TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

SIINA JANTUNEN

UTILIZING TACIT KNOWLEDGE IN DEVELOPMENT OF PRODUCTION PROCESS

Master´s Thesis in Management and Information Technology

University lecturer Rainer Breite has been appointed as the examiner at the Council Meeting of the Faculty of Business and Built Environment on May 4th 2016

ABSTRACT

TAMPERE UNIVERSITY OF TECHNOLOGY
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When work stages are lacking standard operating procedures, the same tasks are done differently leaning heavily on the experience and the tacit knowledge of the operator. The research problem is that production targets are not always reached with given time and materials, because of the variation between different shifts in the quality and the production efficiencies. The aim of this study is to find the key work stages and the key talents that are effecting on the production stability and to plan a road map how the variation can be stabilized in long-term

This thesis consists of the conceptual analysis of Lean Manufacturing theory and impact on work standardization, and theory of Knowledge Management, in scope of tacit knowledge and its transferring methods to explicit form. The second part is the empirical part, in which the information of the key challenges of hitting targets of the case company was gathered interviewing and studying historical data. The empirical data is in addition based on researcher´s own experience. Using the theoretical background, the suggestion was made for mapping the knowledge gaps in the case company and develop tools to transfer tacit knowledge to be shared as standard operation procedures within the production teams. The goal is to improve eventually production stability so that the targets can be achieved in every shift irrespective who is working on the shift.

The purpose was to achieve a feasible road map for the process improvement. By creating the road map for standardizing the key tasks, production stability and output reliability can be achieved, which leads to more flexible production and better customer service in long-term. Production stability comes from producing planned products in the right quality, at the right time and in the right quantity. Standardized processes are also the key for continuous improvement; improvement process starts from the existing standards.

TIIVISTELMÄ

TAMPEREEN TEKNILLINEN YLIOPISTO
Johtamisen ja tietotekniikan koulutusohjelma

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Ilman vakioituja työohjeita, työvaiheet tehdään eri tavalla riippuen kuka työtä tekee, nojaten vahvasti työntekijän omaan kokemukseen ja hiljaiseen tietoon. Tutkimusongelmana oli, että tuotantotavoitteita ei aina saavuteta, koska eri vuorojen laatu ja tuotantoteho vaihtelevat. Työn tavoitteena oli löytää tärkeimmät tehtävät ja avainkyvyt, jotka vaikuttavat tuotannon vakauteen, ja kehittää suunnitelma vaihtelun tasoittamiseksi pitkällä aikavälillä.

Tämä tutkimus koostuu konseptuaalisesta analyysistä Lean-tuotannon teoriasta ja sen vaikutuksesta työvaiheiden vakiointiin sekä tietojohtamisen teoriasta keskittyen hiljaisentietoon ja sen muuttamisesta eksplisiittiseen muotoon. Työn empiria koostuu kohdeyrityksen suurimmista haasteista saavuttaa tuotantotavoitteensa. Tietoa kerättiin haastatteluilla, tarkkailemalla sekä tutkimalla historiallista dataa. Työn empiirinen tieto koostuu lisäksi tutkijan omaan kokemukseen työskenneltyään kohdeyrityksessä kahden vuoden ajan. Teoriaan pohjautuen, työssä esitetään ehdotus kohdeyritykselle tietoaukkojen määrittämiseksi ja kehittää työvälineitä, joilla hiljainen tieto voidaan vakioida ja jakaa tuotantotiimien kesken. Tavoitteena on lopulta parantaa tuotannon vakautta, jotta tuotannon tavoitteet voidaan saavuttaa joka vuorossa, huolimatta siitä, kuka työtä tekee.

Työn tarkoituksena oli kehittää kohdeyritykselle toteutettavissa oleva suunnitelma tuotantoprosessin kehittämiseksi. Vakioimalla työvaiheet, jotka vaikuttavat tuotelaatuun ja tuotantotehokkuuteen, voidaan saavuttaa vakaa ja varma tuotantoprosessi. Tuotannon vakaus johtaa joustavaan tuotantoon ja pitkällä aikavälillä parempaan asiakaspalveluun. Tuotannon vakaus tarkoittaa, että tuotetaan kuten suunniteltu: oikea määrä, oikeita tuotteita, oikeanlaatuisina, oikeaan aikaan. Vakiointi on jatkuvan parantamisen lähtökohta.

PREFACE

This thesis was made for Master's Degree Program in Management and Information Technology of Tampere University of Technology in University Consortium of Pori. The researcher found the case and the research inspiring. This thesis was made for the real need for improvement.

I want to thank the examiner University lecturer Rainer Breite for his support and for the inspiring conversations we had on the topic. I would like to thank my line leader for making this possible and for couching me to become the best possible leader. All my colleagues and employees, I am grateful for the all the conversations and support on this project and in my day-to-day work. Without you this thesis would never have been done successfully.

I want to thank my friends and family for supporting me on this project and during my master studies. Without you, this would be much harder. For my husband I owe special thanks for being my rock solid support and the biggest inspirer.

Today's standardization, instead of being a barricade against improvement,
is the necessary foundation on which tomorrow's improvement will be based.
– Henry Ford

Pori 23.11.2016

Siina Jantunen

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ABBREVIATIONS AND SYMBOLS

CIP	Cleaning In Place. Cleaning of the production line in closed system with water, alkali and acid cleaning circulation.
DTS	Down Time Sheet. Form on which the production line down time is reported and issues described shortly by line operators.
EWO	Emergency Work Order. Operator fill the form to clarify the technical issues on the line.
KM	Knowledge Management.
KS	Knowledge Sharing.
KPI	Key Performance Indicator.
NVA	Non-value adding activity.
OPL	One Point Lesson. One pager form to teach, remind, emphasize or inform operators of something.
R&M	Repairs and Maintenance
SAP	Enterprise resource planning software.
SECI	Model for knowledge creation in organization. Nonaka & Nishiguchi, 2001.
SOP	Standard Operation Procedure.
WOW	Way(s) of Working.

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1 INTRODUCTION

The case company is a part of a multibillion company, which operates all over the world having more than 400 brands in its portfolio. The case company operates in food industry. The company has a common purpose and a vision for all of its functions. The company works to create a better future every day, making sustainable choices every day with brands that help consumers enjoy their life. Company´s first priority is consumers - then customers, employees, suppliers, and communities.

The company values are supporting people every day making decisions and guide everything they do. This thesis is done according to the values and the behavior principles of the case company and the goal is to strengthen these principles with the results this thesis provides.

This thesis was made for the production department of the company operating in food industry. Production volumes are increasing in the case company while more and more production is exported to Europe. Raw and packing materials of products are expensive, and a part from some of materials, the materials are not re-workable, thus waste targets are set very low. During the high season the production plans varies a lot based on the demand and production has to be agile and flexible to answer this demand. Overall equipment efficiency (OEE) targets for the case production lines are high, which is taken in to consideration while planning the production. It is key to hit the production targets within given time and with the raw and pack material batches available.

The current situation is that various improvements have already been made, and the issues or challenges remaining seem to be more difficult to solve. The aim was to find the tasks, which are in key role contributing on the performance of the case company, and which are lacking standard operating procedures, thus leaning heavily on experience and tacit knowledge of the operator. In this thesis the case company is left anonymous.

1.1 Objectives of Thesis

The overall objective of this thesis is to improve the effectiveness of the case company's production processes. The goal of this thesis is to create a long-term road map for the case company to stabilize the variation of the production. This road map is about finding ways and the best practices from the theory of standardizing work stages and ways to transfer tacit knowledge into explicit knowledge among the production team. By standardization

of the ways of working, the production stability and flexibility, and product quality and in the end customer service can be improved.

This study is based on knowledge that there is variation on quality and in production efficiencies between different shifts. If the production is not stable and for example, the set-up times vary depending on who is doing it, the production volumes do not meet the production plans and the flexibility to meet the customer demand is lost. It is important to be able to produce the right products, in the right quality, at the right time, in the right quantity as Lean Manufacturing principles are striving.

Using the theoretical background, a suggestion is made for mapping the knowledge gaps in the case company and to develop tools to transfer this tacit knowledge to be shared as standard operation procedures within the production teams. The goal is to eventually improve production stability in the case company, so that the targets can be achieved in every shift irrespective of who is working on the shift.

The purpose is to achieve a feasible road map for the process improvements. By creating the road map for standardizing the key tasks, which are effecting the product quality and production efficiency, **production stability** and **output reliability** can be achieved, which leads to more **flexible production** and **better customer service** in long-term. The stability of the production processes creates **flexibility**, which is needed in particular in high season, when production plans follow closely the sales. Standardized processes are also the key for **continuous improvement**; improvement process starts typically from the existing standards.

1.2 Research Problem and Questions

As mentioned above, the production of the case company does not always meet its targets by hitting the planned production volumes. The research problem is that production time and materials are wasted and targets cannot be reached with given time and materials. There is variation between different shifts in the product quality and the production efficiencies. The aim of this study is to find the key work stages and the key talents that are effecting on the production stability and to plan a road map how the variation can be stabilized in long-term.

Based on the purposes of the study, the following main research question can be set:

What kind of elements should the improvement road map consist of?

The sub research questions are:

1. Which are the key tasks for hitting the operational targets in the case company?
2. Which are the key talents with tacit knowledge of these critical work stages?
3. How to transfer tacit knowledge of the key talents to explicit knowledge so that it is available for everybody?
4. Which factors have to be taken into consideration implementing work stage standardization?

The answers to these research questions are based on the results and the analysis of the concepts and the case study, researcher´s own experience and observations, interviews and historical data.

1.3 Scope and Structure of the Thesis

Variation is seen, in this thesis, consisting of four matters; Man, Method, Machine and Material, the 4 M´s. Machine and Material are left out in this thesis, because Man and Method are considered to have the most effect on the variation in the quality and the efficiency between the three shifts. Man refers to operators doing their tasks according to his/her best ability. Method refers to the way the tasks are conducted by the operators. Focus is in making the long-term plan, road map, for the case company, how to implement standardized work stages to reduce the variation in production quality and efficiencies between three shifts. This thesis was limited in scope of the individual production orders.

From theory perspective, this thesis is based on the theory of Lean Manufacturing and Knowledge Management. Concepts of work stage standardization, and tacit knowledge and methods to convert it to explicit knowledge are reviewed in more detail. The idea is to study these theories both on a general level and in scope of limitations appointed by the product and the production type being in scope.

This study is a case study. In the case study the detailed and intensive information is collected about the individual case. The typical features of the case study include that the individual case is studied in a connection to its environment, in the natural situation. In case study the information is gathered by using different methods such as observation, interviews, reading and studying documents among others. The purpose of the case study is to describe the typical phenomena related to the case. (Hirsjärvi et al., 1998)

Theoretical part of the thesis is a conceptual analysis aiming to develop a conceptual system. New concept systems are needed for example for describing and discovering phenomena, organizing knowledge and for a base of planning systems. Concept system can be new or a developed version of the known concepts. The concept system itself is not relevant without serving some function or need. Materials for concept system are usually

in addition its purpose of use, other concepts, empirical data and theories of the target phenomenal. Concept analysis consists of analysis, synthesis and comparison. The functionality and superiority of the new resulted concepts compared to the old ones, is usually by experimenting. In experimenting process, evidence is gathered by studying and comparing critically usage of the concept systems in scope of application. Experimenting is aiming to validate that the result is towards the "true knowledge" and above all, worthwhile. (Olkkonen 1993, 65-66 pp.)

