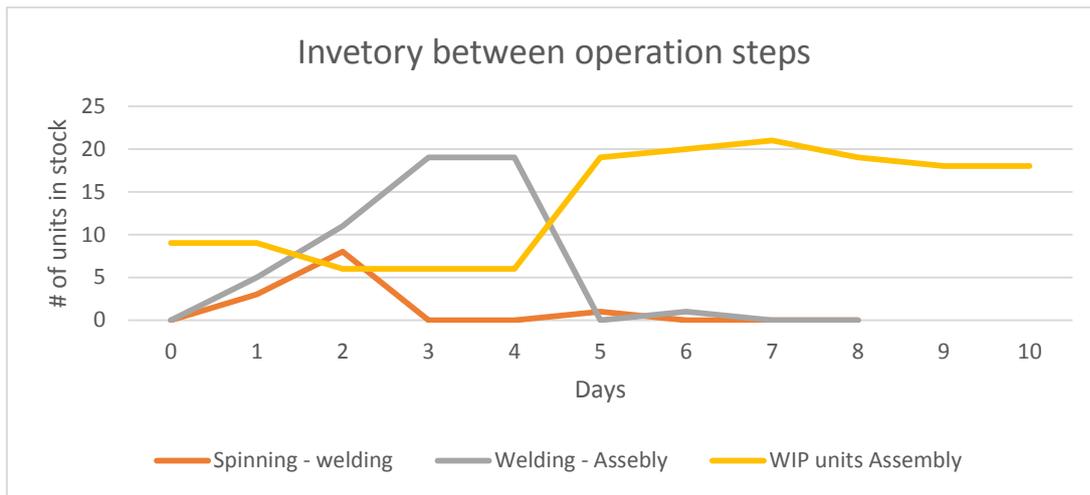


Figure 37 Inventory data was collected by counting the number of units between operations each morning. This resulted in the following graph.

The assembly operation is built up by two steps, case-assembly and final-assembly. The case-assembly consists of all actions done before the rotor is mounted in the case and the final-assembly is all actions conducted after the rotor is entered into the case. The main reason for the inventory build-up between the welding and assembly operation is because it is waiting for casings to be delivered and assembled. As soon as the casing and rotors are ready they are mounted in the casing, because it reduces the risk of damaging the rotor. The assembly team consists of 4 workers that together are responsible for assembling the products. Just by briefly examining the assembly operation it is easy to see that it suffers from lack of organization. There is no real structure for where the assembly should take place, or in what sequence different parts should be assembled. This results in a failing system for how tools and equipment are handled. It starts with a delivery of case-components on pallets that are placed somewhere close to the assembly area, not necessarily in it, the casings are assembled next to where the pallets are placed. When new case-components arrive it is unlikely for them to fit at the same place as they currently are working. The warehouse team will therefore place it where it currently is available space and the assembly workers will move over there to assemble the next batch of cases. This creates a non-standardized work-environment for the assembly workers. Moving around results in that tools are left on the floor together with a lot of electrical wires and it also effect the work procedure, not only is it dangerous to have electric wires crossing each other on the floor. It is also time consuming for the staff to look for tools that are spread out across the area. In the assembly area the production also goes from being a single order production in the spinning and welding operations to a batch production. For example, when the casings arrive all of them are assembled at one time, then all available rotors are mounted into the casings, and they continue to conduct one task at a time until all units are finished. Figure 37 does not present the amount of inventory between the assembly and packing operation, because it was so difficult to determine if a product was finished or not it presents the work-in-progress units at the assembly area. As shown it is between 10 and 20 units all the time that four people are working on. However this work is not synchronized that all four are working on completing one batch at a time. There is often several different units at different

steps in the assembly area. There is also a lot of orders overtaking each other, usually because of customers asking for earlier shipment, which means that the assembly workers suddenly has to stop working on one order and focus on another. These interruptions will of course affect the performance in a negative way. It creates confusion of what to do when the new order is prioritized as well as when the original work is resumed. The main issues within the assembly operation are therefore:

- It builds up inventory between welding and assembly as well as in the assembly area
- No structured working places
- No structured working procedure
- Unnecessary transport for finding tools
- Interruptions
 - Order overtaking
 - Discussions between workers
- Quality issues with the drive-belt

When the product is finished it needs to be packed to withstand the transport. The packing department consists of two workers that are responsible for making the custom pallets, weather sealing the packages, placing the goods into the temporary storage, and loading the truck before it is shipped off to the customer. This means that the products must be transported from the assembly area to the packing area; they are slowly transported by truck at high precision. For units larger than G4 the packing workers require assistance of another assembly worker. The packing of the product itself is generally dependent on the size of the rotor. Smaller units that can be shipped on an EU-pallet require less work than large products that are heavy and require custom packaging. This is however prepared while the units are assembled.

- Fluctuating workload
- Time consuming transport

4.1.2.2 Process Condition

Before examining the issues and deciding a focus for the project it is good to take a step back and comparing the data presented in Step 1 and Step 2 to further understand what actually is required of the process in order for it to maintain its competitiveness. Figure 38 presents an analysis based on Davenport's (1993) process rating framework. On the effectiveness axis the process has been rated competitive because it has a built up although fluctuating demand. No customer audit has been conducted however Heatex claims that the product performance is achieving customer expectations but the high amount of reclaims drags this down to just within the competitive field. Looking at the efficiency, the process is making money so in that aspect it is competitive but as presented above it has a huge improvement potential. If the process is not improved it is only a matter of time before at least one of the five market forces will suppress the process to non-competitive in either effectiveness or efficiency. Based on this analysis the process needs to improve both in its effectiveness and efficiency. This needs to be considered when evaluating what issues to focus on.

Efficiency	Process condition				
Process is defect free there is low unit cost, short cycle time, no waste, and low cost of poor quality					World class
Process is efficient, costs are low, waste is low and cycle time has been reduced					Best in class
Process is operating fairly efficiently, but has room for improvement in cycle time and unit costs					Competitive
Process is inefficient and needs improvement					
Process has major problems with defects, waste, long cycle time, high unit costs, staffing and procedural issues, and high cost of poor quality					
	Outputs do not meet customer requirements	Outputs meet some customer requirements	Output meet customer requirements	Outputs exceed some customer requirements	Outputs exceed most customer requirements
	Effectiveness				

Figure 38 shows the process condition of the order to delivery process for rotors at HSH.

4.1.3 Step 3 and 4 – Evaluation of identified issues and Find the root cause

In this study so far, the improvement project has gone from looking at external factors and assessing their effects on the process, to shift a focus towards the process itself and identify issues within and between sub-processes or “operations”. A complete list of identified issues is presented in Appendix F. This chapter presents the eight major issues that consist of grouped smaller issues. This major issue is represented in Figure 39 based on their estimated improvement potential as well as their required resources. As shown in Figure 38 the process needs to improve in both its effectiveness and its efficiency. Issues that can address both these have been ranked higher compared to the issues that will only address either. The required resources have been estimated based on required investment in money, time, and the amount of stakeholders. For example inter-company process has been ranked higher than intra-company. During this study the issues presented in this chapter were first evaluated and discussed before narrowing it down to three issues to find the root-cause of these issues. However to provide an easier overview for the reader in this report the issues that were chosen for further analysis, marked in in Figure 39, are presented first as well as their identified root cause in section 4.1.3.1. To find the root-cause meant once again stepping into the process with primarily focus on the issues, and applying the five-why analysis. Looking into individual peoples work procedures and performance can be somewhat of a sensitive area. As presented in the theoretical framework, China is a collectivist country. All responses to a five-why analysis will be adapted not to lose face for the individual and/or group. In this case it meant that the five-why analysis could not just be

conducted by asking a translator why five times but had to be evaluated with extensive observations as well. The issues that were not chosen for further analysis are presented in section 4.1.3.2 because of their relevance for the process and are important for HSH and HAB to continue working with.

As displayed in Figure 32 is that Heatex compete in a combination between in price, communication, flexibility, and delivery performance. The issues has therefore been ranked on their abilities to combine these statements to improve in efficiency and effectiveness.

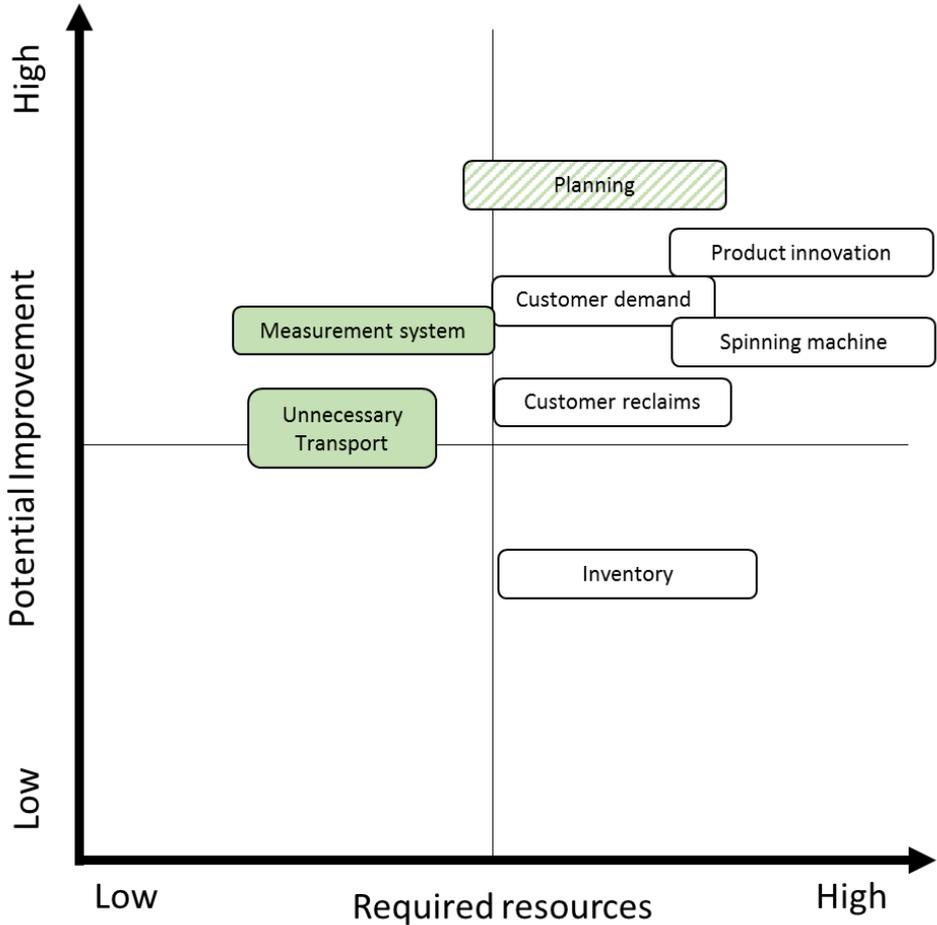


Figure 39 shows an estimated ranking between the issues made by the researcher and managers at Heatex to decide what to continue focusing on. Issues marked in green is the new focus for the study, the issue in striped green has been theoretically analyzed.

4.1.3.1 Issues for further analysis and root cause

4.1.3.1.1 Planning

The planning process involves several people and departments in the company. Even though an ERP-system was implemented ten months ago old habits still exist and information flows the same ways as it used to. This is viewed as one of the biggest challenge facing HAB and HSH. HSH clearly has not realized the potential of using an ERP-system. Implementing this properly offers the opportunity to both communicate easier and more accurately with both suppliers and customers which could improve effectiveness. It could also help to better plan

and coordinate resources and thereby reduce cost and ultimately help the process improve in both effectiveness and efficiency. The goal is that by improving the planning procedure the order will have a shorter processing time and reach production faster and ultimately offer a lead-time reduction. A global standardized use of an ERP-system also offers easier and more frequent communication between the entire Heatex group as well as increase the monitoring abilities for HAB. To get this implemented properly will require further extensive training at almost all levels and functions of the company. It is more of an organizational issue than an issue for the order-to-delivery process.