This study is a qualitative study. The purpose of qualitative study is to describe the subject studied as comprehensively as possible. For this thesis, the information was gathered on an open interview and by studying literature and documents. In an open interview, the interviewer clarifies the interviewee's thoughts, opinions, feelings and ideas according to how they come out in a discussion. (Hirsjärvi et al., 1998)

According to hermeneutic conception, the comprehension of the researcher and the people operating with the researched phenomenon is essentially included in data collection. Comprehension includes particularly contexts that are difficult to measure such as cause of the phenomenon and processes of the incidents. The observations are mainly qualitative and the analysis is based on the interpretation of the researcher. Cases are often unique, for example new operating method, where understanding is key to guide the development. (Olkkonen, 1993. 52 p.)

The researcher of this thesis has been working in the production of the case company in daily basis for over two years, solving problems with line operators, engineers and Repairs and Maintenance (R&M) staff. The researcher has gained, due this first-hand experience, wide experience of the daily and reoccurring issues in the case company and good knowledge of the operations and also knows the members of the staff personally. The study is limited to apply one part of the case company, the production. Even though the work is a case study, the results can also be adapted elsewhere, where structure is wanted by standardizing the work stages. In this thesis, it is assumed that people are willing to share their knowledge to grow each other and themselves, when the right type of environment is achieved.

The first part of the thesis is a conceptual analysis of Lean Manufacturing theory and impact on work standardization, and the theory of Knowledge Management, in scope of tacit knowledge and ways to transfer it to explicit form. The second part is the empirical part, in which the information of the key challenges of hitting production targets was gathered interviewing operators, R&M staff and engineers and studying historical data. The empirical data is also based on researcher´s own experience, as she has worked over two years closely with production team, first in production improvement role and then in managerial role.

The structure of the thesis is as follows. First, the theories and concepts utilized in the case study are presented. Theories of lean philosophy, the seven types of waste and work stage standardization are presented in Chapter 2. In Chapter 2, also the theory of Knowledge management is presented in scope of tacit knowledge and ways to transfer it to explicit form. In Chapter 3 is presented the research environment, methods and materials. In the chapter 4, is displayed the results and discussion. In the final chapter 5, conclusions and proposal for further study is presented.

2 STANDARDIZATION OF PRODUCTION PROCESS

This thesis is based on the theory of Lean Manufacturing and Knowledge Management. Standardization, tacit knowledge and ways to convert it to explicit knowledge are reviewed in this thesis in more detail. The idea is to study these theories both on general level and in scope of limitations appointed by the product and production type in question. Figure 2 shows the theoretical framework for this thesis.

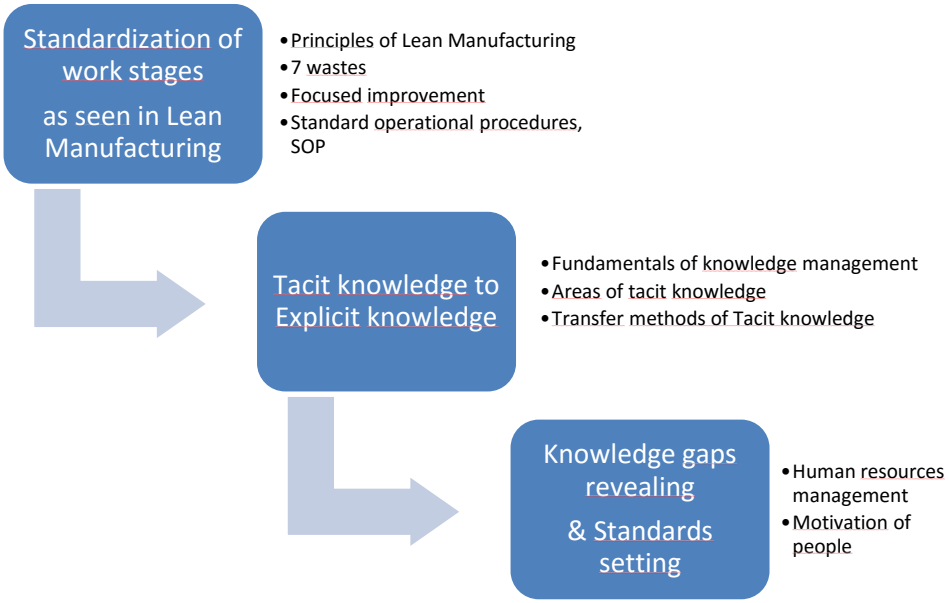

Figure 1. Forming of theoretical framework

First, Work stage standardization is reviewed in chapter 2.1, to understand the process and the conditions of standardization. In chapter 2.2 Lean philosophy and Lean methods are presented, to review the improvement environment. The waste types of Lean are reviewed to understand how to prioritize the improvement areas in production environment.

Knowledge Management theory is reviewed dividing it in two types of knowledge: Tacit and Explicit, and SECI model is presented to see how tacit knowledge can be transformed to explicit knowledge. Obstacles of knowledge sharing and motivating people for knowledge sharing is reviewed in the last chapters.

2.1 Workstage Standardization

In 1926, Henry Ford wrote (cited in Santos et al. 2015):

- *To standardize a method is to choose out of the many methods the best one, and use it. Standardization means nothing unless it means standardizing upward.*
- *Today's standardization, instead of being a barricade against improvement, is the necessary foundation on which tomorrow's improvement will be based.*
- *If you think of ''standardization'' as the best that you know today, but which is to be improved tomorrow- you get somewhere. But if you think of standards as confining, then progress stops.*

As Henry Ford has stated, standards are the basis for improvement, and this thesis is based on that citation. Here the theories for standardization are reviewed to fully understand the standardization process. First is defined the concept of standard and then the standardization process.

Jang & Lee (1998), by studying factors influencing the success of management consulting projects, found that in order consultants to be able concentrate their focus on new or exceptional tasks in the company, teams need to define and set standards for their work routines and repetitive tasks and this requires the active participation of all interested parties. Jang & Lee define standardization of procedures as the degree to which work rules, policies, and standard operating procedures are formalized and followed. (Jang & Lee, 1998)

Hsieh et al. (2002, cited in Ungan 2006) found by empirical study that work standardization will help companies to stabilize their processes by minimizing uncertainty and variability, which can be caused by differences in the way people perform their work. Skills, talents and behaviors of an individual have effect on how he/she performs, and the results of the work are different when performed by different people. To reduce the performance variation, the best practice to perform the task has to be documented in detail and followed strictly. Ungan (2006) however admits that in many cases the documentation process can be very challenging as the level of detail increases. This is mainly because what Polanyi´s (1966, cited in Ungan 2006) stated that people know more than they can tell. In other words, people develop their own ways to do thing but it is not easy to communicate to others. Challenge is to get this tacit knowledge in written form. (Ungan, 2006)

ISO (1996, cited in Münstermann et al. 2010) defines standards as documents, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Wüllenweber et al. (2008, cited

in Münstermann et al. 2010) define the aim of standardization as "to make process activities transparent and achieve uniformity of process activities across the value chain and across firm boundaries." Münstermann et al. (2010) empirical study, based on business process standardization, shows that process standardization positively affects process time, cost and quality, and should be considered as a regular driver of process success.

De Vries & Slob studied 2008 company standardization by investigating how company standards are developed in practice and in developing a best practice for this. They find that developing standards does not mean that every standard has to be formed from scratch. Company standard can be formed as follows; a reference to company adopted external standards, company modified standards, a subset of an external standard, standards reproduced from for example documents of supplier or a self-written standard. (de Vries, 1999, cited in de Vries & Slob, 2008)

De Vries & Slob (2008) compared standardization activities of six Dutch companies, trying to improve their own standardization performance, to establish the best practice of the company standardization process. In figure 3 is shown de Vries´ & Slob´s outlook for company standardization model.

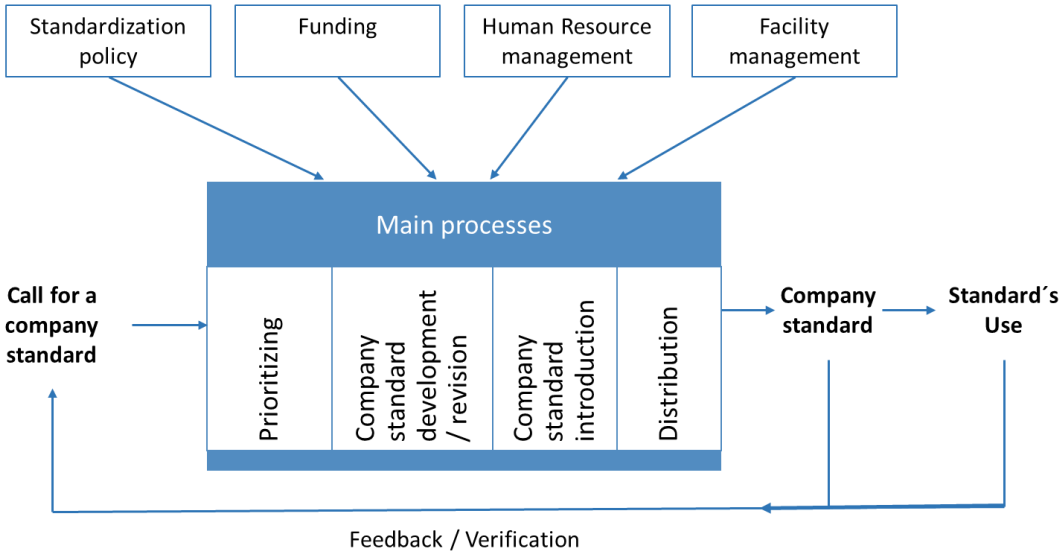

Figure 2. Company standardization model (adapted from de Vries & Slob 2008)

De Vries & Slob (2008) distinguish three step for successful standardization process. **Step 1. *Standard should be there.*** Call for a standard is either internal or based on external obligation. This need for standard has to be evaluated and decided, based on policy and prioritizing, is the standard necessary to develop. After prioritizing comes development of the standard which includes formation of a draft version, commentary rounds, writing the final version of the standard and finally output is the approved company standard. This development process needs competent personnel (Human Resource Management),

funding and IT tools to support the process (facility management). (de Vries & Slob, 2008)

Step 2: ***The Standard Is Known and Available.*** Once the standard is developed and approved, the next step is to get the standard available for the intended users. During the introduction the benefits and reasons behind the standard can be explained to the direct users. Introduction should be started already beginning of the development process and continue the promotion after introduction; better the standard is known the higher is the possibility the standard actually gets used. In this model user´s output is the input for the standardization process, so their feedback is taken into consideration and standard can be modified based on direct user feedback. Distribution process should be in place to ensure standards are available for direct users. Distribution can be arranged using intranet, subscription or for instance ordering on demand. Important is that always the newest version of the standard is available and being used. (de Vries & Slob, 2008)

Step 3: ***The Standard Is Used.*** Standardization can be successful only if the standards are being used. The potential users have to be able to understand the standard and also have a will to use it. De Vries & Slob describe this accordingly: the standard, the product of the standardization process, has to solve the matching problem, the demand out of the organization, which is the starting point of the whole process. If the direct users are not satisfied, the standard can be withdrawn, maintained or changed according the feedback. The figure 6 show the simplified feedback loop. (de Vries & Slob, 2008)

According to Slob (1999, cited in de Vries & Slob, 2008) the standard should be user-friendly to achieve success and to get there, actual users should be involved in standardization process. De Vries & Slob (2008) have found several literature sources for arguments for user involvement, such as Nakamura (1993), Adolphi (1997), Brown and Duguid (1991), Gouldner (1954), De Gelder (1989), and Winter (1990). Slob (1999) concludes the following:

- Standardization is a way to manage technical (company) knowledge.
- Standardization is a structured way to transfer tacit knowledge into explicit knowledge.
- When tacit knowledge is made explicit, it should be considered by whom this codified knowledge will be used in the future.
- It also should be considered that there can be an important difference in the knowledge domain of the specialist(s) or writer(s) of the standard and the intended direct users of that standard.
- The users of the standards, therefore, should be drawn into their development.

(Lee, 2008)

Ungan (2006) states that standardization process is challenging, but it can be done with right team including process masters. Ungan proposes framework for standardization, shown in figure 4. This framework is based on previously published materials, which are outputs of interviews, company reports, e-mails, memos etc. (Ungan, 2006. 139 p.)

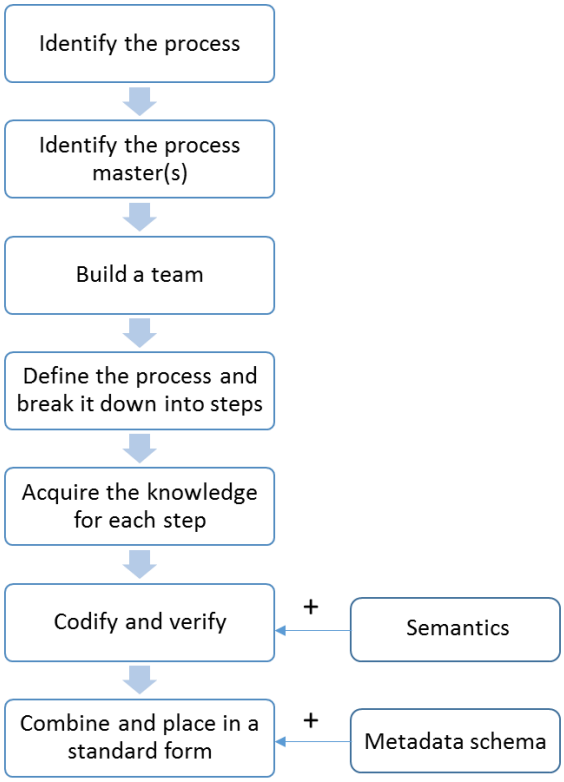

Figure 3. Proposed framework for standardization (adapted from Ungan 2006)

First step for standardization, according to Ungan (2006), is identifying to process, because all processes are not suitable for standardization. Inputs, outputs and operations has to be identical, otherwise process cannot be standardized. For example, custom-tailoring process has different inputs and output depending on what the customer wants. (Ungan, 2006. 139 p.)

The process master or masters are identified in next phase, to articulate and codify their knowledge. The process master knows the best way of conducting the task. Sometimes this knowledge master is the only one in the company who can perform the task, and he/she is usually well-known member of the organization. Consequently, the process master has tacit knowledge which needs to be converted to explicit form. Ungan (2006) assume in his study, that process master is willing to cooperate and share his/her way of working. (Ungan 2006. 140 p.)

Nesbitt (1993, cited in Ungan 2006, 140 p.) states that there are two techniques collecting flowchart data from process master; interview or team method. Ungan (2006) finds the team method more effective way to convert tacit knowledge in to explicit knowledge, because tacit knowledge here is action oriented and acquisition requires experience sharing. The synergy among the team will help articulate the process master´s knowledge. Meaningful dialog conducted, when the team is formed of people who perform the same tasks as the process master and are familiar of the process. Team then defines the process, set boundaries and the purpose of the process is articulated clearly. Process is then divided into steps and inputs, customers, supplier, outputs and tasks are identified and listed for each step. (Ungan, 2006. 141 p.)

Acquisition of knowledge can be also called knowledge capture, knowledge representation, and knowledge extraction. Acquired knowledge can be both tacit and explicit from. Explicit knowledge acquisition is a straightforward process, but tacit knowledge is the challenge and the trust between knowledge provider and knowledge seekers must maintain, and knowledge provider must not be unwilling to share his/her knowledge. Nonaka´s knowledge externalization is explained in the chapter 2.4. (Ungan, 2006. 141 p.) After acquisition of knowledge, team writes it down. Documentation of knowledge is iterative process (Savory & Olson, 2001, cited in Ungan 2006, 143 p.) and step-by-step revision of the model is needed to get the wanted chart (Biazzo 2000, cited in Ungan 2006, 143 p.).

Because there are hundreds of different tasks in most production areas, it is hard to decide where to start. Dudbridge (2011) suggests to start with listing all tasks that are to be covered. He uses a tray-sealing machine as example:

- Start-up checks
- Starting the machine
- Changing the date code
- Alignment of date code in target box
- Changing the roll of film
- Testing for seal strength
- Testing for leakers
- Changeover of sealing heads
- Cleaning of sealing heads.

After all the tasks are listed, decide which are the curial ones and form a small team to look closer the task in detail and eventually create a standard. Several standardization projects can be running simultaneously, because the teams are small. In these teams should be people that has these tasks as part of their job. Together they can have consensus about the standard method and they can also discuss ways to improve the task in terms of safety, quality, efficiency and cost. The new standard should be recorded so that it is

available for others to learn the method. A good practice according to Dudbridge is to record the standard in writing and use photographs or videos to clarify the method. (Dudbridge, 2011)

Companies all over the world are spending time and money to standardize their processes to improve operations and increase their business opportunities. Challenge is to transfer tacit knowledge of the people to explicit form. (Ungan, 2006)

2.2 Lean Philosophy

As Santos et al. (2015) defines, Lean manufacturing is, in principle, the systematic elimination of waste. The name lean indicates cutting ‘‘fat’’ from production activities. Lean manufacturing has been adopted during the last few decades, but many of the lean manufacturing tools can be traced back to at the turn of the twentieth century to Fredrick Taylor, Henry Ford, and the Gilbreths. The development of improvement tools was systematized by the Japanese Toyota.

Toyota’s production system can be defined as Lean manufacturing or Muda, which is Japanese word for waste. Therefore, lean can be described also as waste-free production. (Santos et al. 2015, p. 9). According to Shah & Ward (2003) lean is focused on cost reduction by eliminating non-value-adding (NVA) activities and using improvement tools to remain stability and optimize supply. The goal is to establish streamlined, highly efficient system that produces finished goods at the right amount at right time, when customers want it, with little or no waste (Shah and Ward, 2003, cited in Cervai et al. 2014, 66p).

Lean manufacturing is based on three tools according to Santos et al. (2015), just-in-time (JIT), Kaizen, and Jidoka. Kaizen means continues improvement and Jidoka translates as ‘‘autonomation,’’ a type of automation in which machinery automatically inspects each item after produced and notifies humans if a defect is detected. (Santos et al. 2015, p. 9)

Liker (2006) describes 14 principles of Lean, which are divided into four categories; philosophy, process, people/partners and problem solving (show in fig 5). Toyota Production System (TPS) is based on these 14 principles and they are in use in all Toyota´s factories.

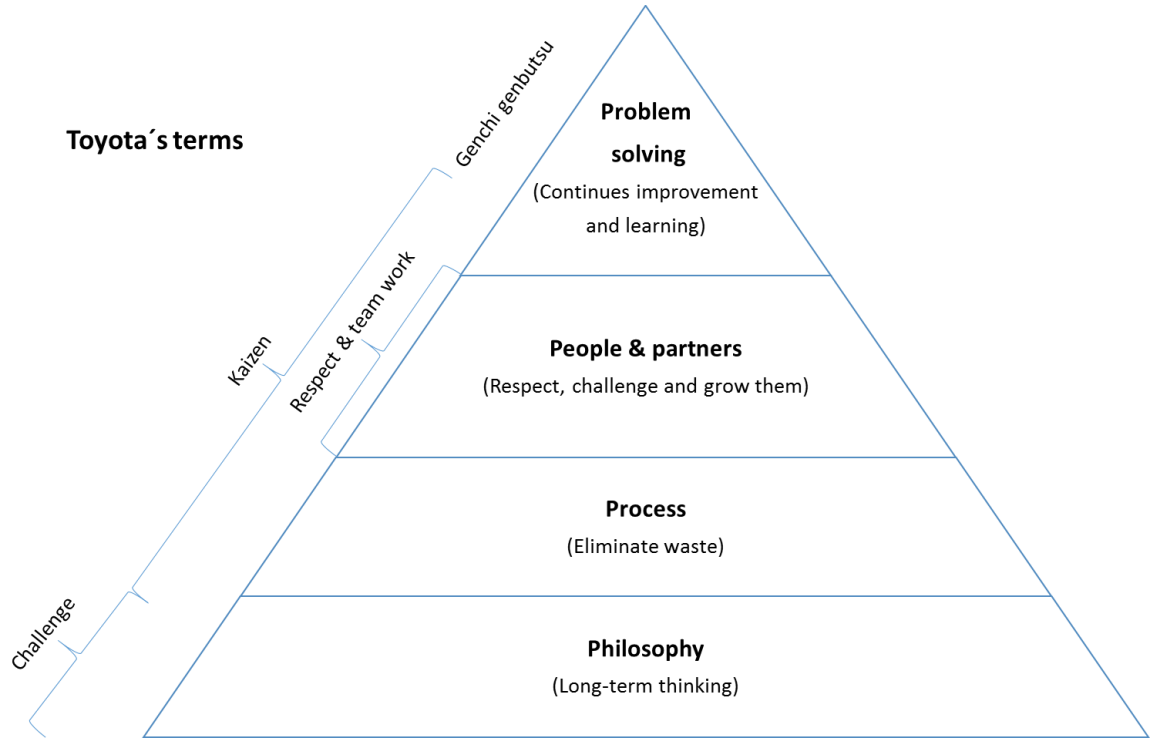

Figure 4. The four categories of the Toyota way (4P´s) (adapted from Liker, 2006. 6 p.)

Long-term *Philosophy*

Base management decisions on a long-term philosophy, even at the expense of short-term financial goals (Principle 1). Grow and guide the whole organization towards common purpose, which is beyond making money. Develop value to the customers, community and economy. Evaluate all the functions based on how well they follow this principle. (Liker, 2006. 37 p.)