Improving the planning can also help to solve some policy related issues, such as the production starts manufacturing before the customer has provided a delivery date. HSH thinks that by producing the order early they will maintain available capacity in the future if they receive an order. However this does not only bind capital it is also a risk if the customer change their mind, or the project is placed on hold e.tc. The researcher has identified this to be one aspect that has an impact on the large amount goods in the finished goods warehouse. Another issue is that it has been witnessed that products have gotten stuck in the assembly area due to missing components. By improving planning and communication the process can work with these issues in an easier way. It may also open possibilities to work closer with the supplier to reduce the risk of this happening.

There are two types of innovation projects, continuous and innovation. One way to look at it is that continuous improvement is the daily fight to keep the process competitive and innovation improvements aims to dramatically improve the process to win market shares and climb between steps in the process rating framework, Figure 38. For the process to be able to move up to best in class, the planning issue has been identified as the main problem to deal with. It is therefore placed at the very top right end of Figure 39 with high improvement potential but does require a substantial amount of resources. To deal with this issue it requires behavioral change, the cause is identified as the lack of understanding at HSH for the possibilities that an ERP-system come with.

4.1.3.1.2 *Unnecessary transport*

There is a lot of unnecessary transport in the production. This is a large problem at HSH as goods and people are frequently moved across the facilities. This has mostly been witnessed within the labor intensive operation steps welding, assembling, and packing. The welding and assembly operations are viewed as the most critical and this study has focused on them. Even if the welding operation is more time consuming the assembly operation is depending on both the welding as well as the delivery performance from the supplier. Since dealing with this issue will mostly improve efficiency it is ranked as a medium-high level in Figure 39. However it could increase flexibility as well as delivery performance and is therefore chosen to be further developed in this study.

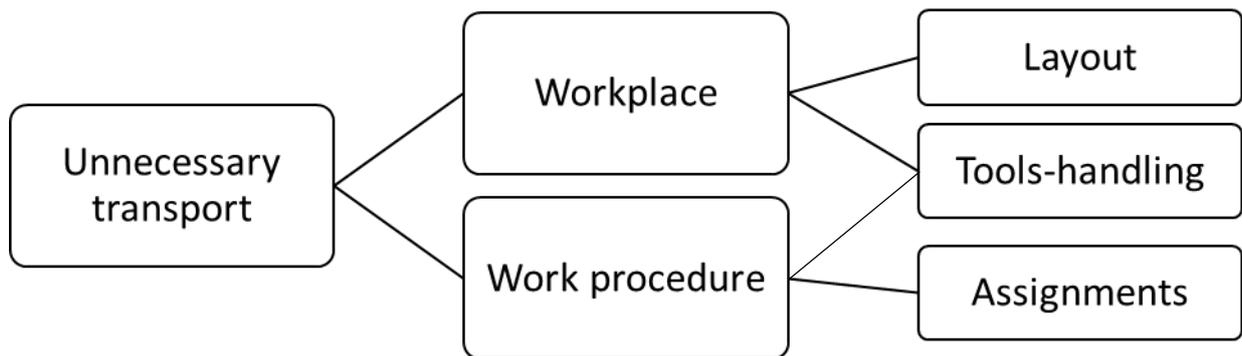


Figure 40 shows the unnecessary transport that is built up by where the work is located "workplace" and how the work is executed "work procedure". The workplace is of course affected by the overall layout but it also have a large impact on the tools-handling for the assembly operation which of course effects the work procedure. The work procedure is for the welding and assembly area mostly built up by small individual tasks that have limited dependencies and offers frequent interruptions.

Presented in Figure 40 is a graphic representation of why the unnecessary transport exist in the production. It is built up by a combination of both where the work is conducted "workplace" as well as how "work procedure". The workplace and work procedure are of course related, and needs to be adapted in relation to each other. The layout should determine where work is being conducted and for the welding operation that require the use of fixed machinery for spoke- and sweep-cutting it does. The problem is that these machines are located at opposite sides of the assembly area which results in the welder having to walk between these places see Figure 41. A return trip between the welding table and the cutting area takes on average three minutes. The transport itself is not just an issue but all the interruptions that comes with it. This is a high-precision operation step which requires careful measuring. If the welder has made a mistake and measured wrong or when he/she is about to cut gets insecure and decides to double check, then it is suddenly two return trips and every time that work is interrupted it take some time to resume it again. This can lead to errors and miscommunications. While walking across the assembly area the welder is also frequently asked to assist with handling the large products which creates further interruptions. The spokes can be over one meter long and the sweep can be longer than eight meters. It is not only heavy to carry when it is dragged across the concrete floor it results in marks on the product that is visible for the customer. For the assembly area, the lack of structured workplaces creates a non-standardized work-environment that results in efficiency loss as well as it increases the risk for quality issues and danger for the workers. The handling of tools shows the relationship between the work place and work procedure. The products that are manufactured are large, heavy and difficult to move even with a truck. This makes it easier for the assembly workers to move themselves rather than the products. However it is not actually just the people that have to move around the goods, it is also all of the required tools and components that are required to assembly a finished products. The current set-up is that all tools and components are stored in lockers close to the motor station, if the system were followed that would mean that the workers would have to go

back and forth between every components has been assembled, this would probably be even more time consuming than just leaving the tools on the floor.

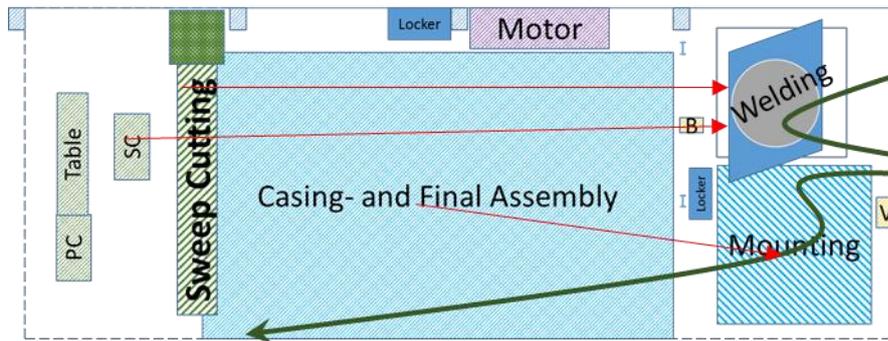


Figure 41 shows the layout for the welding and assembly operation. The welding operation has fixed machines such as the welding table, spoke cutting (SC), and sweep cutting that are located on different sides of the assembly area. The assembly operation have no fixed location for casing- or final-assembly.

As discussed earlier the tools handling is also dependent on how the work is supposed to be conducted, the working procedure. Both the welding and the assembly area is built up by small tasks that in themselves are not particularly time consuming. When a worker has started with one task he/she tends to conduct it on all available units. The work procedure is depending on the layout, just as the layout should reflect how the work is being conducted. For HSH the layout has been identified as the largest problem. Before a proper layout is set it is not possible to evaluate the working procedure. This is a good example of how HSH could work with continuous improvement, as soon as a layout has been implemented HSH should focus on optimizing the work procedures to help the process remain competitive on the efficiency axis and help with delivery performance.

By adjusting the layout together with looking over the tools-handling can improve performance of both the welding and assembly operation, which will improve overall efficiency. Therefore the following root-causes have been identified to develop improvement suggestions for:

- Reduce the distance between the cutting station and welding table
- Develop a system that handles the tools in the assembly area

4.1.3.1.3 Measurement system

The fact that the process doesn't have a measurement system is a large problem. Not only is it a prerequisite for process development it also a way of finding issues as early on in the process as possible. The only company provided KPIs found for the process are delivery performance, and customer claims. These KPI's tells only of the outcome of the process rather than the process itself and since all but customer claims show perfect score they do not identify issues before it is too late. To be able to develop a process it needs to be continuously monitored to know that it is being developed in the right direction. There is no cause for the fact that the process doesn't have a measurement system. It has simply not been implemented.

This issue is one of the causes for why the researcher was sent to HSH and will off course be evaluated further. By addressing this issue it brings the opportunity to increase

communication and visibility which in itself opens up for further improvement. It also should offer input to detect problems in time to be able to improve delivery performance. Since this issue has the opportunity to in the long run improve both efficiency and effectiveness it has been rated as a high improvement potential. The biggest difficulties and require most resources is to develop a system that can fit into the low-tech environment at the production floor as well as training the staff that only speaks Chinese.

4.1.3.2 Description of identified issues that have not been evaluated further

4.1.3.2.1 The spinning machine

The spinning machine is old and suffers from frequent unscheduled downtime. All set-up and change-over-time is done manually practically with a screwdriver. This is not only time consuming but also requires substantial “know-how” from the spinning operator. HAB and HSH are together looking into the different options for how to deal with this issue the available options are replacing or renovating. Both are expensive alternatives and will probably mostly to improve in efficiency and reduced quality issues. It is therefore ranked as a high potential improvement but also high required resources. The reason for why the potential improvement is so high when it will only affect one process step is because at one point in the future the spinning line will break down beyond repair and unlike any other operation step getting a new spinning line is much more time consuming and expensive than for example buying new welding equipment.

4.1.3.2.2 Inventory

There is inventory building up both between the operations as well as in the finished goods area. Inventory between operation steps is a common symptom for bad line-balancing. It means that inventory is waiting without any value being added to them. These are warning signals for poor line-balancing which can result in poor efficiency. There is also a lot of goods in the finished goods warehouse. This is of course capital binding. However dealing with this issue alone before the operation steps such as welding and assembly are in order will probably not yield much result. The fact that it builds up inventory in the finished goods warehouse as well indicates that there is other issues than just poor line balancing.

This is an expensive issue for HSH to have. At this point however it looks like it is the price of flexibility. Decreasing the work in progress inventory or the finished goods warehouse before having a process that is flexible enough to respond to customer demand and changes will most likely result in a tougher customer climate. This is why the potential improvement has been ranked low for now, however with a more flexible process it should be a direct requirement from HAB for HSH to reduce their finished goods area.

4.1.3.2.3 Customer reclaims

January to September, HSH has delivered 835 rotors. Of these rotors 8.6 percent has been reclaimed by customer. For some issues HSH has taken steps to deal with them. However there is a feeling of lack of know-how for some of the issues and products are currently being delivered with the same set-up. This is by far the largest issue on the effectiveness axis. HAB has launched an extensive program to deal with this issue and is therefore not further evaluated in this study. It is however presented here to demonstrate that if they are

focusing on the effectiveness of the process this study can focusing on develop the efficiency. To deal with this issue require customer visits to examine already installed rotors as well as supplier co-operation to and was therefore marked high on the required resources.

4.1.3.2.4 *Product innovation*

There has also been identified an opportunity for diversification by developing new products. This issue is rated outside of scope because it is more of a research and development project. There is a general feeling presented both at HAB and HSH that they have fallen behind on their product development. This could prove necessary to maintain products that reaches customer requirements. It will of course require a substantial amount of resources.

4.1.3.2.5 *Customer demand*

That the customer demand is fluctuating is a problem that creates tension in the production process and perhaps could be aided by closer co-operation with the customers. However the extensiveness of this issue have not been evaluated further because it was deemed outside of scope.

4.2 Analysis of the empirical findings and implementation of improvements

This marks a turning point for any development project. Up until now the goal has been to extract as good and objective data as possible from the process to analyze and identify what to focus on to achieve improvement. From this point on the goal is to develop sustainable solutions that will remove the issues and work in reality. This is why the culture evaluation was conducted at this point and is presented in chapter 4.2.1 to give input to the development and evaluation of the suggestions presented in chapter 4.2.2. In chapter 4.2.3 and 4.2.3.2 the results of the changes are presented as well as the future state map and an action plan for the improvements.