Right *Process* produces the right results

Create process flow to reveal the problems (Principle 2). Redesign work processes to have a high-quality, value adding flow and strive to eliminate time losses based on waiting for other work stage to finish. Create flow to move rabidly materials and information and to link processes and people together so that problems reveal immediately. Flow is the key to true continuous improvement process and people development. Use pull systems to avoid overproduction (Principle 3). Offer the customers what they want, when they want it in right quantity. Consumption based supplementing of materials is the key principle for JIT. Minimize semi-finished and finished goods inventory. React on daily changes in customer´s demand, rather than lean on it systems, to keep track on inventory. Leveling the workload (Heijunka) (Principle 4). Elimination of waste is not all what makes Lean successful. Leveling overconsumption of people and machine and eliminating the unevenness of the production plans are equally important. Try to level the workloads of all processes.

Stop in case of a quality problem (Jidoka) (Principle 5). Quality that customers demand is basis for every process. Use modern quality assurance systems with ability to detect defects and stop the production. Jidoka, machines with human intelligence, are base for in-built quality assurance. Standardize tasks for continuous improvement (Principle 6). Standardize present best practices to learn about current process. Allow creativity and personality improve standards; include improvement into standard so that if this person leaves one day the standard can be taught to the successor. (Liker, 2006. 37-39 pp.)

Use visual control, no problems can be hidden (Principle 7). Use simple visual control systems on post so that people can immediately find out if they are on standard or moving away from it. This will help process flow and pull. Avoid computer usage, it distracts people from their post. Use one-pagers when possible, even in case of the most important financial decisions. Use technology to help people, not to replace them. The process should be tested manually before implementing new technology. New technology is often unreliable and hard to standardize, which compromises the process flow. Never compromise good manual process by implementing unreliable and not tested technology. Good testing is necessary before implementing technologies into processes or products. If new technology is proven successful in testing, implement rigoursly and courage people to consider technologies when thinking improvements. (Liker, 2006. 37-39 pp.)

Adding value by improving your *People and Partners.* Grow leaders who understands work thoroughly, follows the philosophy and teaches it others **(Principle 9)**. Liker states, that managers should grow their own people, rather than hire from outside of the company. Leaders should be role models for strategy and philosophy of the company. Good leader knows the daily work in detail, so that he/she can be the best teacher for others. Respect, develop and challenge your people and teams **(Principle 10)**. The goal is to create strong and stable culture, where company´s values and conception spreads broadly. Train outstanding individuals and teams, who carry out company´s philosophy for outstanding results. This culture has to be boosted continuously. Use cross functional teams to improve quality and flow, by fixing technical problems. People are empowered when using company´s improvement tools. Continuously train people to work in teams. Respect, challenge and help your suppliers **(Principle 11)**. Treat partners and suppliers as part of the company. Challenge them to improve and help them achieve the goals.

Continuous *Problem solving* forwards organizational learning. Go to the place to see yourself to understand the situation (genchi genbutsu) **(Principle 12).** Improve processes or solve problems by going where the problem occurs and seek for yourself root causes behind the problem and not just relay on opinions and facts from others. Even the biggest directors or managers should go to the place to have more knowledge than superficial story about the situation. Make decisions slowly by consensus, considering all options and implement rigoursly (Nemawashi) **(Principle 13).** Nemawashi means process where problem and possible solutions are discussed with all the people it might consider to share

ideas and to have common solution. While consensus process takes more time, it widens solution selection and when the decision is made, implementation can be made rabidly. Continual organizational learning by Kaizen **(Principle 14).** When stable process is implemented, use improvement tools to find sources for ineffectiveness and apply counter measures. Processes should be designed having limited inventory so waste can be detected by all. When waste is detected put all employees to eliminate it by using continues improvement process i.e. kaizen. Evaluate the progress and whole project afterwards to recognize all defects openly. Set counter measures to avoid these defects from happening again. Learn by standardizing best practices rather inventing the wheel again with all new projects and leaders. (Liker, 2006. 40-41 pp.)

Lean philosophy is used as one of many methods in major businesses around the world to remain competitive in the increasingly global market (Womack et al., 1991; Schonberger, 2007).

2.2.1 Process Improvement with Lean Method

The Lean production´s main philosophy to elimination of the waste sources is based on five step process. Lean Enterprise Institute uses circle to demonstrate the iteration process of the five process steps of lean (Fig 6). These steps are maybe easy to remember but hard to implement.

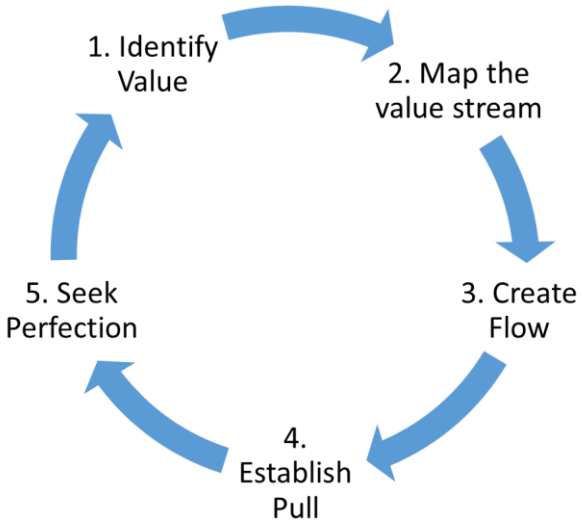

Figure 5. Lean principles shown as iterative process (adapted from Lean Enterprise Institute 2009).

Value for company has to be specified based on the customer's point of view and needs. Manufacturing process has to be evaluated for mapping the necessary activities and eliminate whenever possible steps that do not create value. The manufacturing of the product is based in a continuous flow triggered only by customer´s placing the order which is the

fundamental of the pull production. As value is defined, value streams are identified, wasted steps are eliminated, and flow and pull are introduced, start the process again and continue it until a state of perfection is reached in which perfect value is created with no waste. (Feld, 2001; Singh et al., 2009; Antony, 2011. cited in Cervai et al. 2014. 532 p.)

In order to improve production processes; quality, cost and lead time, it is important to know the sources behind the problems. Before the challenges can be found, it is necessary to define and understand the root causes of the problems. Santos et al. (2015) underlines the fact that variability in both quality and productivity are considered as major problems. There are three factors that production managers fear the most, these factors are considered as signs of weak production management. (Santos et al. 2015. p. 3-4) / s.264

1. Poor quality
2. An increase in production cost, and
3. An increase in lead time.
(Santos et al. 2015. p. 3-4) / s.264

Santos at al. (2015) stated that in production area, problems could be related to any of the basic elements of the area: Materials, Worker (or man), Machines and Tools, Energy, Methods or Products. These resources have to be managed well. Problems can be for example some of the following; defects, obsolete work methods, energy waste, poorly trained workers, and poor performance in machine and materials. Santos et al. (2015) found that the Japanese success is based on simple improvement methodologies, worker involvement, and respect and teamwork. (Santos et al. 2015)

2.2.2 Waste types of Lean

According to Santos et al. (2015) Shigeo Shingo identified seven main wastes which are common to all factories:

1. **Overproduction.** Producing products which are not ordered. Producing more than is necessary.
2. **Inventory.** Materials stored as raw material, semi-finished goods and finished goods.
3. **Transportation.** Material handling between processes, for example to warehouse and back.
4. **Defects**. Products with bad quality has to be reworked, fixed or destroyed. Lowers the productivity, stopping the flow of high-quality products.
5. **Processes.** Producing higher than agreed quality is not adding value.
6. **Operations.** Tasks which not add value.
7. **Inactivities.** Idle time of operator or machine.

(Santos et al. 2015, 7-8 pp.)

Liker (2004, 28-29 pp.) adds one more waste to the list;

8. **Underutilizing people´s talents, skills and knowledge.**

Figure 6. The seven wastes, which occurs in any operations (adapted from Dudbridge, 2011).

Inventory waste is considered to have the biggest impact according to Santos et al. (2015), because inventory hides the problems, not solve them. Santos et al. describes example; when production quality is low, the lot sizes are typically increased and products which have no demand get stored and possible never used. When problem causing bad quality is solved, inventory can be reduced having no effect on service. (Santos et al. 2015. 7-8 pp.)

Ohno (1988, cited in Liker, 2006) considered overproduction as the greatest waste, because it leads to most of the other wastes. If in any stages of manufacturing process is produced more products than customers demand, there will be extra inventory. Problem is that big buffers lead to other un-optimized activities like lack of motivation towards continuous improvement. Why worry about preventing maintenance or machines, when shut-downs does not effect on service anyway? Or why to mind some defected products, when thy can be just thrown away? Because these problems lead to time lost in other part on the process waiting to get good quality part instead of the one defected and material waste. (cited in Liker, 2006. 29 p.)

2.3 Knowledge Management

Knowledge has become one of the most important success factor driving for business success. Companies are hiring “minds” rather than “hands”, and value of knowledge usage is appreciated more and more. This has led to companies to explore the field of knowledge management (KM) to improve their market position and competiveness. (Wong, 2006)

The aim for knowledge management is typically some of the following; smooth knowledge transfer from retiring to the successor, to minimize knowledge lost due attrition or retirement, understand where the critical knowledge resources and areas are, to create set of methods that can be utilized with individuals and teams and which prevent organization to loose intellectual capital. (Dalkir & Liebowitz, 2011. 4-5 pp.) Roberts (2000) views KM as, getting the right information to the right people at the right time to achieve a competitive edge (Roberts, 2000).

Dalkir & Liebowitz (2011) also finds management of knowledge crucial for business competiveness; creation and spreading the knowledge have become increasingly important in today´s knowledge economy. Knowledge is widely considered as valuable asset or commodity, which is inside the products and in tacit knowledge of the employees. Although seen as value asset, knowledge differs radically from other commodities:

- Knowledge is not consumed by using it.
- Knowledge is not lost when transferred.
- Knowledge is substantial, but ability to use it is minor.
- A lot of valuable knowledge walks out of the door end of the day.

(Dalkir & Liebowitz, 2011. 2p.)

The multidisciplinary roots of knowledge management are the reason for lack of consensus defining KM. Interdisciplinary nature of knowledge management is shown in the figure 8.

Figure 7. Interdisciplinary nature of knowledge management (adapted from Dalkir & Liebowitz, 2011. 8 p.)

Knowledge management spreads widely in diverse fields such as; organizational science, cognitive science, linguistics and computational linguistics, information technologies (knowledge-based systems, document and information management, electronic performance support systems, database technologies), information and library science, technical writing and journalism, anthropology and sociology, education and training, storytelling and communication studies and collaborative technologies such as computer-supported collaborative work and groupware as well as intranets, extranets, portals, and other web technologies. (Dalkir & Liebowitz, 2011. 8 p.) In this thesis the purpose is to improve documentation and information management.

Nonaka & Nishiguchi (2001) sees that the traditional management models focus only on ways to control the flow and processing the information within the organization, and fails to see the organization as knowledge creating entity. Organizations not only solve problems, organizations create and determine problems and to solve them, organizations needs to create new knowledge. Thus, knowledge management should accomplish dynamic knowledge-creating process rather than static management of information. (Nonaka & Nishiguchi, 2001)

Dalkir & Liebowitz (2011) defines KM as coordination of people, technology, processes, and organizational structure in systematic and conscious way, in order to add value through using again gathered knowledge and innovation. This is accomplished with the encouraging of creating, sharing, and applying knowledge as well as with lessons learned and the best practices shared with organization enabling the organization to learn continuously. In other words, companies need to learn from their past errors and avoid reinventing the wheel over again. (Dalkir & Liebowitz, 2011. 4 p.)

2.4 The Two Types of Knowledge: Tacit and Explicit

Nonaka (1994, cited in Nonaka & Nishiguchi 2001) defines types of knowledge as tacit or explicit. Tacit knowledge is internal knowledge of a person, including technical expertise, cognitive learning and mental models. Explicit knowledge is knowledge that is external to a person and has been documented into some form, for example; paper documents, electronic databases and files, and the operating procedures.

Explicit knowledge can be easily transferred across the organization formally and systematically, because it can be expressed for example in words, number, data, scientific formulae, specifications or manuals. Tacit knowledge is hard to communicate or share to others, because of its highly personal nature and it cannot be formalized easily. Tacit knowledge is person´s subjective insights, intuitions, and hunches. Tacit knowledge is hard to put in words, because it is deeply embedded in a person´s experience, ideals, values, or emotions. Explicit and tacit knowledge complement each other and are both needed for knowledge creation. To truly understand the process of knowledge-creation, it is key to understand this interconnection of tacit and explicit knowledge. Nonaka & Takeuchi calls this interaction knowledge conversion (Nonaka 1990; Nonaka & Takeuchi 1995, cited in Nonaka & Nishiguchi 2001).

2.5 Transforming Methods of Tacit Knowledge and Knowledge sharing

Once knowledge has been captured and codified, knowledge needs to be shared and disseminated throughout the organization (Dalkir & Liebowitz, 2011). Researchers, interested in KM, share common concern of knowledge sharing (KS) in organizations. Such close attention to KS is comprehensible, since it is key part of the KM value chain, and without efficient knowledge sharing, value of knowledge is lost. (Teng & Song, 2011. 104 p.)

Teng & Song (2011) have identified two forms of KS; solicited and voluntary KS behaviors. Their study implies that, when people routinely exchange knowledge during long period of time, trusting relationships are built, which in turn increases the willingness of sharing

knowledge. The results suggest also that more routine type of knowledge exchange through solicited KS, is critically supported by high levels of open communication. However, open communication is not enough to engage employees in voluntary KS, solidarity and tacit-oriented KM processes are also needed. Open communication encourages collaboration and team learning. Tacit-oriented mechanisms can be such as face-to-face contacts, informal dialogues, and accumulated experiences. (Teng & Song 2011, 112-113 pp.)

Some of the strategically important benefits of knowledge sharing include:

- Connect professionals
- Standardize professional methods
- Minimize mistakes
- Utilize best practices
- Speed up the learning
- Build the company brand
- Utilize the strategic capabilities

(Dalkir & Liebowitz, 2011, 173-174 pp.)

Although KM and KS are seen as success factors, many shop floors and control rooms of manufacturing sites are less structured than shop floors of automakers. In these unstructured environments, procedures are not fully recorded, and production efficiency is depending on tacit knowledge of the blue-collar workers. According to Nakano et al. (2013) lack of documentation in these shop floors may not be because of a poor management, but because of high recording cost. In case of an abnormality, workers must take action to solve the problem. Skilled blue-collar worker quickly creates tacit knowledge to understand the issue and take action to solve it. Although these abnormalities can reoccur, they slightly vary, and that´s why it may be costly and hard or even impossible to externalize and often remains tacit, only in minds of the blue-collar workers. (Nakano et al. 2013, 291 p.)

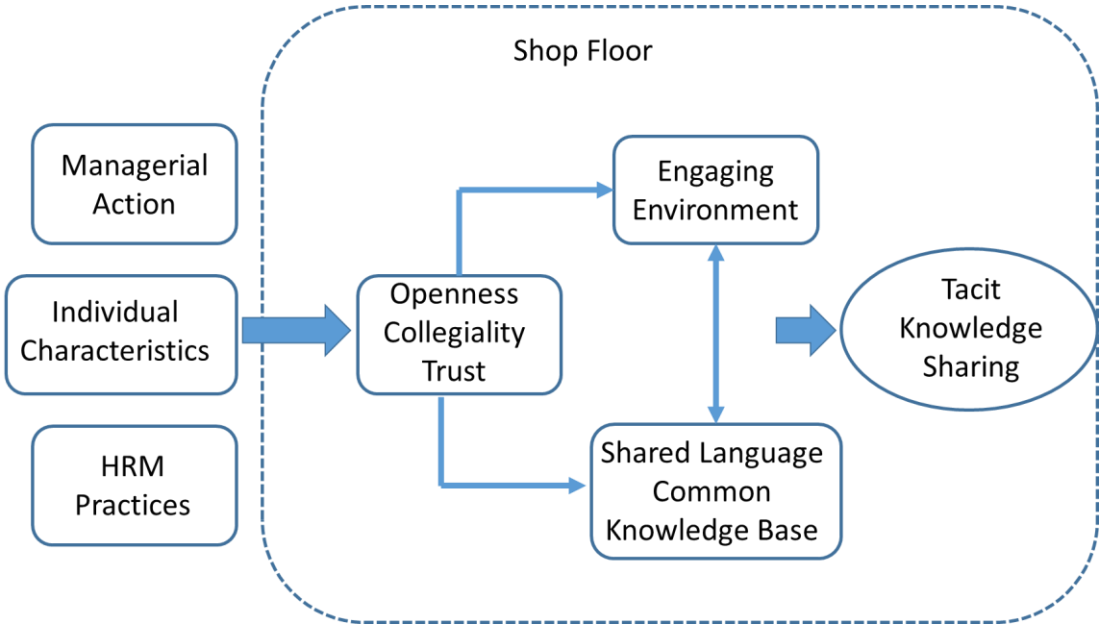

Figure 8. Engaging environment and tacit knowledge sharing (adapted from Nakano et al. 2013, 302 p.)

According to the study by Nakano et al. (2013) an engaging environment enables knowledge sharing in shop floor (figure 9). This kind of environment is facilitated by shared language and knowledge, developed through intense communication and shared sense of collegiality, openness and trust. In additional, managerial contribution for providing good working conditions, sharing company goals and providing Human Resource Management (HRM) activities such as formal and on-the-job training and incentives. (Nakano et al. 2013, 290 p.)

Roberts (2000) says that whatever knowledge management strategies are pursued, the message is the same; technology can help in various ways, but without the human aspect, such as making knowledge sharing part of performance management, or providing time for employees to record what they learn on the job, it is only technology without any content. (Roberts, 2000)

Ungan (2006) finds trust among knowledge provider and knowledge seekers crucial. Ungan refers to Nonaka´s SECI model, which is explained in next chapter, when explaining that knowledge is shared the team members must accompany process master on the job. Ungan´s knowledge conversion model is shown in figure 10. (Ungan, 2006. 142 p.)

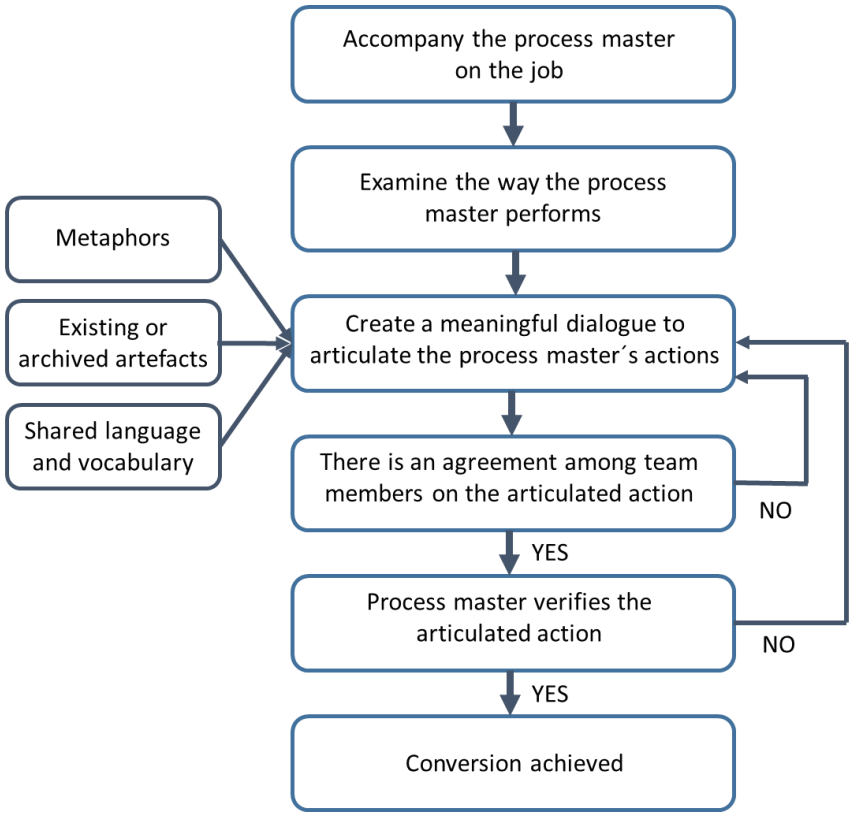

Figure 9. Conversion of tacit knowledge into explicit knowledge (adapted from Ungan, 2006. 142 p.)

According to Ungan (2006) during the work, the team members observe and communicate with the process master and try to articulate how he/she is performing the task. Team members helps each other to articulate their knowledge and errors can be immediately corrected by providing feedback, during sharing the experience. Meaningful dialog is sustained by shared mental models, metaphors and artefacts. After the agreement is achieved, the process master has to verify the articulate actions. The dialogue continues until process master verifies it, and then conversion is achieved. (Ungan, 2006. 141 p.)

Ungan (2006) emphasizes the role of semantics in process codifying the knowledge, because standardized operations will be used by multiple employees maybe also in different locations. If there is attached to the document the explanation of essential words and concepts, there will be no interpretation differences. Ungan finds also important that the knowledge is illustrated in a metadata schema to be successfully organized, used and stored. (Ungan, 2006. 141 p.)

2.5.1 SECI model

SECI model is the fundamental model for knowledge creation in organization. SECI comes from the initials of the four modes of knowledge conversion: socialization, externalization, combination and internalization. Through these four phases, knowledge is

originated in individuals converting it into explicit knowledge and turning it to organization knowledge: (1) from tacit to tacit knowledge, called socialization, (2) from tacit to explicit knowledge, called externalization, (3) from explicit to explicit knowledge, or combination and (4) from explicit to tacit knowledge, called internalization. (Ichijo & Nonaka, 2007. 296 p.)