4.2.1 Step 5 – Culture evaluation

This chapter presents the national culture evaluation based on Hofstede's national culture dimensions (Hofstede, Hofstede et al. 2010). Before evaluating the national culture a corporate culture evaluation was conducted, presented in Appendix G. Since HSH and HAB are managed similar differences are more likely to stem from national culture than corporate culture which is why the corporate culture analysis is left outside of the report. However the order to delivery process is still affected by the corporate culture and was therefore evaluated as well. It is important to note that all statements presented in this chapter are generalizations that has been observed by the researcher, experienced by employees at HAB, or explained by employees at HSH. They tell nothing of the individual people's response which of course can be very situation specific. The Score presented in the beginning of each section is collected from Hofstede's research (Hofstede 2014).

4.2.1.1 *Power distance*

- Chinese score: 80
- Swedish score: 31

Just like the score for China suggest, Heatex Shanghai has a strong hierarchical chain of command to make decisions that are respected by the employees. If for example there is a problem in the production, the production worker would tell the shift leader who would tell the production leader. If the decision is outside of his mandate then the production leader would go and discuss with the operations manager. The result of this is that the information is interpreted several time as it climbs through the organization and when it finally reaches the decision authority it often requires for that person to go evaluate the problem himself to be able to make an informed decision.

A high score in power distance could imply that people should not have aspirations beyond their rank. This does not necessarily apply to HSH because of their history of promoting hardworking and competent employees.

4.2.1.2 *Individualism*

- Chinese score: 20
- Swedish score: 71

China is a collective country, a country where it is important not just how you present yourself but how the group is reflected in you. The collectivist culture in China is difficult from the individualistic culture in Sweden and can be very difficult to get a grip on. Individual representation in China is to a greater extent reflected on the group and blame should never be placed within the group. This in combination with a high score in power distance creates a culture were issues are hidden or polished and is only brought to a superior when it is absolutely critical. When confronted the answer provided will often be a combination of the actual cause, what he or she thinks the other person wants to hear, and also not to reflect badly on the person or the group. This collectivist culture combined with a strict chain of command results in that employees don't want to disturb their boss unnecessary and only the most critical issues and problems reaches the surface. This means that issues must be easy to visualize in a matter that they cannot easily be hidden.

At HSH, groups and formations can clearly be seen, however no hostility or unfriendliness has been witnessed between groups or towards the researcher.

4.2.1.3 *Masculinity*

- Chinese score: 66
- Swedish score: 5

Success is important in China, if problems arise they are mostly handled on the spot and when suggesting changes preparation is of most importance. Chinese managers are used to making rapid decisions and when they are presented with an issue within their responsibility they want to fix it immediately. Rather than pointing out issues it is better to present suggestions that deal with these issues and discuss the best solution with the manager. It is

important to remember that in the end it is their decision to make. Not understanding this can hurt the relationship.

Chinese people, in general, work hard and have a drive to succeed, this is also seen in the underlying governmental system as the legal holidays and vacation days are few compared to Europe. The urbanization is a huge driving force and several of the employees at HSH have moved far away from family and friends to live and work in Shanghai. Even if China is a masculine country, acknowledging this and ask questions about an employee's origin will strengthen the relationship significantly. Maintaining a good relationship in China is a make or break factor.

4.2.1.4 Uncertainty avoidance

- Chinese score: 30
- Swedish score: 29

Chinese people have an entrepreneurial spirit and are not afraid to try new things to achieve a certain goal in that sense they are not afraid of uncertainty. They are however still affected by their collectivist way of thinking. If they are unsure of why an issue is being questioned or just a question being asked, chances are that they will adapt the answer or change the conversation to a positive attribute within the same problem. Pressing on about an issue will not yield any results, as discussed in the masculinity section, it is better to focus on alternatives for how the work should be conducted to deal with the issue.

4.2.1.5 Pragmatism

- Chinese score: 87
- Swedish score: 53

The sense of shame in China is big and relationships are valued highly. Their view on long-term orientation is to maintain a long and prosperous relationship. This makes it an excellent negotiation point. By acknowledging the relationship and developing it, the exchange of favors, which is a fundamental part of Chinese culture, is also acknowledged.

4.2.1.6 Indulgence

- Chinese score: 24
- Swedish score: 78

The Chinese restrained culture may be hard to identify especially in Shanghai where the outwards appearance is of extreme importance. Expensive handbags, cars, clothes, and of course very tall buildings are all part of everyday Shanghai and absolutely must be categorized as extreme indulgence, however these are all superficial signs of culture. The individual is still restrained and highly controlled by social norms. For example is people employed to do what they do and do not require thank you, and smiling when not among friends is considered weird.

4.2.2 Step 6 – Developed suggestions

Keeping the culture evaluation presented in chapter 4.2.1 in mind as a tool for how change can be created and suggestions can be adapted. The researcher first developed suggestions

to deal with the presented causes. These were the presented to the operations manager, production leader, and shift leader and discussed and developed through a Kaizen event.

4.2.2.1 Planning

To deal with the planning issue will require substantial organizational change and to achieve this extensive training of the staff is required. HSH does not have the required skills to manage this on its own and require help from HAB. To deal with this issue the researcher recommends that a cross-functional team is put together with team members both from HSH and HAB. It should ideally consist of sale-support manager, Purchasing manager, and production planner from Sweden. From China it should ideally be the operations manager, production leader, sale-supporter, and purchaser. This is because of their required professional and ERP-system expertise within their respective field. The sale-support manager and production planner in Sweden have a close co-operation for all actions required to take a product to the production and the purchasing manager and production planner together with the operations manager and production leader together have a good understanding of how to get a product through production. Their goal is to develop a planning process that works in the Chinese environment that can be adapted to suit all the production lines. By implementing it at function after function and assuming that the same system that works in Sweden will work in China is what made the first implementation attempt to fail.

Presented in Figure 42 is an action plan for how HAB and HSH could conduct improvement projects for the three issues of planning, inventory, and the spinning line. By involving the Swedish managers will not only give a required boost in the form of a management push, it will also give them an understanding of how HAB can monitor and assure that the system is followed even after they go home. It will also give them a deeper understanding of how they can improve the current system in Sweden. Since the cause of this has been identified as a lack of understanding of how an ERP-system can improve production it is important that the project focuses on giving this insight at HSH. Not only demonstrating what to do but why to do it as well. To succeed with this kind of project it should be conducted over a few weeks, no less than two, with everybody in place in China at the same time and at least another week for someone to stay behind and assist with questions or issues that come up. While addressing this issue it is also suitable how this can help to limit the inventory in production. While training the staff in the office, this could be implemented in the production. The team will probably need extensive technical support from the IT-department to adapt the ERP-system as well as develop a solution that gets around the slow connection between Sweden and China. What the planning process itself should look like has not been developed further because it requires further extensive cross-functional analysis.

Action Plan							
Week	1	2	3	4	5	6	7
Planning							
Evaluate and Develop solutions							
Implement							
Train Staff							
Audit compliance							
Inventory							
Evaluate with the planning issue							
Implement							
Spinning machine							
Evaluate alternatives							
Develop solutions							
Make action plan							

Figure 42 presents the recommended action plan.

4.2.2.2 Unnecessary transport

Several suggestions for how transportation could be reduced in the workshop was developed and are presented in Appendix H as well as a Pareto analysis that evaluates the different suggestions. Presented below are the chosen suggestions that were implemented during the Kaizen event.

4.2.2.2.1 New layout

The new layout is shown in Figure 44 and compared to the old layout presented in Figure 43. By twisting the welding table it was possible to fit the testing area on the other side of the welding table this together with dividing the casing assembly and final-assembly area the production flow becomes a straight line with a slight curve at the end. After a discussion with the production leader it became apparent that the profile cutting that provides the other production lines with components would also benefit by moving it next to the welding operation. The profiles are six meters long before they are cut, both the profiles and the spokes have up until now been stored on the floor next to the cutting area. This would not be possible at the new location. For a single person to be able to cut the long profiles it requires support from underneath at the same height as the saw. To solve this, workers had placed a table in level with the saw, but this would also not fit at the new location. As it turned out, HSH had a spare profile rack disassembled behind the factory. By assembling it and placing a shelf at the same height as the cutting saw this shelf could replace the table and be used as a forward piece pick area while the rest of the shelves are used as storage for profiles and spokes.

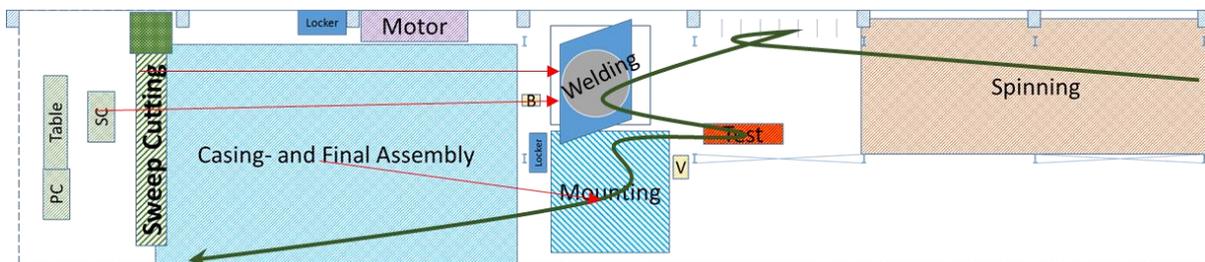


Figure 43 shows the old layout at HSH

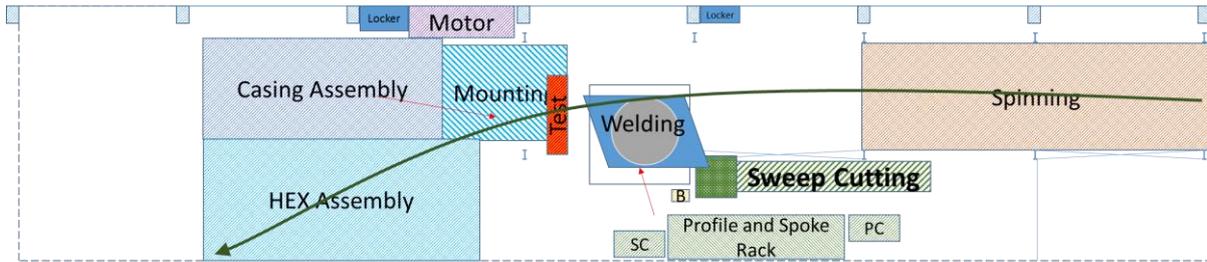


Figure 44 shows the new layout for HSH spinning line.

The new layout does not only make it easier for the welder to cut the spoke and sweep. It also makes it easier for either the spinning operator or an assembly worker to help with the non-welding activities, such as profile and spoke cutting. Presented in Table 9 is the estimated improvement that the new layout presents for the welding operation. The minimum improvement is the return trip across the assembly area. The expected improvement is the same trip and the estimated interruption time before work resumes and the long-term benefit is for high demand situations when for example the spinning operator can assist the welder by cutting profiles and spokes.

Table 9 presents the potential improvement of changing the production layout. Minimum improvement is calculated based on the reduced walking time for the welder, expected improvement is reduction of walking time and interruptions due to the walking. Long-term benefits are achieved if the welder is helped by either the spinning operator or an assembly worker.

	Current capacity	Minimum improvement	Expected improvement	Long-term benefit
CT reduction		3	10	17
Current CT	89	86	79	72
Capacity per shift	24	25	27	30
Improvement (%)	0%	3%	13%	24%

4.2.2.2.2 Tool-belts, cart and a 5-s working environment

As mentioned before there is no real structure in the assembly area. Tools are spread out on the floor which is dangerous for the workers, creates unnecessary damage to the tools and is also time consuming to find the requested tool. While every tool currently has a marked place it should be placed along the wall to one side of the area. It may make perfect sense in theory to place all the tools to one side to get an overview, however in reality as soon as there is a minimum amount of pressure on the production line this system will fail.

By giving the assembly workers belts with the most frequently used tools and placing the less frequently used tools on carts with wheels between the casing-assembly and final-assembly the work-environment would become more structured without having to move the products more than they currently do. As presented in Table 9 and Table 10 this could increase efficiency. These estimations are based on timed observations for how long time operators spend searching for searching for tools and components for the different assembly steps.