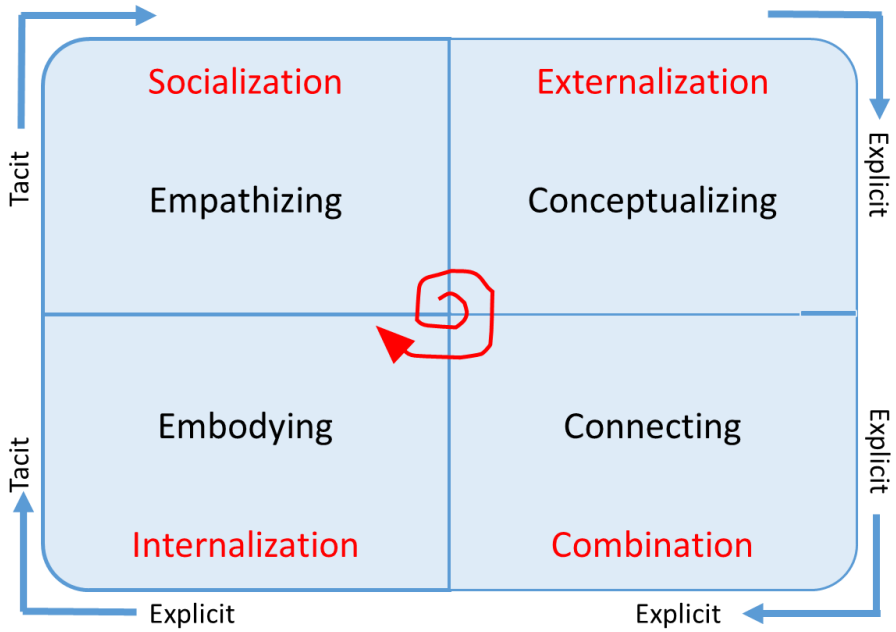

Figure 10. The SECI process (adapted from Nonaka & Nishiguchi, 2001, 18 p.)

Socialization is sharing experiences though joint activities, like spending time or living in the same environment, and hence creating tacit knowledge. A good example for socialization is traditional apprenticeship, when apprentices learn their tasks by observing and imitating the work of their masters, not by spoken words or written procedures. Other example is informal meetings outside work, talking and sharing worldview and creating mutual trust over meal and drinks. (Nonaka & Nishiguchi, 2001, 14-15 pp.) The key to gaining tacit knowledge is experience. It is extremely challenging to reflect to other persons thinking without having some shared experience. (Ichijo & Nonaka, 2007. 296 p.)

Externalization is a process of expressing tacit knowledge into explicit concepts. It is a characteristic knowledge creation process, where tacit knowledge is transformed to explicit knowledge in such forms that can be understood by others, such as metaphors, analogies, concepts and models. Externalization process is usually triggered by dialogue or collective reflection. (Ichijo & Nonaka, 2007. 283 p.) There are often discrepancies or gaps between images and expressions, which can help encourage reflection and interaction with other individuals. There are two supportive factors in externalization process. First, technics which enable person to express his or her ideas into explicit form through combining deductive and inductive analysis and also through abduction with metaphors, narratives and visuals. According to Bohm (1980, cited in Nonaka & Nishiguchi, 2001,

16 p.) dialogues support greatly externalization process. The second supporting factor is translation of tacit knowledge of the experts into comprehensible concepts. (Nonaka & Nishiguchi, 2001, 16 p.) In this thesis the focus is consequently on externalization, i.e. to articulating tacit knowledge in explicit form, which can be then processed and documented as standard.

Combination is process where concepts are arranged into a knowledge system by combining different groups of explicit knowledge through such media as documents, meetings, phone calls or it-communication systems. Combination can create new knowledge when individuals sort, add, combine and categorize knowledge together. Combination is, in practice, a three step process, in which explicit knowledge is first collected and combines, then the new explicit knowledge is shared inside the organization and finally the explicit knowledge is processed to be more practicable. (Nonaka & Nishiguchi, 2001, 16-17 pp.) This type of knowledge creation takes place in formal education and training at schools. (Ichijo & Nonaka, 2007. 277 p.)

Internalization process is transforming explicit knowledge into tacit knowledge and it is closely related to "learning by doing" concept. Through this process, newly created knowledge is shared among the organization. When knowledge is internalized through socialization, externalization and combination into tacit knowledge bases such form as shared mental models or technical knowhow, it becomes valuable assets. (Nonaka & Nishiguchi, 2001, 17 p.) To form explicit knowledge into tacit knowledge, it helps if the knowledge is articulated as documents, manuals or oral stories. Documentation helps both individuals to internalize the situation they expiring, therefore increase their tacit knowledge, and transfer knowledge to others. (Ichijo & Nonaka, 2007. 285 p.)

This is a continuous process, where the new tacit knowledge triggers a new cycle of knowledge creation. Nonaka & Nishiguchi (2001) call this the knowledge spiral, in which the interaction between tacit knowledge and explicit knowledge will become larger in scale as it moves up the ontological levels. (Nonaka & Nishiguchi, 2001. 17-18 pp.)

2.5.2 Obstacles to Knowledge Sharing

There are many obstacles that can complicate knowledge sharing in organizations. The biggest obstacle according to Dalkir & Liebowitz (2011) is the notion that knowledge is property and the people find ownership of knowledge very important. By reassuring individuals that they will keep the authorship and have credit of their knowledge, the obstacles can be overcome. There is a general association that knowledge is power. (Dalkir & Liebowitz, 2011. 168-170 pp)

People may end up hoarding they knowledge, because of the fact that individuals are in many cases rewarded for what they know, not what they share. Hoarding of the

knowledge can cause negative issues such as empire building, reinvention of wheels, feeling of isolation and resistance to ideas outside of the team. The reward system is best to adapt such a way that rewarding hoarding of the knowledge is stopped and knowledge sharing is appreciated and valued. (Dalkir & Liebowitz, 2011. 168-170 pp)

Dalkir and Leibowitz (2011) sees that another common obstacle for not knowledge sharing is either the knowledge provider´s uncertainty if that the receiver will understand and use the knowledge as provider means it to be used, and/or the recipient´s uncertainty about credibility of the shared knowledge. Both matters will disappear in connection with the community when it is a self-regulating system which continuously checks and confirms both contents and membership. (Dalkir & Leibowitz, 2011. 169 p.)

Organizational culture and climate effects knowledge sharing. It may either help or hinder knowledge sharing. Without an open knowledge sharing culture, effective knowledge exchanges cannot occur. If the organizational culture encourages discovery and innovation knowledge sharing get easier, whereas one that nurtures individual genius will make it hard. The collective work should be rewarded instead of creating culture based on social status, because rewarding teams creates a climate of trust. (Dalkir & Leibowitz, 2011. 169 p.)

On the other hand, while the organizational knowledge sharing may be seen as weak due to any or all of the earlier mentioned factors, knowledge sharing may be flourishing quite well, without being detected. The phenomenon is often referred of the " undernet", where employees share knowledge, but not due the official knowledge base. The official knowledge bases may be seen too difficult to find what they are looking for. This goes with the prevalent view that successful KM is a grassroots or demand-driven rather than from top to down technology pushed. Knowledge appears to flow well when the climate of trust is distinguished by the members sharing the knowledge and others are seen credible. It is also important that the knowledge is exchanged both ways. In small organizations the undernets bring different experts together, but in larger organizations the undernets tend to separate different departments into their own groups, having different ways of working and the groups do not understand each other. Weinberger (1999, cited in Dalkir & Leibowitz, 2011. 170 p.) emphasizes the usefulness of identifying the undernets, because it defines how people really share knowledge. Weinberger refers the undernets to be the "lifeblood" to the organization. Without interest or investigation of the undernets, top-down KM initiatives end up having the "other" network, which people really use. (Dalkir & Leibowitz, 2011. 170 p.)

2.5.3 Motivating People to Adapt Knowledge Sharing Culture

An engaging environment is according to Nakano et al. (2013) indicated to facilitate sharing of tacit knowledge. An engaging environment needs to flourish a shared language and knowledge, which comes from intense communication and a strong sense of collegiality and an open and trusted social climate. According to Nakano et al (2013) to contribute on developing engaging environment, although it may appear obvious, managers should make an effort on proving appropriate work conditions, and communicate company goals and HRM practices such as the provision of formal training, on-the-job training and incentives. (Nakano et al. 2013. 290 p.)

Nakano et al. (2013) found that engagement and shared concerns regarding efficiency help to maintain and share tacit knowledge on the shop floor. Data and field observations revealed to Nakano et al. in the study that communicating clearly to blue-collar workers both their responsibilities and the importance of good practices, engaging environment can be created. Managers create engagement also being concerned both with operational performance and with allowing workers to obtain opportunities to undergo professional development. (Nakano et al. 2013. 292 p.)

Nakano´s et al. (2013) results indicated in addition that blue-collar workers, particularly those with low levels of education, require a suitable environment to share their tacit knowledge. White-collar workers are normally more engaged in discussions and arguments and demand the assets that they require to improve their productivity, but blue-collar workers are less vocal, because they are not feeling confident or prepared to express their opinions, and some blue-collar workers may have poor self-images. Thus some blue-collar workers need support until they feel confident and will begin to take initiative sharing their knowledge by talking with other operators and expressing to the managers where the improvement areas are, and suggesting solutions. An engaging environment supports cooperation and teamwork, learning by doing and sharing of tacit knowledge. Although not all of the tacit knowledge can be saved, this type of environment is helping. (Nakano et al. 2013)

3 RESEARCH METHODS AND MATERIAL

The empirical research context and methods of data collection and analysis are described in this chapter. The concept analytical approach was applied to examination of the theory of the key concepts of the study. Data for the empirical part of the thesis was collected via participating observational research, using qualitative study methods such as interviews and observation and analyzing historical data trough qualitative study.

3.1 Research methods

This study is a case study in which the production of the case company was studied. In the case study the detailed and intensive information is collected about the individual case. The typical features of the case study include that the individual case is studied in a connection to its environment, in the natural situation. In case study the information is gathered by using different methods such as observation, interviews, reading and studying documents among others. The purpose of the case study is to describe the typical phenomena related to the case. (Hirsjärvi et al., 1998)

Theoretical part of thesis is a conceptual analysis aiming is to develop conceptual system. New concept systems are needed for example describing and discovering phenomena, organizing knowledge and base for planning systems. Concept system can be new or developed version of know concepts. The concept system itself is not relevant without serving some function or need. Materials for concept system are usually in addition its purpose of use, other concepts, empirical data and theories of the target phenomenal. Concept analysis consists of analysis, synthesis and comparison. The functionality and superiority of the new resulted concepts compared to the old ones, is usually by trying. In trying process, evidence is gathered by studying and comparing critically usage of the concept systems in scope of application. Trying is aiming to validate that the result is towards the "true knowledge" and above all, worthwhile. (Olkkonen 1993, 65-66 pp.)

This study is a qualitative study. The purpose of qualitative study is to describe as comprehensively as possible the subject studied (Hirsjärvi et al., 1998). The data for this study was gathered on an open interviews and by studying literature and documents. In an open interview, the interviewer clarifies the interviewee's thoughts, opinions, feelings and ideas according to as they come out in a discussion.

According to hermeneutic conception, the comprehension of the researcher and people operating with researched phenomenon is essentially included is data collection. Comprehension includes particularly contexts that are difficult to measure such as cause of the

phenomenon and processes of incidents. Observations are mainly qualitative and analysis is based on the interpretation of the researcher. (Olkkonen, 1993. 52 p.)

3.2 Data collection and Analysis

This thesis is based on theory of Lean Manufacturing and Knowledge Management. In more detail reviewed is concepts of work stage standardization, and tacit knowledge and ways to convert it to explicit knowledge. The idea is to study these theories both on general level and in scope of limitations appointed by the product and production type being in scope.

Data from the production was collected from several data sources of the case company. The key performance indicators (KPI´s) and other meters used in the case company were studied. There are company core KPI´s, which are reported to concern level, and smaller scale meters internally used for measure company performance. Every production order has time frame booked in the production plan and raw and packing materials are ordered accordingly. The performance of the case production unit is compared to these standards as good volume produced against planned volume, this is called *Hitrate*. Target for hitrate is 100 %. Operator manually reports time losses and other challenges per shift. Material consumptions and inventory are reported in the SAP. Waste bins are weighted and reported manually on a form. As the measurements and reporting systems are mainly manual in the case production, there is always some possible deviations in the data and human error cannot be ignored analyzing the data.

Going through operational KPI´s, it was noticed that comparison of the three shifts is difficult with existing KPI´s. Based on this findings, new set of KPI´s are recommended to implement in the case company, to improve the understanding where the focus areas for improvements lay. What you measure, can be improved.

Empiric data was collected in addition by interviewing and otherwise communicating with the operational team members, operators, shift leaders, engineers and R&M staff. Communication refers to data collection by asking those who have the experience on particular phenomenon so that they can explain it to the researcher. This enables generalization of results and testing the theories. There are four main ways to collect data from this source: survey, personal interview, telephone interview and email interview. Since questions are formulated by the researcher, this type of data collection is in any case more or less structured, which helps to analyze the answers.

In previous role, the researcher spent several hours per day in production hall observing and interviewing operators on the challenges and technical issues they have. During this one and half year period, people and processes became familiar to researcher. In this role, researcher’s job included facilitating improvement workshops and root cause analysis,

follow-up and collecting data from the lines on failures and waste, making instructions together with operations team and R&M team and training people. One aspect of the observation was in addition the observation of the behavioral of different operators facing challenges. Moreover, how they coped these situations. Researcher has visited three similar factories in Europe and interviewed the Operations Managers and improvement engineers on those manufacturing sites. In the scope of the visits was to find out operational best practices and understand challenges they are facing in similar set-ups and in same manufacturing environment.

3.3 Operational Environment

The manufacturing process is one of the three functional processes of the case company and it is divided into two sub processes; to process and production. The manufacturing process starts from the production plan, which is the final result of production planning process. In this thesis the focus is on the production, which is owned by the Operations Manager. The results are applicable also for other departments of the company. The manufacturing process of the case company includes ten steps through the production to palletizing the finished goods.

The case company uses, as support of its manufacturing and packing processes, outsourced service operations such repairs and maintenance, and contract manufacturing in which a part of the processing of the product is made by the third party, in their production premises. The maintenance consists of the corrective maintenance actions of the production machines and devices, and preventive maintenance. Operations Manager is responsible for the follow-up of their functions. The key target, written in company´s process description, for the manufacturing process, is to produce flexibly and cost-effectively products, which meet the customer demand.

3.3.1 Human Resources

As the one of the source of the variation is seen in this thesis being Man, it is relevant to describe the human resources and its limitations and challenges in the case company. Nonacademic blue-collar workers operate the case production unit and efficiency and output of the production are highly dependent on the tacit knowledge of the blue-collar workers. There are five types of operators working in packing hall; Technical Specialists, Line Leaders, Machine Operators, Packing Operators and Palletizing Operators. Packing Operators are only working during the high season as temporary workers. Age and service year distribution of the permanent work force is shown in figure 13.

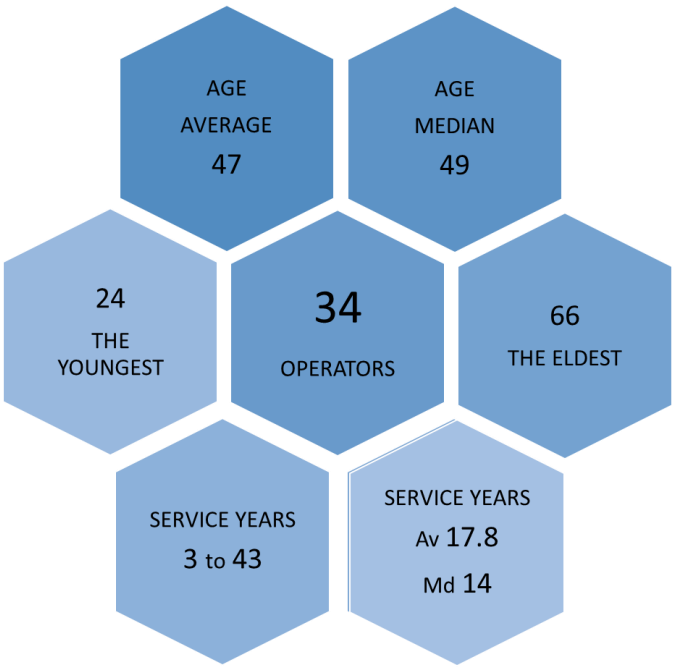

Figure 11. Age and service year distribution of the operators working in the production of the case company

Age distribution of the operators in the case production is from 24 to 66 years, average age being 47 years. The service years variates from three to 43 years; average is around 18 years work experience in the company. Sixty percent of the operators are female in the case unit.

The case unit has multicultural working environment, having employees from six different countries: Estonia, India, Thailand, Vietnam, Russian and Finland. In addition, many of the Finnish employees have Swedish as their first language. All operators understand written and spoken Finnish, but multiculturalism has raised some challenges in the past in communication and with different cultural behavior habits. This has to be taken into consideration when communicating, training and making instructions for operators.

Operators work in discontinuous three-shift, eight hours per shift, stopping the lines for the weekends. The manufacturing season starts usually from January onwards, and then 8-10 temporary workers starts working beside the regular staff. The high season for the case company is from April to August, depending on sales. During the high season, there is also agency-hired labor needed, when more lines are operating simultaneously on three shifts, five days a week.

Next, the job description for Technical specialist, Line Leader and Machine Operator are described to clarify, what their contribution is on the line and what is expected from them. These job descriptions are based on the concern standard job descriptions, modified by researcher to suit the case company.

Technical Specialist is required to operate, maintain, improve and repair equipment within the manufacturing unit. He/she will support the delivery of operational KPIs (Productivity, Quality, Safety, Health and Environment, Cost, Delivery, Morale and Innovation). Working within an autonomous team the Technical Specialist will drive excellent standards of production delivery and continuous improvement, whilst always protecting a safe and sustainable environment. He/she will be required to champion specific skills and coach others. He/she will have a basic understanding of key cost drivers in the factory and will grow this in line with her/his wider project management skills.

In the case company there is one Technical Specialist working in each shift, supporting operators working in the packing lines. These operators have several years of experience from the company and they are experts of running the lines. They have also essential understanding how the different functions of the site operate together. Technical Specialist are seen as the Key talents in the company.

Line leaders are leading the operator team on the line to deliver the operational KPI´s. The job purpose of the Line Leader is to safely carry out general line operations and cleaning regimes according to planned operational requirements in order to deliver a good quality packed product.

Operational activities of the Line Leader:

- Start-Up/Shutdown procedures - Carries out pre start-up checks to ensure that the area and equipment is clean and is in a safe condition as per the SOP. Shuts down equipment and the area as per the SOP.
- Raw and Pack material consumption set-up and follow-up. Consumption booking in SAP. Material ordering from warehouse, when needed.
- Administration – Conducts effective hand-over activities and records accurately events that have occurred during shift (down time, cases packed/rejects) to Down Time Sheet (DTS). Daily report.
- Change-over procedures organization; CIP and other cleanings on the line, material inventory etc.

The Line Leader monitors quality against set standards, hourly quality check, and reports any product and packaging defects and should have an awareness of how to use performance measures to identify and prioritize losses in production area, in other words have continuous improvement mindset. Problem Solving is also part of the job; they identify, prioritize and address problems using appropriate tools and techniques that eliminate recurrence. Some of the Line leaders are experienced and, seen as Key Talents in the case company.

Improvement tools in use in production lines:

- **Focused Improvement - Initiative form.** Operators can propose for example technical, safety or quality related improvements. Operators get a small initiative bonus for each implemented improvement.
- **Emergency Work Order – EWO**. Operators fill EWO-form every time the line is stopped for over an hour. There are clarifying questions about the occurred issue. EWO helps R&M technicians to understand the issue better and the reoccurrence may be prevented with actions made. Improvement Engineer collects the EWO forms and together with R&M staff takes actions to prevent the issue to reoccur.
- **One Point Lessons - OPL.** OPL´s are good way to teach, emphasize or inform everybody about some point. For example, operators to pay extra attention to some quality issue, which may occur with some particular product.

Machine Operator. The range of Operator (Basic) roles varies between categories and technologies, but generally sits within the Machine, Packer, Palletizer job families. The job purpose of the Operator (Basic) is to safely carry out general line operations and cleaning regimes according to planned operational requirements in order to deliver a good quality packed product. The Machine Operator and Packer also monitors quality and immediately reports any product and packaging faults. They identify and notify problems to Line Leader or Technical Specialist, who will decide how to proceed. If the line has to be stopped for longer time, also Shift Leader has to be informed. If the line cannot be started after 30 min of down time, Shift Leader informs the Operations Manager.

3.3.2 Production Process

The case company has production lines, where different types of products are produced. The production lines are semi-automated, meaning that operators are required to perform tasks, such as cleaning, setup, loading of packing and raw materials, before machine can process the products. During the production, the operator will perform other functions such as quality inspection on finished products, data entry and preparing a new lot of raw and pack material for the machine. One operator normally operates two or more machines in a shift. There is also manual handling in some of the lines, where operators pack finished products into sales units by hand.

Production plan and product card are the driving documents, which guide the production process. Production plan is a result of the production planning process, which is not explained in this thesis. Weekly production plan provides information about; products ordered, product numbers, production quantities and production rate. The raw and packing materials are ordered based on the long-term production plan.

Product card has information about each product. Line operators use product cards to check against the production plan:

- Product number
- Production speed
- Raw and pack materials
- Raw and pack materials consumption per hour / shift
- Volumetric and weight information of the product
- Possible allergens in the product

3.4 Known Challenges of the Case Production Process

Operational culture has changed significantly since the case company was bought by the multi-national company. More and more operational structure is implemented based on the company standards and programs. The company is driving for structure, all factories should be comparable to each other, and all the factories report monthly the same key performance indicators (KPI´s).

The core KPI´s are reported monthly to the Central Team and these KPI´s are also visible to other factories as they are all compared on these same indicators. Explained here are only KPI´s which are relevant in scope of this thesis; OEE, waste and Quality KPI´s such as Manufacturing quality incidents and cost of the quality incidents.

Overall Equipment Effectiveness (OEE) measures the operational performance of the production taking into account performance losses. It reflects how effectively the Loading Time is being used to produce Good Volume. As a minimum, the OEE measure should be calculated for every production order, but in the case company the OEE is calculated currently only in weekly basis. In the case company, the time losses are booked manually on the lines in paper by Line Leaders.