Table 10 by implementing tool-carts and belts for pre-assembly the following improvements could be achieved. The results are calculated based on timed observations.

	Current	Minimum improvement	Expected results	Long-term benefit
CT reduction		1	2	3
CT	31	30	29	28
Capacity per shift	69	71	74	76
Improvement (%)	0%	3%	7%	11%

Table 11 by implementing tool-carts and belts for pre-assembly the following improvements could be achieved. The results are calculated based on timed observations

	Current	Minimum improvement	Expected results	Long-term benefit
CT reduction		3	6	8
CT	36	33	30	28
Capacity per shift	59	65	71	76
Improvement (%)	0%	9%	20%	28%

Another reason for implementing this change is the frequent customer and supplier audits in China. If issues are found action plans must be provided to deal with these problems. HSH has frequently received bad performance in the 5-S audits and this could improve the 5-S audit results.

4.2.2.3 How and what to measure

Since the current KPI's are focused on measuring the output of the process. The new system should therefore complement the current system by evaluating the production rate. Based on the corporate strategy provided by Heatex and a discussion with the operations manager at HSH and global operations manager at Heatex the system were decided to contain the following information or KPI's:

- Produced units compared to maximum capacity
- Average product throughput time and waiting time

There are no computers in the production which makes it a challenge to extract good information in an efficient way. It turned out that the easiest and fastest way to get the information was by pen and paper. By having the workshop workers filling in a paper for each manufacturing order:

- Manufacturing order number
- Start date and Start time
- Finish date and Finish time
- Amount of products produced
- Rotor diameter

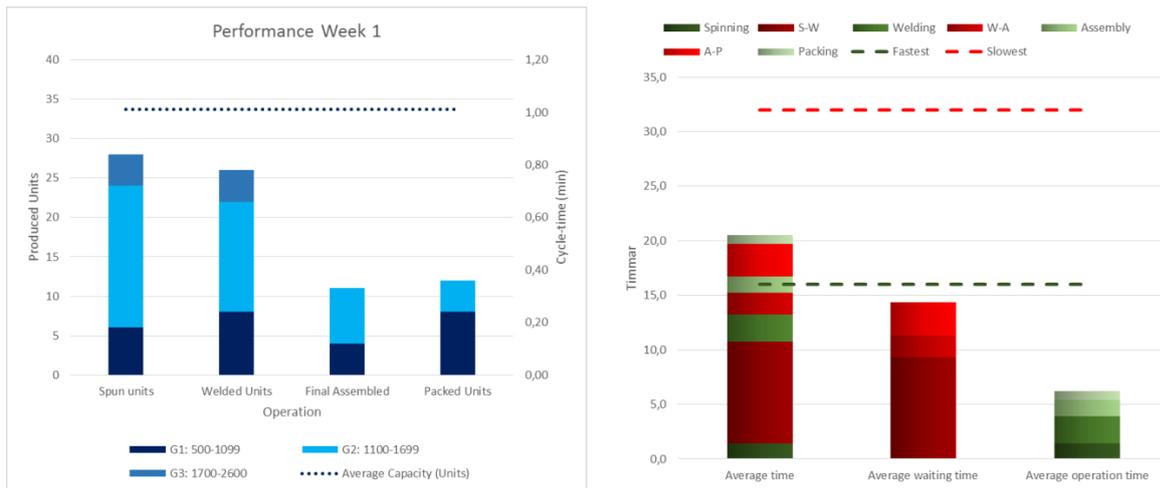


Figure 45 shows the new KPI's for HSH spinning line and are updated weekly. The left graph shows the production rate, and the bottleneck capacity (currently the welding operation). The graph on the right shows the throughput time compiled into waiting time in red and operating time in green. The green dotted line shows the fastest throughput time and the dotted red shows the slowest.

This data is then weekly entered into a pre-programmed excel sheet, and the Graphs presented in Figure 45 is printed and discussed at the Monday production meeting as well as placed in the production. The measures that are shown are:

- Produced units based on size (small, medium, and large)
- Average bottleneck capacity
- Throughput time
- Operating time
- Waiting time

4.2.3 Step 7 – Action plan, implementation, and measured results

The suggested changes presented in section 4.2.2.1 – 4.2.2.3 will only have a limited effect on the future-state map. A reduction in cycle-time for welding and the assembly operations which is easier to see in Table 9, Table 10, and Table 11. It is therefore no need to present a map here. A more long-term theoretical future-state map based on conducting the planning improvement project is presented in Appendix J.

4.2.3.1 Implementations and Action plan

To implement the changes the researcher, operations manager and production leader developed an action plan that clearly divided responsibility for each action as well as deadline. In this way everybody knew what were supposed to be done and who was responsible for it as well as why it needed to be finished by a specific date, see Appendix I. The new layout and the measurement system were implemented during the first week of December 2014, while the other changes were spread over the following month.

4.2.3.2 Measured results

The implemented KPI-system was used for measuring the results. This is of course not ideal as it was implemented at the same time as the other changes which makes the data measured by the researcher and the data from the KPI-system difficult to analyze. The only available data is for December 2014, presented in Figure 46 are the amount of produced

units for each operation step compared to the bottleneck capacity for welding, one shift production. For all weeks the process is well below the desired demand. This means that the workers can work slower and still make the deadlines. This is also reflected in the throughput time in Figure 47. The fastest order to pass through production did it in 39 hours which is about five days However the slowest order passed through production in 85 hours which is well above ten days which indicates that they are still manufacturing orders too early to keep available capacity for potential orders to come in or it has been overtaken by higher prioritized orders.



Figure 46 shows the measured results from the KPI system from 2014-12-01 - 2014-12-30

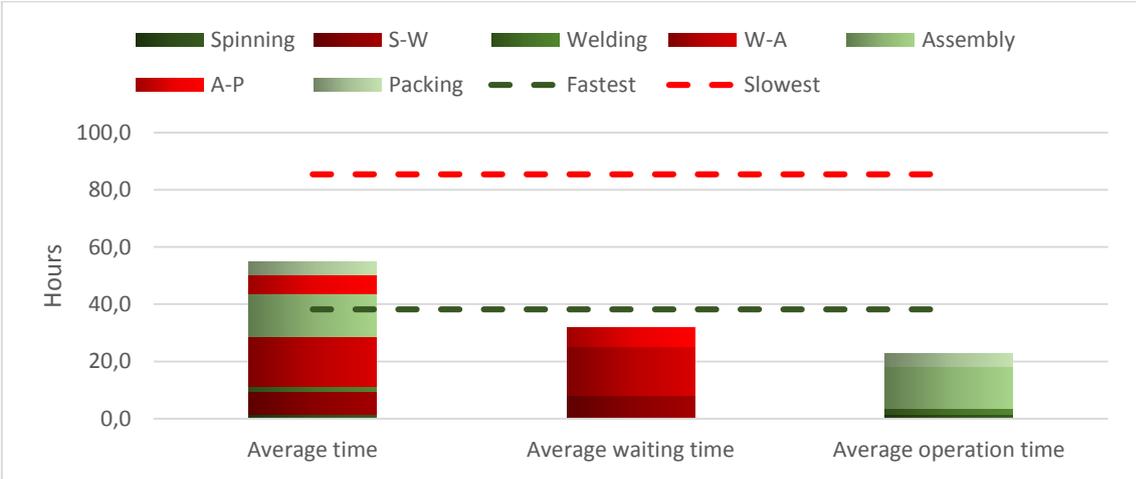


Figure 47 presents the average throughput time and shows both waiting time and operation time.

As we can see in Figure 47 the average waiting time is longer than the average operation time. This operation time is just the difference between starting and finishing time and probably contains some waste time as well. Despite this is there even more waiting time between the operation steps. Much like the inventory issues suggest. By assessing the planning issue the development team should also aim to develop a process that can handle the waiting time in a better way.

Presented in Table 12 is a comparison of the cycle-times presented in the VSM and the cycle-times presented from the KPI-system. It mostly shows the importance of carefully measuring before and after. Since the measurement is not done in the same way or by the same people, the data hard to compare but some similarities can be identified. The spinning cycle-time is faster than the welding cycle time. Although they are longer than in the VSM that can probably be related to the low demand. For the cycle-time for the final-assembly something drastic has happened. The fault has been derived down to four possibilities.

1. The assembly workers start measuring from when they assemble the bearings. This is usually done when the rotor is welded which means that some of this time should be waiting time for casing arrival.
2. They have included the time for casing-assembly
3. The researcher has measured substantially wrong
4. Combination of the above and the low demand

This makes it impossible to evaluate if the changes has improved as much as the estimations. But if the system is continued to use it will be easier to evaluate future changes.

Table 12 presents a comparison between the average CT that the researcher calculated in the current-state analysis and the numbers presented by the KPI system. Since the measuring were not done in the same way or by the same people the data is hard to compare.

	Spinning	Welding	Final-assembly	Packing
Average CT VSM (min)	63,7	89,2	45,5	40,9
Average CT after (min)	85	120	840	270
Differentiation (min)	22	31	794.5	229,1

4.2.3.3 New Process condition

Even though the results are somewhat hard to analyze the process has taken a step towards being more efficient and effective. According to the operational manager, HSH spinning line has reduced the amount of tools on the floor to zero, and he experiences a more natural flow and working environment which makes it easier to assign resources. But the biggest reason for why the process is somewhat more efficient and effective is that the management has at least for now realized the need to carefully measure the process both before and after improvements in order to stay competitive. Presented in Figure 48 is three different scenarios. Alternative 1 presents the process condition with the implementations that this study has conducted which to be honest will only have limited effect on the

efficiency axis. Alternative 2 presents the process with the HAB launched quality projects finished. This would move the process further into the competitive area however it is not enough to place the process into the best in class field. Alternative 3 presents the process if HSH and HAB together look into the planning issue and design a process that addresses the substantial amount of waiting-time currently in the process.

Efficiency	Process condition				
Process is defect free there is low unit cost, short cycle time, no waste, and low cost of pro quality					World class
Process is efficient, costs are low, waste is low and cycle time has been reduced					Best in class (3)
Process is operating fairly efficiently, but has room for improvement in cycle time and unit costs					(1) (2) Competitive
Process is inefficient and needs improvement					X
Process has major problems with defects, waste, long cycle time, high unit costs, staffing and procedural issues, and high cost of poor quality					Non competitive
	Unhealthy				
	Outputs do not meet customer requirements	Outputs meet some customer requirements	Output meet customer requirements	Outputs exceed some customer requirements	Outputs exceed most customer requirements
	Effectiveness				

Figure 48 shows the current process condition based on Davenport's (1997) framework (1). It also shows the potential process condition based on the quality improvement project (2) and the if a planning and inventory project is launched (3). The X marks where the process was before.

4.3 The Heatex model

This chapter presents the concluding results based on the overall process improvement project that the researcher conducted at HSH. The Heatex model for multi-cultural business process improvement, see Figure 49. It is a ten step model basically following the same methodology as this study.

4.3.1 Identified goal opportunity or problem

All process development projects should start with the aspiration of creating change towards improvement and development. This is to develop a focus for the assessment and an understanding for what is the right direction to develop the process. An example can be to start from the yearly overall goal for the process and break it down in to a list of measurable requirements that will assure that the process meets its goal and is in-line with the company's strategy.

4.3.2 Assemble team

To achieve change it is important to have a team with the required knowledge, resources and mandate to create change. In multi-cultural projects this step provides input to compare

the culture from where the project is taking place to the individual team member as well as the culture within the team. By looking at culture aspects before the actual team meets can improve both the relationship within the team as well as help to get correct and informative data from the process

4.3.3 Draw boundaries

Look at the bigger picture, what factors affect the supply chain and break it down to how it affects the single company as well as the process itself. By defining boundaries and stakeholders of the process it becomes possible to understand how the process must react to changes in the surrounding context. To do this a SIPOC map can come in handy:

1. Write down the process steps
2. Identify all required input and output for each process step
3. Where does the input come from and to who is it going?
4. When all stakeholders are identified screen them all individually and identify external factors that indirect will have an effect on the process.

4.3.4 Examine process

Create a current-state analysis of the process and make a list of identified issues. Unlike the previous step that focus on who does what this step is primarily aimed towards how. How does work get don and how long does it take e.tc. This can be done in several different ways. A VSM analysis is a good tool to evaluate performance. The most important thing is to draw the process and measure it in a way that identifies issues and tells what improvements are required to achieve the overall goal for the process improvement project.

4.3.5 Evaluate issues

No projects have infinite resources, and most process improvement projects want to achieve as much as possible with as small amount of resources as possible. For large processes it is advisable to spend time in this step and thoroughly go over all issues and potential improvement and compare it to the overall goal of the process and how well it corresponds with the overall goal for the organization. It is important to already in this step start thinking of how the results can be measured and start to measure them to be able to see before and after results.

4.3.6 Find cause

Identify the root-cause to these issues. When the project has received green light to continue with the issues it is important that future implementations deal with the actual problem and not just the symptoms. For example by writing down the cause for a problem it becomes easier to grasp and can help the team to reach a consensus on what to improve.

4.3.7 Culture analysis

Before developing suggestion it was proven effective in this study to look at the softer aspects of the process. For example to identifying key procedures, artefacts or even people with influence. The Hofstede dimensions provide this kind of framework for discussing softer aspects of a process can give insight not only an individual but the entire team for what might work. By acknowledging the foreign culture and culture differences they can be used

as an advantage to create change. Seek for adaptations that can make the suggested changes stick to the process.

4.3.8 Develop solutions

All projects need to develop specific solutions to deal with not just handle the issue but to fit in the context as well. By having culture aspects in mind as a tool to create change rather than a critical filter and by drawing a future state map trying to visualize and improve both softer and harder aspects of the process. Solutions that will both stick and improve overall performance can be developed.

4.3.9 Implement

Based on the future-state map create an action plan with assigned responsibilities and deadlines. This will help to create an understanding of what needs to be done and when. It will also help not to lose track during the implementation and understand how disturbance will affect the project.

4.3.10 Evaluate

Continue to measure your result, compare results from before and after the implementation and evaluate the results. This step can also serve as step one by identifying, issues, problems or opportunities.

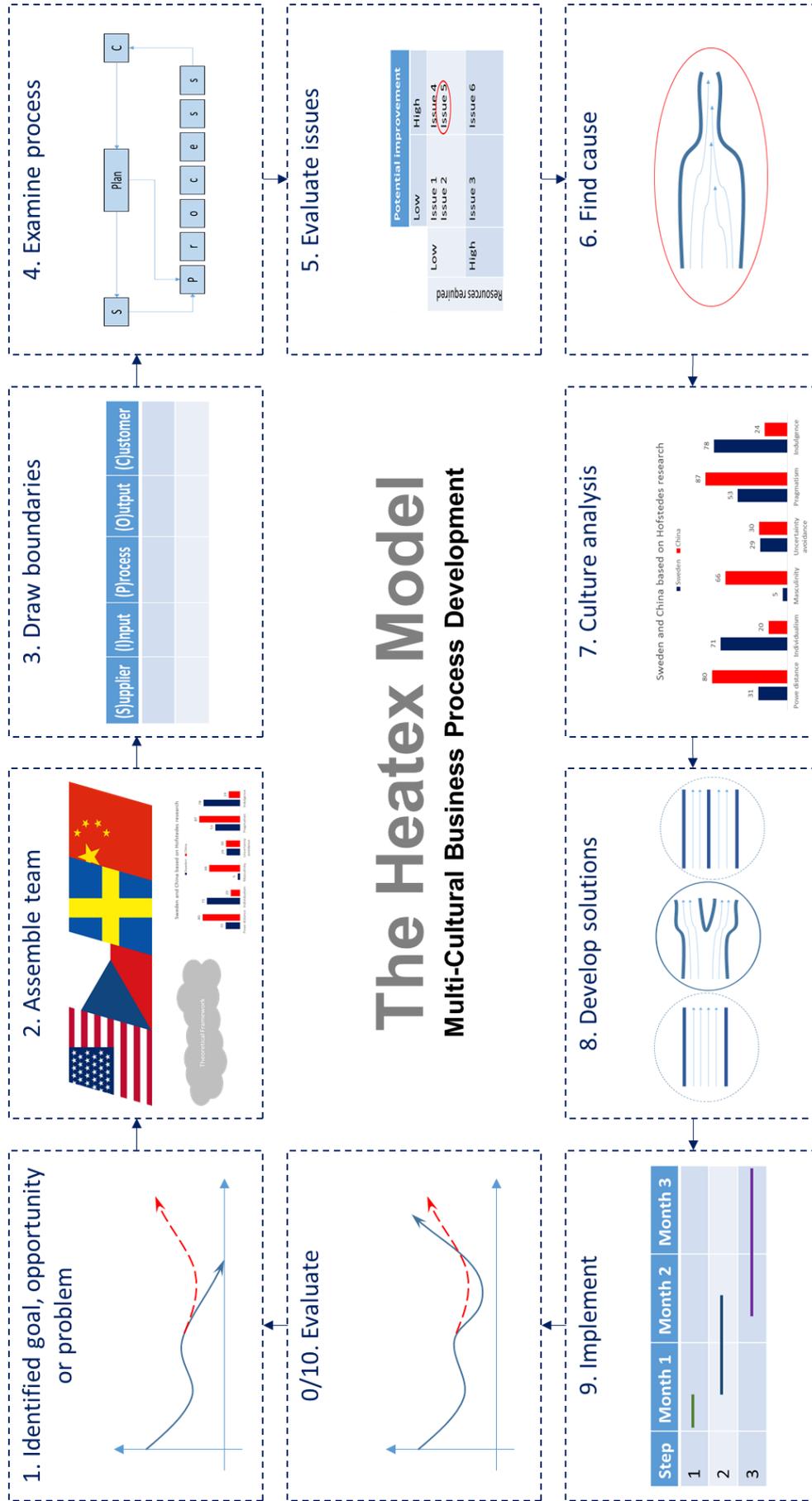


Figure 49 The Heatex model, multi-cultural business process development, from root-cause analysis

5. Discussion

The discussion starts by examining the credibility of the result that was achieved before discussing business process management, section 5.2, culture evaluation, section 5.3, and the Heatex model, section 5.4.

5.1 Credibility

Underlining this entire project is the fact that the researcher has been working alone in a foreign culture and at a foreign company. This creates the need to be extra careful when gathering, compiling and analyzing data. This study started by conducting a literary review primarily within business process management, analysis and development tools, and national culture research which was incorporated into a model. This model was then applied to a case company and an empirical analysis was conducted and compared to the theoretical model which means that this study provides an abductive result. By asking similar questions to employees both at HSH and HAB combined with when possible observations triangulation was achieved and by having frequent meetings with both supervisors, Dag Näslund and Jonas Bengtsson to assure that the project was moving in the right direction a credible result has been achieved.

5.2 Business process management

The Idea was to look at the process as if it was built up by layers and by first looking at the entire chain of actions so that when changes are made the entire chain would benefit and not just the sub-process. By conducting an outside in research study this was possible to achieve. When the current-state analysis was conducted and it revealed that the planning and monitoring of the processes were such a severe issue there was discussions of exclusively looking at this issue. This was decided against based on a few reasons. Firstly this would mean that the work would be purely theoretical, implementing changes was both a wish from the researcher and from HAB. Not only because it could improve performance to HSH, it would also give insight to the employees at HSH and the researcher about process development. For the researcher implementing a project meant working closer with all levels at HSH which gave further insight and data to the culture research. The last and perhaps main reason for not only focusing on the planning issue was because of the low maturity level in the production. Before implementing any advanced tools that potentially can send the efficiency skyrocketing, the basic foundation needs to be in place. At HSH there was a clear lack of structure for the physical flow. The flow was almost impossible to visualize, and if you cannot visualize it, it is even more difficult to plan. An effect of this is that the changes implemented will mostly improve within operations steps, rather than between and the effects will be next to zero on the future-state map. However to create large and sustainable process change the researcher strongly believe that it is necessary to have a future-state map that should act as a consensus for the people involved with the project. This type of large change should ideally be conducted organically with cross functional teams.

There is an outspoken interest from HAB in Sweden to streamline and make their production processes more efficient. They have applied for example 5-S tools and a replenishment system steps to take steps to shorten lead-time and free up capacity. These tools have not necessarily been applied with the overall goal in focus or given the requested results. This is probably related to the skipping of steps 2, 3 and 4 in the Heatex model by directly looking at the issues and trying to cure the symptoms instead of looking deeper to prevent them from returning. To evaluate the current-state of the process is time consuming. It is however a necessity to bring enough insight for how the work actually is conducted and understand overall changes, at least within the production facility. For this to spread within in Heatex will require encouragement from top management to constantly work with improvement projects.

5.3 Culture

The culture analysis may seem like an unnecessary step for someone who is experienced working with other cultures. The researcher does however believe that by keeping the culture dimensions in mind it increased the understanding of why and how things happened. Hofstede's research is statistical and does not necessarily tell you anything about the individual but it can help to distinguish patterns.

As mentioned before this is not a culture study. It is a study that tries to apply the previous work of Geert Hofstede to draw benefits in process improvement projects. The idea was that applying the cultural dimensions could serve as a framework for discussing both softer and harder aspects in the process. Instead of thinking "one size fits all" and by making small adjustments to the suggestions and using the findings as a tool for change it gives a better chance of it sticking. There are two main risk with doing this. First it can create an us versus them feeling not necessarily that one think that they are better than the other but creating a tone of "this will never work here". The second risk is that it can create a sort of tunnel vision by the score of the culture dimension; only looking at signs that suggest that they are true or false and can easily create misinterpretations. Both of these risks will counteract the idea of using it as a tool to create and achieve change. But the researcher believes that keeping an opened mind and being friendly will go a long way no matter the culture.

Changes are often met with negativity because of a fear of the unknown. It is good to clearly state why these changes are made and what is hoped to be achieved. For example at HSH, the monthly pay for the workshop workers is strongly affected by the amount of overtime hours they work. When the workshop workers were informed that the idea of the changes are not just being done to reduce overtime cost but the fact that HSH is assuming an increasing order demand and by making these changes a better readiness to handle this demand increase with the same amount of overtime but without having to add another shift.

5.4 Heatex model

The Heatex model is developed with Heatex in mind and it represents a framework for how work can be conducted. Different tools than used in this study may of course be needed to other improvement projects.

6. Conclusion and contribution

The purpose of this study was to develop a model for business process improvement that integrates national culture aspects to achieve sustainable performance improvement. The Heatex model presented in section 4.3 presents a suggestion for how the Hofstede culture research can be used to gain knowledge about a foreign culture and there through extract trustworthy data. By comparing the theoretical knowledge to the experienced culture come it can be used as a framework to discuss how sustainable change can be achieved. Presented below are the conclusions drawn about the research questions in chapter 6.1, followed by the deliverables in 6.2. In chapter 6.3-6.5 the practical, and academic contributions as well as suggestions for future studies are presented.

6.1 Answer to the research questions

6.1.1 How can national culture aspects be combined into a business process management model?

By using the previous research conducted by Geert Hofstede (Hofstede, Hofstede et al. 2010) this study presents a model that uses national culture as an advantage to create sustainable change. There are of course other models and frameworks for how culture can be evaluated and measured, however the Hofstede model was chosen based on the extensiveness and width of the research. The idea is to have a model that can be applied on a global basis. If a process development project takes place in Czech Republic then the Czech culture dimensions can be applied. During a process development project it is easy to get fixed on a specific issue and get a tunnel-vision of what needs to be fixed. This can lead to the project losing track of the overall goal. If another team-member get a similar tunnel-vision about another issue then can of course lead to friction within the team. The idea with process development is overall improvement from start to finish, by evaluating cultural aspects it provides a framework for discussing how the changes will be adopted in reality. It can also explain further why a process works a certain way and how it will react to changes. The topic of discussion should not necessarily be strict culture based but rather open the mind to new impression and be able to develop more suitable solutions.

The question now really is “Should you use culture analysis in your process improvement projects?” the researcher advocates this strongly. Culture is frequently the topic of discussion in our personal life, if a friend has been abroad and they speak about the trip they will most likely say something like “Do you know what they do in this country...” and it is usually followed by something that sounds foreign to their own culture. So why not use this knowledge in our professional life as well? But to be fair in non-multi-cultural projects, step 7 in the Heatex model does not necessarily has to be about culture dimensions or even culture for that matter. The important part is that when a project goes from the point of having retrieved all necessary information from the process and have a list of issues in, take a step back look at the both softer and harder factors affecting the process and compare it to the overall goal of the project and the improvements can actually help achieve this goal.

6.1.2 What is the difference between mapping methods? How do they relate to each other and their intended scope?

This study conducted a literary review over different mapping methods in order to further deepen the knowledge of when to apply what method. Based on the theory it was very difficult to know what knowledge one could expect after finishing a map. While gathering data and compiling the maps it was also difficult to know what information to include. An example of this is the SIPOC map, after conducting the literary review the researcher thought that a SIPOC would provide excellent information about all the stakeholders and where the hand-offs happened. In hind-sight this was exactly what the SIPOC map delivered however since this was the first step to be conducted the researcher had very limited insight to the process itself other than hand-offs, stakeholders, and start and stop. The SIPOC map proved necessary about halfway into the VSM, when the researcher has gained some insight to the process itself, had gotten a better understanding of the internal stakeholders. The SIPOC also helped to set the boundaries for the VSM, what steps to include and to understand the relationship between external factors such as the industry and supply chain, and their relationship to the order to delivery process.

Creating the VSM was by far the most time-consuming process step, the difficult part is to keep track through the entire map. Since it is a medium to high level map it is difficult to know what information to include. The process that was monitored produced less than ten products per day which makes the cycle-times long and highly irregular. This is of course also affected by the low degree of automation. To succeed with a VSM the team must be able to remain the high-level thinking while collecting medium-level data. What is meant by that is that the overall process should be examined by collecting data that is relevant to explain the relationship between the operations and not go into detail about every single observation step.

For the low-level and high detailed maps such as spaghetti maps and flowcharts the problem is not what information to collect but rather to limit the scope. When it comes to spaghetti maps it is easier because there are several “natural” limitations such as looking at one assembly worker for one order which can then be repeated and the different movements can be shown together on the facility map. When a flowchart is drawn it is difficult to stop at a certain point. It is so easy to just add another box, and another, and another to describe as much as possible. However this will end up in one massive flowchart that tries to explain too much and it will make no sense to anyone. It is therefore better to use a few flowcharts that clearly indicates output and input and have an overall flowchart that explains the relationship between the flowcharts.

6.2 Practical contribution

The practical contribution is concluded based on Heatex gains from this study. There may of course be other organizations or private citizens that can benefit from this study however this is not further discussed here.

HAB has because of this study an increased insight to their subsidiary. By applying mapping methods as well as conducting a process development project a better understanding of how the subsidiary works has been presented to HAB.

HSH has experienced a process development project as well as implemented improvements in their production that could increase bottleneck capacity with up to 24 percent. Whether this results in HSH starts to conduct their own process development projects remains to be seen.

Heatex has received a model for how they can work with process development. This model has incorporated a culture analysis step that can help the company to successfully implement improvement projects on all their production sights.

6.3 Academic contribution

Applying culture research to business process management has to the researcher knowledge previously not been conducted. This study shows that culture aspects can be used as a tool for business process development primarily to develop and create sustainable change.

This study presents a literary study over business process mapping methods, their relationship between each other, their intended application level and level of detail. These mapping methods were then applied at HSH and evaluated. This study provides a further explanation to how and why process mapping should be conducted.

By answering the research questions this study provides an explanatory result between culture analysis and business process management, and within business process mapping.

6.4 Future studies

Business process management and culture studies as well as business process mapping can benefit substantially from further research.

First of all it would be interesting to go back to Heatex in 1-2 years and examine the traces of this project. Whether they are working with the model and what improvements they have done on their own. This being a single case study it is impossible to draw conclusion beyond this case.

There is of course several different culture models and frameworks available today. It would be interesting to conduct an evaluation of different culture frameworks that are the most suitable to apply to the business process development model.

This model was applied to a foreign company for the process development team. However it has not been applied to a multi-cultural process. It would be interesting to see how the model should be adapted to fit in a multi-cultural process.

This model was also applied within the same company with similar corporate culture. By applying it to inter-company processes, conclusions could be drawn about how to incorporate corporate culture into the model.

This study was primarily focused within mapping and implementing culture into a business process development mode. However there can be substantial benefits to be drawn by having multi-cultural teams. Much like having different skills within a team there might be potential to having different cultures within a team.

There is also a large potential in conducting a multi-case study focused on mapping in different companies and different industries to better understand how to conduct business process mapping, what information to include and exclude.

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Appendix B – Data collection Plan

This table presents all the steps conducted in this study, what information were sought, how to get it, why, and how to analyze it.

Step	Needed data	How to get it	Why and how to analyze it
Define boundaries	Who is the external/internal customer?	Interview with sale support and production leader	Customer identification is key to know what to improve
		ERP-System	
	What are the key outputs?	Interview with sale support and production leader	To identify what the process does, and relations inside the process
	What are the process steps?	Interview with the production leader	To identify what the process is and who is doing what
Internal documents			
Who supplies key inputs?	Interviews with purchasing	TO identify what is needed for the process to work	
Evaluate current-state and identify issues	Inventory stockpiling	Observation	Inventory often hints about problem in the process, for example uneven cycle-time for different process steps, machine break downs e.tc. This is a good tell if there are issues in the process. Focus on where it is and how much inventory
		Ask why inventory is placed where it is	
		Walk-the-flow	
	Bottlenecks	Cycle-time	The identification of a bottleneck can improve lead-time and free up capacity.
		Look for stockpiling	
		Walk-the-flow	
	Scrap/rejections	Internal documents	Scrap in the process might be necessary but if it can be reduced the cost will decrease. The cost of quality can be applied.
		Walk-the-flow	
	Cycle- and set-up- time	Observation with stopwatch	If the machine has to be stopped then set-up time is non-value adding time. This could be analyzed by SMED and 5 S.
		Walk-the-flow	
Un-/scheduled downtime	Interview with operator, shift leader and production	Downtime is difficult to do schedule, unscheduled downtime is even worse for a process. To evaluate this extensive study has to done over the machine and may not be possible in this project.	
	Ask operator to time the downtime during my stay		

		Walk-the-flow	
	Claims from customer	Internal document	The claims can give guidance to where there are problems in a process. If a part is frequently rejected the process steps handling that part should be evaluated.
Evaluate issues		Evaluate issues based on the collected data, and chose suitable one for further analysis.	
Find root cause	Unit and information hand offs, Waiting time, Approval, Availability of information, tools drawings and instructions	5-Why analysis	To get a deeper understanding of why an issues exists
		Participating in the process	
		Observation	
Culture evaluation	How can the culture differences help me create change?	Use the Hofstede model as a framework to discuss softer and harder aspects of the process	To be able to design improvement suggestions that are adapted to the Chinese working environment
Develop suggestions and future state map	Previous theory for inspiration to create an overall idea of what the process should look like	Literary review	To create an overall efficient process without sub-optimization

Action plan & Implementation Plan	Who is the most suitable person to be in charge of the different required actions	Discussion with the operations manager at HSH	To be able to set the change in motion and finish the project.
Measured results	Performance before and after changes	Comparing measured current-state with measures from after the change	

Appendix C – Interview guides

Heatex Sweden

Sale-support

1. What are your responsibilities?
2. How would you describe Heatex Relationship to Customers?
3. How do you work with customers in comparison to the sales-people?
4. How is the sales department evaluated?
5. How do you work with improving the department?
 - a. Heatex overall?
 - b. Process development?
6. How do you work with HSH today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
7. How well does the work with HSH work today?
8. How is the sales-department structured in China?
9. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
10. From your perspective, what are the main challenges facing Heatex?
11. What are Heatex main weaknesses?
12. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
13. What are Heatex main strengths?
14. What substitutes are there to Heat-exchangers?
15. How frequent are order changes or other disruptions?
 - a. How does it affect your department?
 - b. What do you do to deal with it?

Global Purchasing Manager

1. What are your responsibilities?
2. How is the purchasing department structured?
 - a. Globally
 - b. Sweden
 - c. China
3. How is the purchasing department evaluated?
4. How do you work with improving the department?
 - a. Heatex overall?
 - b. Process development?
5. What are the strategies for working with suppliers?
6. How would you describe Heatex relationship to suppliers?
7. How does your department work with HSH today?

- a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
8. How well does the work with HSH work today?
 9. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
 10. From your perspective, what are the main challenges facing Heatex?
 11. What are Heatex main weaknesses?
 12. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
 13. What are Heatex main strengths?
 14. What substitutes are there to Heat-exchangers?
 15. How does customer or supplier changes and disruptions affect your department?

Production Planning

1. What are your responsibilities?
2. How are your work evaluated?
3. Are you involved in the development of the production?
 - a. Heatex overall?
 - b. Process development?
4. How does your department work with HSH today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
5. How well does the work with HSH work today?
6. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
7. From your perspective, what are the main challenges facing Heatex?
8. What are Heatex main weaknesses?
9. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
10. What are Heatex main strengths?
11. What substitutes are there to Heat-exchangers?
12. How does customer or supplier changes and disruptions affect your department?

Global quality manager

1. What are your responsibilities?
2. How is the quality department structured?
 - a. Globally
 - b. Sweden
 - c. China

3. How is the quality department evaluated?
4. How do you work with improving the department?
 - a. Heatex overall?
 - b. Processes?
5. How does your department work with HSH today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
6. How well does the work with HSH work today?
7. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
8. From your perspective, what are the main challenges facing Heatex?
9. What are Heatex main weaknesses?
10. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
11. What are Heatex main strengths?
12. What substitutes are there to Heat-exchangers?
13. How does customer or supplier changes and disruptions affect your department?

Global operations manager

1. What are your responsibilities?
2. How is the production structured?
 - a. Globally
 - b. Sweden
 - c. China
3. How is the production department evaluated?
4. How do you work with improving the department?
 - a. Heatex overall?
 - b. Processes?
5. What are the strategy for the production?
6. Why did you start a production unit in china?
7. How does your department work with HSH today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
8. How well does the work with HSH work today?
9. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
10. From your perspective, what are the main challenges facing Heatex?
11. What are Heatex main weaknesses?
12. How well does Heatex meet the competition?

- a. Product performance
 - b. Deliver performance
13. What are Heatex main strengths?
 14. What substitutes are there to Heat-exchangers?
 15. How does customer or supplier changes and disruptions affect your department?

Research and development

1. What are your responsibilities?
2. How are your work evaluated?
3. Are you involved in the development of other parts than products?
 - a. Heatex overall?
 - b. Production?
 - c. Process development?
4. How does your department work with HSH today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
5. How well does the work with HSH work today?
6. From your perspective, what are the main challenges facing Heatex?
7. What are Heatex main weaknesses?
8. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
9. What are Heatex main strengths?
10. What substitutes are there to Heat-exchangers?
11. How does customer or supplier changes and disruptions affect your department?

Heatex Shanghai

Sale-support

1. What are your responsibilities?
2. How would you describe Heatex Relationship to Customers?
3. How do you work with customers in comparison to the sales-people?
4. How is the sales department evaluated?
5. How do you work with improving the department?
 - a. Heatex overall?
 - b. Process development?
6. How do you work with HAB today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
7. How well does the work with HAB work today?

8. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
9. From your perspective, what are the main challenges facing Heatex?
10. What are Heatex main weaknesses?
11. How well does Heatex meet the competition?
 - a. Product performance
 - b. Delivery performance
 - c. Price
12. What are Heatex main strengths?
13. What substitutes are there to Heat-exchangers?
14. How frequent are order changes or other disruptions?
 - a. How does it affect your department?
 - b. What do you do to deal with it?
15. Could you show me how you enter an order?
16. Could you retrieve the information for a specific order?

Production Leader

1. What are your responsibilities?
2. How are your work evaluated?
3. Are you involved in the development of the production?
 - a. Heatex overall?
 - b. Process development?
4. How do you work with HAB today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
5. How well does the work with HAB work today?
6. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
7. From your perspective, what are the main challenges facing Heatex?
8. What are Heatex main weaknesses?
9. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
10. What are Heatex main strengths?
11. What substitutes are there to Heat-exchangers?
12. How does customer or supplier changes and disruptions affect your department?
13. Could you show me how you enter an order?
14. Could you retrieve the information for a specific order?

Quality manager

1. What are your responsibilities?
2. How is the quality department structured?
 - a. Globally

- b. Sweden
 - c. China
- 3. How is the quality department evaluated?
- 4. How do you work with improving the department?
 - a. Heatex overall?
 - b. Processes?
- 5. How does your department work with HAB today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
- 6. How well does the work with HAB work today?
- 7. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
- 8. From your perspective, what are the main challenges facing Heatex?
- 9. What are Heatex main weaknesses?
- 10. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
- 11. What are Heatex main strengths?
- 12. What substitutes are there to Heat-exchangers?
- 13. How does customer or supplier changes and disruptions affect your department?

Operations manager

- 1. What are your responsibilities?
- 2. How is the production structured?
 - a. Globally
 - b. Sweden
 - c. China
- 3. How is the production department evaluated?
- 4. How do you work with improving the department?
 - a. Heatex overall?
 - b. Processes?
- 5. What are the strategy for the production?
- 6. Why did you start a production unit in china?
- 7. How does your department work with HAB today?
 - a. Frequent contact?
 - b. How is your relationship?
 - c. Do you see problems with the cultural differences? Can they be opportunities?
- 8. How well does the work with HAB work today?
- 9. Describe, at least for your department, what actions are required to get an order to become finished and shipped product?
- 10. From your perspective, what are the main challenges facing Heatex?

11. What are Heatex main weaknesses?
12. How well does Heatex meet the competition?
 - a. Product performance
 - b. Deliver performance
13. What are Heatex main strengths?
14. What substitutes are there to Heat-exchangers?
15. How does customer or supplier changes and disruptions affect your department?

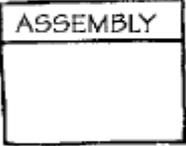
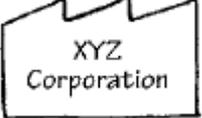
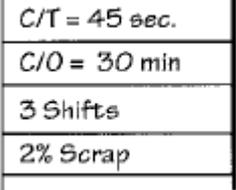
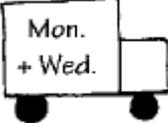
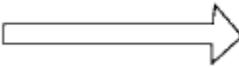
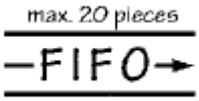
Appendix D – Product Matrix at HSH

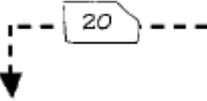
In this appendix the product matrix for HSH is described. The focus for this study are the rotors, marked in blue. They are the same heat exchanger but are sold with and without a casing. Rotors that are sold without casing are usually sold for replacement of old exchangers but also to some customers that directly mounts the exchanger into a complete system.

Line\Operation	Cutting	Retooling	Pressing	Spinning	Assembly Cross	Assembly Counter	Assembly Wheel	Final Assembly	Coating	Inspection	Packing	Produktgrupp
Counterflow 095/140	X	X	X			X			X	X	X	Counterflow
Counter flow190/235	X	X	X			X			X	X	X	
Crossflow 200	X		X		X			(X)	(X)	X	X	Crossflow
Crossflow 250	X		X		X			(X)	(X)	X	X	
Crossflow 300	X		X		X			(X)	(X)	X	X	
Crossflow 1000	X		X		X			(X)	(X)	X	X	
Rotor	X			X			X			X	X	Rotor
Rotor & Casing	X			X			X	X		X	X	

Appendix E – VSM-symbols

These pictures are gathered from Rother and Shooks Learning to see method and workbook version 1.2 (1999)

	Manufacturing process
	Outside source
	Data box
	Inventory
	Truck shipment
	Push production
	Movement of finished goods to customer
	Supermarket
	Withdrawal
	First-in-first-out

 	<p>Manual information flow</p> <p>Electronic information flow</p>
	<p>Information</p>
  	<p>Production Kanban</p> <p>Withdrawal Kanban</p> <p>Signal Kanban</p>

Flowchart symbols

Symbol	Description
	<p>Start/end</p>
	<p>Direction</p>
	<p>Decision</p>
	<p>Activity</p>
	<p>Multiple choice</p>
	<p>Connection within the same page</p>
	<p>Connection between pages</p>

Appendix F – Found issues

Presented in this chapter are a complete list of found issues that were grouped into the eight major issues:

- There are no computers in the production
- The customers are not providing the correct Heatex product description
- The planning is complex and hard to trace
- The ERP-system is badly used overall
- There are several different documents for planning, material supply e.tc. the ERP-system is not used to its full potential
- It is time consuming to find and change a manufacturing order
- It is a volatile demand
- Problems with shipment from Sweden
- Inventory build-ups
- Manufacture without delivery date (as soon as the order arrives)
- The manufacturing order does not follow standard
 - Several different products
 - To several different customers
- A lot of unnecessary transport in the production
- No logical layout, products are moving back and forth
- Requires substantial amount of manual labor
- Large amount of claims from customers
- A lot of finished goods in the FGA
- Welding operation is time consuming and require specialist competence
- The lead-time from supplier sometimes hinder production
- Assembly operation is also time consuming and would require training of staff from other operations
- The spinning machine is old and needs updating or replacement
- Bad utilization of welder's skills
- Fluctuating workload

Appendix G – Corporate culture evaluation

The cultural evaluation starts by compiling the corporate culture at Heatex. HAB and HSH have are managed in a similar way and therefore have a similar corporate culture. It is more likely that the differences between the companies are related to national culture than corporate culture. This is why the corporate culture is left outside of the report. However the corporate culture can give further insight to how HSH is managed and why decisions are made a certain way.

Means oriented versus goal oriented

Heatex is a goal oriented organization, what matters is the result and not so much how you get there. China has a large entrepreneurial spirit and this can also be seen at Heatex Shanghai. Whether it is a customer demand or an internal goal, Heatex Shanghai will find a way to achieve it.

Internally driven versus externally driven

While Heatex have a lot of “know-how” for what the customer wants and needs, it is more externally than internally driven. The focus is on pleasing the customer at every cost.

Easygoing work discipline versus strict work discipline

Even if China is a hierarchical country with a high score on power distance, the work discipline at Heatex is easy going (both in Sweden and China). While approval for decisions has a strict chain of command the production and planning has a surprising amount of room for improvisation. Production stops due to lack of components are common and in general there is a lot of “fire-fighting”.

Local versus professional

Heatex is a small company, normally for small companies is a local social atmosphere. While there is a friendly atmosphere at Heatex. In comparison to Heatex AB the atmosphere at Heatex Shanghai is more professional than local. Titles are important in China, employees identify with their title and act accordingly.

Open versus closed system

Since this issue is about outsiders it has been evaluated based on the researchers personal experience at Heatex, which points to an open system.

Employee versus work oriented

Heatex is generally more of a work oriented organization than employee oriented. Especially at HSH are the decisions made by the managers and tasks are expected to be performed.

Degree of acceptance of leadership style a

To be able to answer this dimension accurately would require further analysis.

Degree of indication with your organization

To be able to answer this dimension accurately would require further analysis.

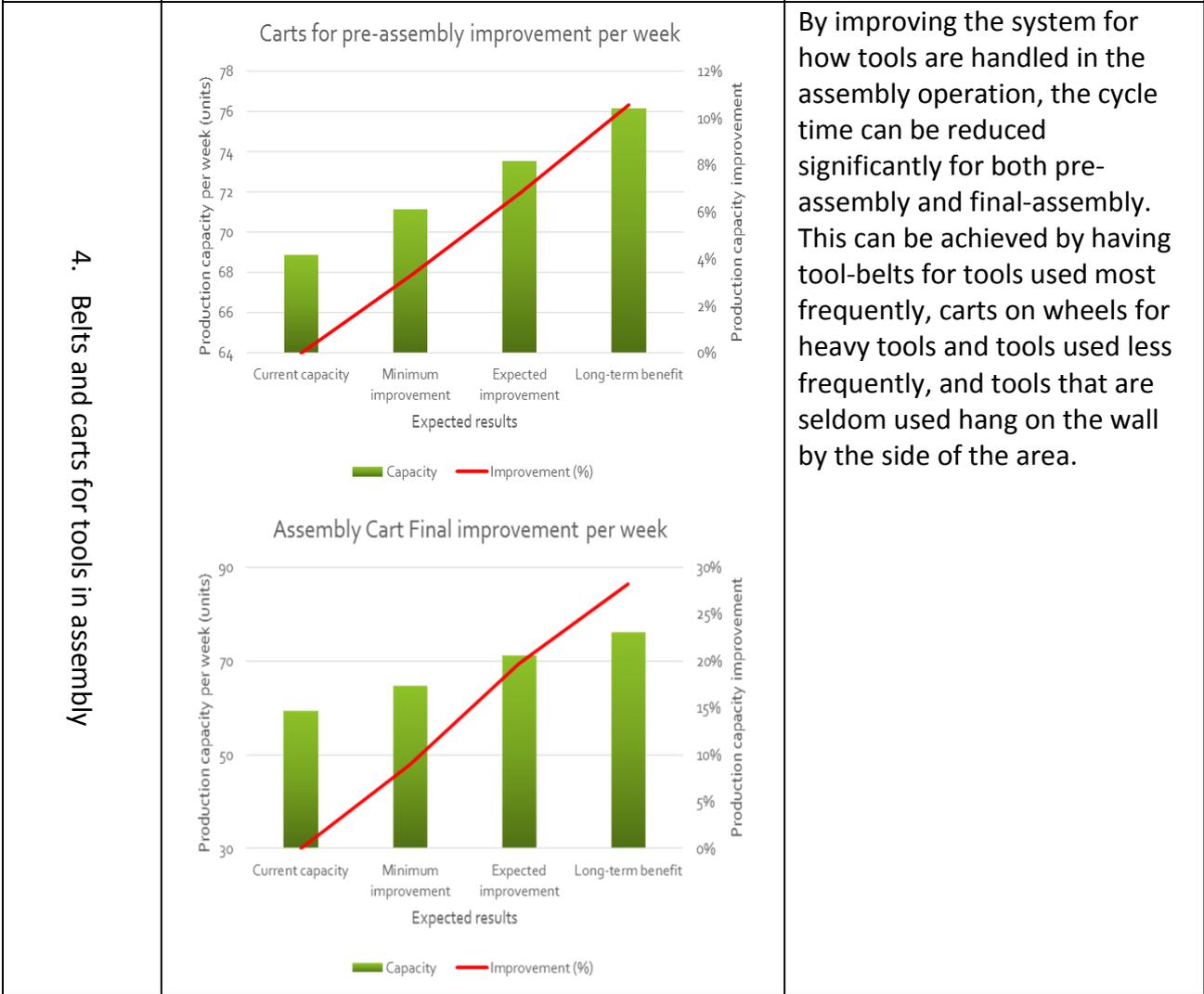
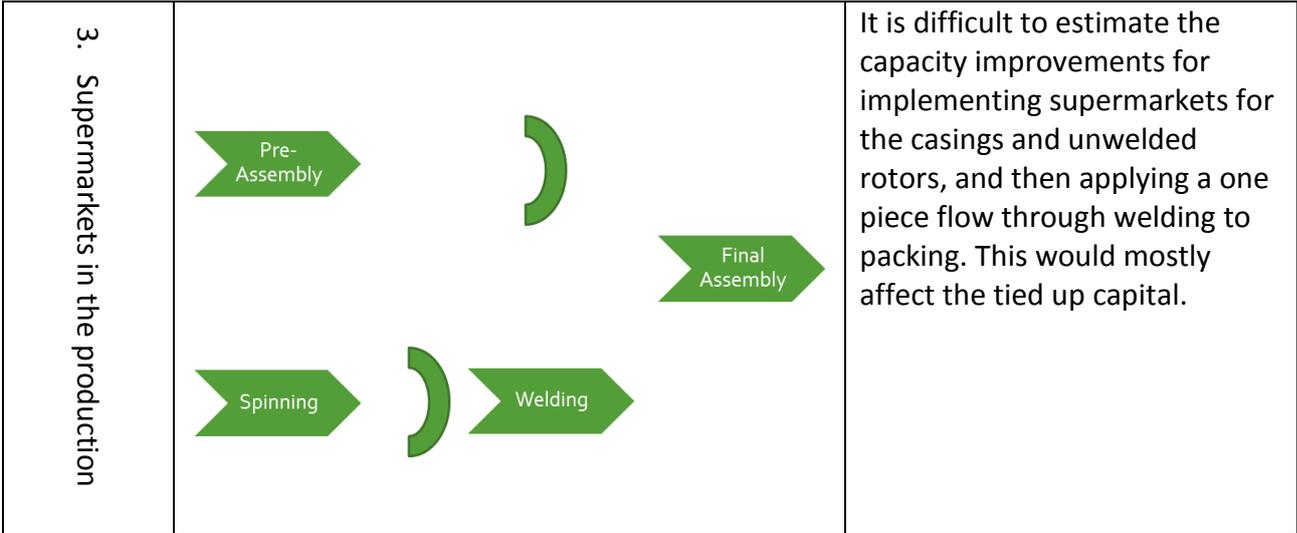
This section discusses how the national culture dimensions are expressed at Heatex Shanghai. Each dimension starts by presenting the score provided from (Hofstede 2014). For the Chinese score examples and exceptions are presented while the Swedish score is used as a reference for understanding the conclusions drawn by the researcher.

Appendix H – Improvement suggestions

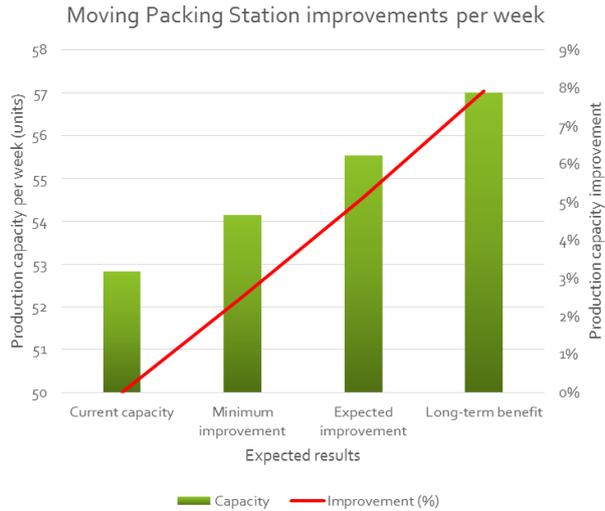
To deal with the excessive transport and to free up capacity in the production the following suggestions were developed:

1. Optimized welding layout
2. New welding table
3. Supermarkets in the production
4. Belts and Carts for the tools used during assembly
5. Moving the packing station

Suggestion	Improvement	Description															
1. Optimized welding layout	<p style="text-align: center;">New welding layout</p> <table border="1"> <caption>Expected results for New welding layout</caption> <thead> <tr> <th>Stage</th> <th>Capacity (Units)</th> <th>Improvement (%)</th> </tr> </thead> <tbody> <tr> <td>Current capacity</td> <td>24</td> <td>0%</td> </tr> <tr> <td>Minimum improvement</td> <td>25</td> <td>5%</td> </tr> <tr> <td>Expected improvement</td> <td>27</td> <td>15%</td> </tr> <tr> <td>Long-term benefit</td> <td>30</td> <td>25%</td> </tr> </tbody> </table>	Stage	Capacity (Units)	Improvement (%)	Current capacity	24	0%	Minimum improvement	25	5%	Expected improvement	27	15%	Long-term benefit	30	25%	<p>By moving the cutting station closer to the welding table approximately 3 minutes per rotor is saved in transportation which represents the minimum improvement. By dividing the cutting responsibilities onto the entire spinning line staff can reduce the cycle time for the welder by approximately 17 minutes which represents the long term benefit of this improvement.</p>
Stage	Capacity (Units)	Improvement (%)															
Current capacity	24	0%															
Minimum improvement	25	5%															
Expected improvement	27	15%															
Long-term benefit	30	25%															
2. New welding table	<p style="text-align: center;">New Welding Station</p> <table border="1"> <caption>Expected results for New Welding Station</caption> <thead> <tr> <th>Stage</th> <th>Capacity (units)</th> <th>Improvement (%)</th> </tr> </thead> <tbody> <tr> <td>Current</td> <td>24</td> <td>0%</td> </tr> <tr> <td>Lowest</td> <td>34</td> <td>42%</td> </tr> <tr> <td>Probably</td> <td>44</td> <td>83%</td> </tr> <tr> <td>Long-term benefit</td> <td>48</td> <td>100%</td> </tr> </tbody> </table>	Stage	Capacity (units)	Improvement (%)	Current	24	0%	Lowest	34	42%	Probably	44	83%	Long-term benefit	48	100%	<p>A possible solution if demand increases beyond 1-shift production. By having two tables, while one rotor is being welded another wheel can be cut and prepared at the same time and offering a long term possible capacity increase by at least 100 percent. And still only require one welder per shift.</p>
Stage	Capacity (units)	Improvement (%)															
Current	24	0%															
Lowest	34	42%															
Probably	44	83%															
Long-term benefit	48	100%															

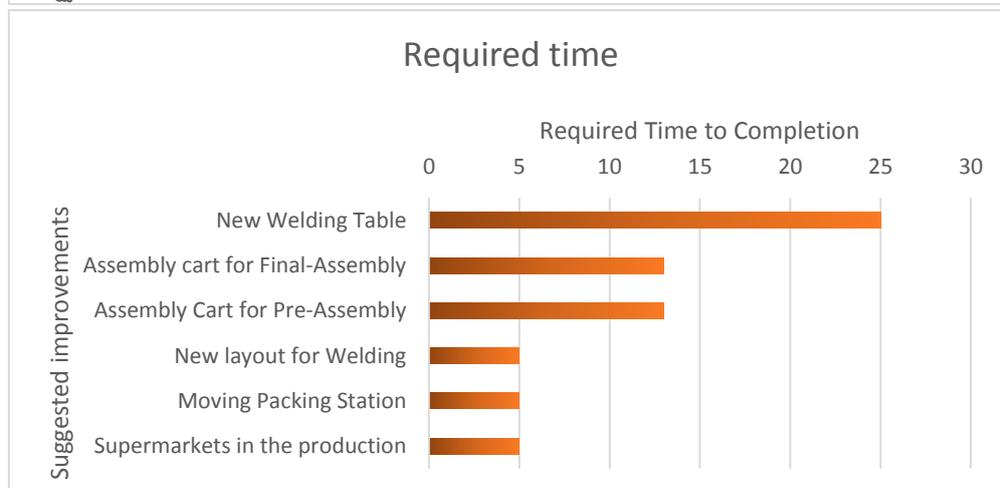
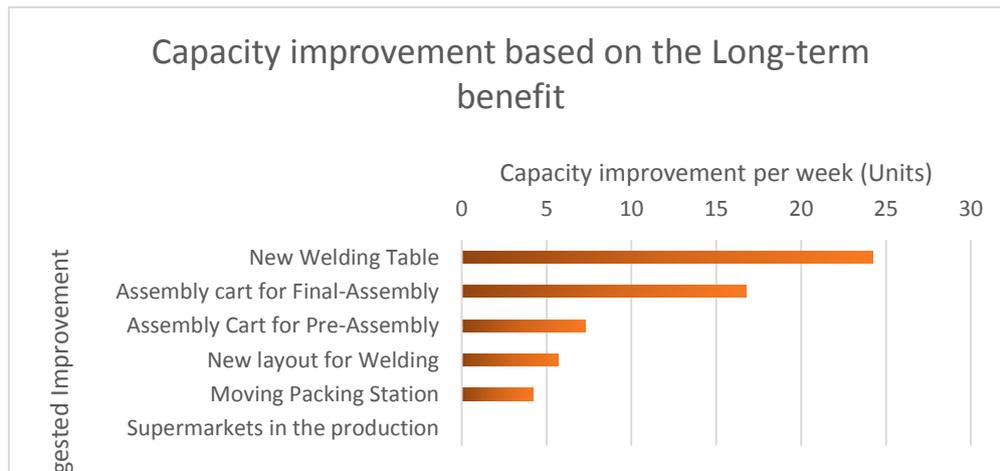


5. Moving the packing station



Since this is large and heavy products, transportation and movement is time consuming and require several workers assistance to the truck driver. It could therefore be faster to move the pallet and packing material to the assembly operation and have the products packed there. Or have the casing assembled on the product assembled on the pallet from start.

Presented below is the Pareto analysis of the suggestion. As we can see a new welding table offers the most capacity increase. But due to uncertain demand and the required time to achieve it were scrapped. The focus were therefore shifted to assembly carts and production layout



Appendix I – Action plan

Two action plans were used, the first presents the all changes that were made during the project. The second one is specific to the closing and moving of production equipment.

Improvement	Responsible	November									December													
		25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
New Welding Layout	Jack/Sebastian																							
Develop suitable layout	Ken/Sebastian																							
Inform and plan move	Ken																							
Inform staff	Shift Leader																							
Find gap in schedule	Ken																							
Move operation	Ken																							
Train team	Shift Leader																							
The new flow	Shift Leader																							
Who does what?	Shift Leader																							
KPI -System	Sebastian																							
Place for sheets in production	Ken/Sebastian																							
Train team	Ken/Sebastian																							
Assure op. Fill out sheet	Ken																							
Excel Program	Sebastian																							
Tools, Carts & Belts	Jack/Ken																							
List over necessary tools and how much they are needed	Ken/Shift leader																							
Design a system for if the tools should be on Belts, Carts or in a Locker	Ken																							
Purchase	Grace																							
Tools																								
Belts																								
Carts																								
Assign responsible for tool and cart	Jack/Ken																							
Design the Flow	Jack																							
Kaizen event to design flow	Jack																							
Implement flow	Ken & Shift Leader																							

	Responsible	2014-11-28	2014-11-29	2014-11-30	2014-12-01	2014-12-02	2014-12-03	2014-12-04	2014-12-05
Prepare									
Material	Ken								
Electricity	Ken								
Gas for welding	Shift Leader								
Fence	Jack								
Clean Cutting Saws	Maintenance								
Clear area	Shift-Leader								
Move welding table	Ken								
Move welding locker	Welder								
Move test station	Shift-Leader								
Build rack	Sebastian								
Stock Inventory	Warehouse								
Move cutting saw X2	Shift Leader								
Move sweep rack	Ken								
Move bend block	Ken								
Train Workers	Ken & Shift Leader								

Appendix J – Theoretical future state map

There are two main areas to which Heatex should divert resources before being able to improve the efficiency in the production:

1. Create a globalized standard for how the ERP-system should be used for planning and assure correct usage
2. Have a proper system for timing and reporting manufacturing orders by the workshop workers

Before these two areas has been fulfilled it is no point in trying to improve production because it will be limited by not being able to measure the results accurately as well as not knowing what to focus on.

The future state map is therefore mostly focused on the planning and ERP-system. By first sorting out and visualizing the planning processes it will be a lot easier to apply efficiency improving tools and achieving the requested results. But by assessing these issues it Heatex should also take actions to design a controlling system that can reduce the waiting time and the necessary inventory.