The standard method of calculating OEE considers the actual Good Volume at the end of line, as it was confirmed at the end of the production order, along with the required loading time. Good volume is all the products, which are not rejected and can be sold.

$$Overall\ Equipment\ Effectiveness\ (OEE) = \frac{Value\ Operating\ Time}{Loading\ Time} \quad (1)$$

In which;

Value Operating Time (VOT) is the minimum amount of time that will be consumed by the line for a given production plan under ideal conditions (operating at Nominal Speed and without any loss of any kind). It is calculated as:

$$Value\ Operating\ Time\ (VOT) = \frac{Good\ Volume}{Nominal\ Speed} \quad (2)$$

Loading Time is the time for which the machine is loaded, including uptime, failure time and activity time.

Waste. Waste is reported as Raw material (RM) waste and Packing material (PM) waste. Waste going to bin and generated rework is reported in kilograms per day in the morning meetings. There is always some rework generated in the production lines, but the goal is to keep the amount as low as possible. Waste is generated also when having some quality issue on the line and products must be thrown away immediately. Waste numbers varies by shift. Some shifts seem to generate more rework and waste than others. Since change-overs and technical issues effect directly to waste, it is difficult to follow-up the waste variation in different shifts.

Quality. Two of the quality KPI´s are: Quality incidents and cost of the Quality incidents. Quality incidents are divided in case company based on gravity. A-incident is the worst possible case and leads always to recall of products. D-incident is a quality defect which is spotted before the three days of quarantine is over and product pallets are released for sale. Some of the reasons for D-incidents:

- Dirty packaging
- Foreign matter suspicion
- Too little or too much ingredients
- Missing ingredient or pieces
- Mix packing – product in wrong pack
- Code missing, error in code

These defects are so significant that pallets have to be blocked in SAP system and samples have to be taken for more investigation. Cost is generated only if pallets cannot be re-leased for sale. Some rejected pallets can be sold at the discount in factory shop for em-ployees. If the defect is spotted directly on the line, the defected production can be thrown away immediately and these products are seen directly in the waste numbers. Possible outcome from this is that production volume target is not met due materials are limiting.

Production time and variation. As Lean philosophy is striving (Liker, 2006), different work stages should be standardized and documented as standard operational procedures. While work stages are standardized, the operating time should also be standard. In this thesis, hit rate and OEE data were studied. Hit rate percentage tells how much of the planned production is actually produced and OEE tells how well the production time is utilized.

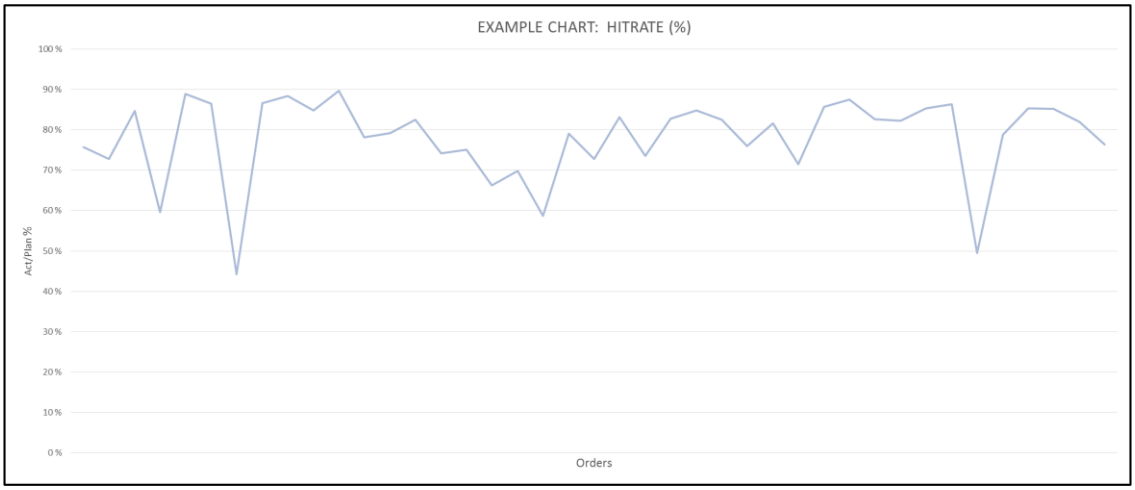

Figure 12. Example chart: Hitrate %.

Figure 16 shows an example chart of hit rate percentage. Hit rate is an indicator for actual produced versus planned production per individual production order. This data is an example and does not reflect to true actual data. This shows only orders which are not in target volumes due OEE loss on line. Hit rate target is always 100 %, not under nor over. Also the target is minimum variation on hit rate, because this data is utilized in production planning. Having lot of variation makes production planning more of challenge, thus output cannot be forecasted reliably.

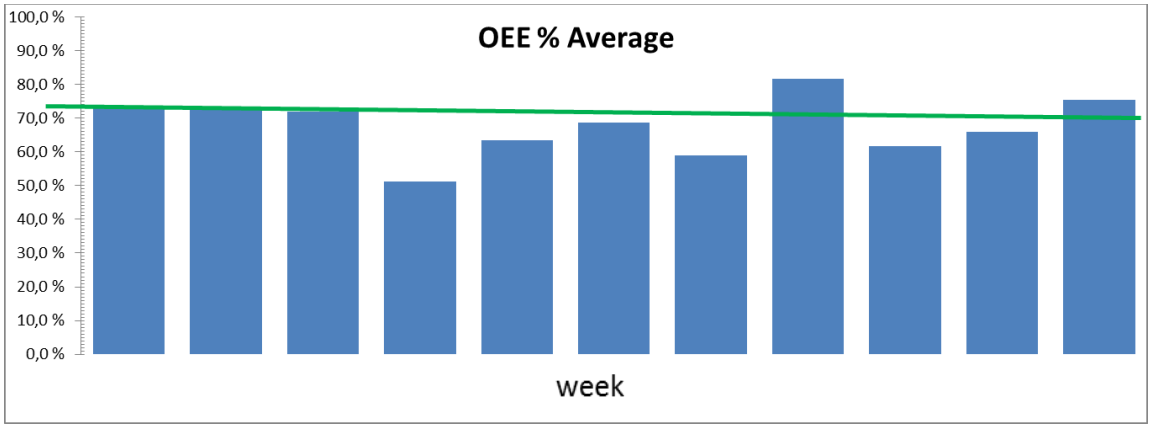

Figure 13. Example chart: OEE %

An example of the OEE data chart is shown in figure 17. The chart presents the weekly OEE average from all the lines. This data is an example and does not reflect to true actual data. The chart does not take in to account, which lines or how many lines were producing these weeks, how much volume or how many changeovers there was. All of these factors effect directly on OEE. Although OEE might be above the target in year to date (YTD),

the situation is not desirable. The variation in weekly OEE´s is high. From this data, the key factors and tasks can be determined.

Factors and tasks, which effect directly or indirectly on OEE, i.e. is causing time losses:

- Technical issues
- Technical issue solving
- Quality defects
- Changeovers and changeover time
- Raw material consumptions and follow-up (over consumption of ingredient)

Operator and line staff related factors in OEE:

- Skills
- Know-How
- Experience
- Motivation
- Response time or reaction time

In addition, the distribution of above-mentioned, operator related, factors in the shifts are effecting to the OEE on the production line. When producing in more lines in high season, skilled own staff is spread over more lines and the staff is doubled, when there is third party temporary staff operating, which lacks experience and know-how of how to handle unexpected situations on the line. Thus, the line speed is high, operators have to react fast, when something interrupts the production flow, or lot of waste is generated. In worst case, line has to be stopped. Stopping and starting-up the line causes, without exception, time loss, waste and re-work. Induction process of the third party operators is key, but even with extensive induction it is not covering all the situations that may occur during production.

4 RESULTS AND DISCUSSION

The key findings of this study are presented and analyzed in chapter 4. The proposed improvement road map for the case company is introduced based on these findings. The variation in production performance is seen consisting of two matters; Man and Method. Machine and Material are left out in this thesis, because Man and Method are considered to effect the most in variation in quality and efficiency between the three shifts. This thesis is not taking a stand on all the factors, which may cause variation in the case production, for example employee personal willingness to improve and develop themselves. In this thesis it is assumed that people are willing to share their knowledge to train each other, when the right type of environment is achieved.

The down time data and the quality defect data from three previous years were studied, to understand which are the most down time and quality cost causing tasks or issues. In the case company, various improvements have been done in previous two years, investing time and money into improving and renewing technical equipment and into training of the staff. The OEE´s of the packing lines have increased significantly and operators are more trained than ever.

Now all the easiest improvements are done or in other words “low hanging fruits” are picked, and the issues or challenges remaining seem to be more difficult to solve. The aim was to find the tasks, which are in key role contributing on performance of the scope unit, and which are lacking standard operating procedure, thus leaning heavily on experience and tacit knowledge of the operator. Comparing data and information gained through observation and interviews the key tasks can be determined. As line performance (OEE % and Hit rate %), quality issues and waste are hard to separate, they are in this thesis combined together. In other words, OEE and hit rate percentage cannot be high if the there are quality issues and waste is generated on the line, but it is hard to say which caused which. The goal is to get all these indicators in good level by stabilizing the operations. This is linking directly to eliminating waste as Lean philosophy is striving (Liker, 2006).

4.1 Road Map for Process Improvement

The goal for this thesis was to propose an improvement road map towards more stable and structured operations. Münstermann et al. (2010) state that process standardization positively affects process time, cost and quality, and should be considered as a regular driver of process success. In figure 18, there is the proposed road map presented.

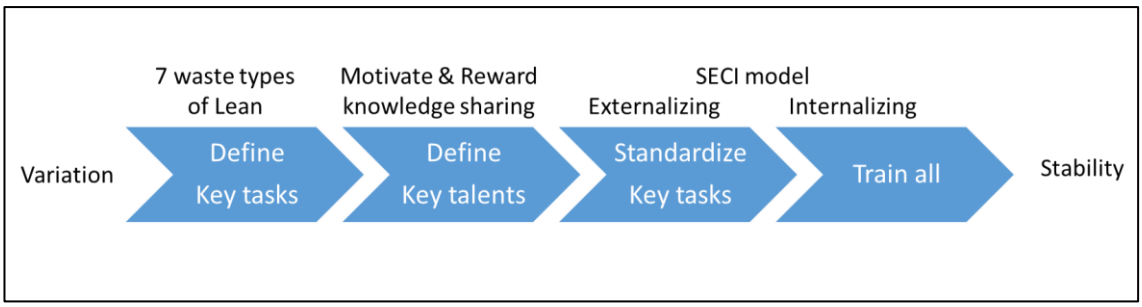

Figure 14. The proposed Road Map for Process Improvement.

This road map is linking variation of the production performance to Lean waste types and utilizing Ungan´s standardization process and SECI-model of Nonaka & Nishiguchi to achieve eventually more stable production in the case company.

Ungan´s (2006) standardization process (figure 10) is based on Nonaka & Nishiguchi´s (2001) SECI model: Team members must accompany process master on the job to knowledge to be shared. Combining to Nakano´s (2013) statements on creation of engaging environment the improvement road map is complete. An engaging environment needs to flourish a shared language and knowledge, which comes from intense communication and a strong sense of collegiality and an open and trusted social climate. Based on these theories the steps for work stage standardization is made for the case company (figure 19.)

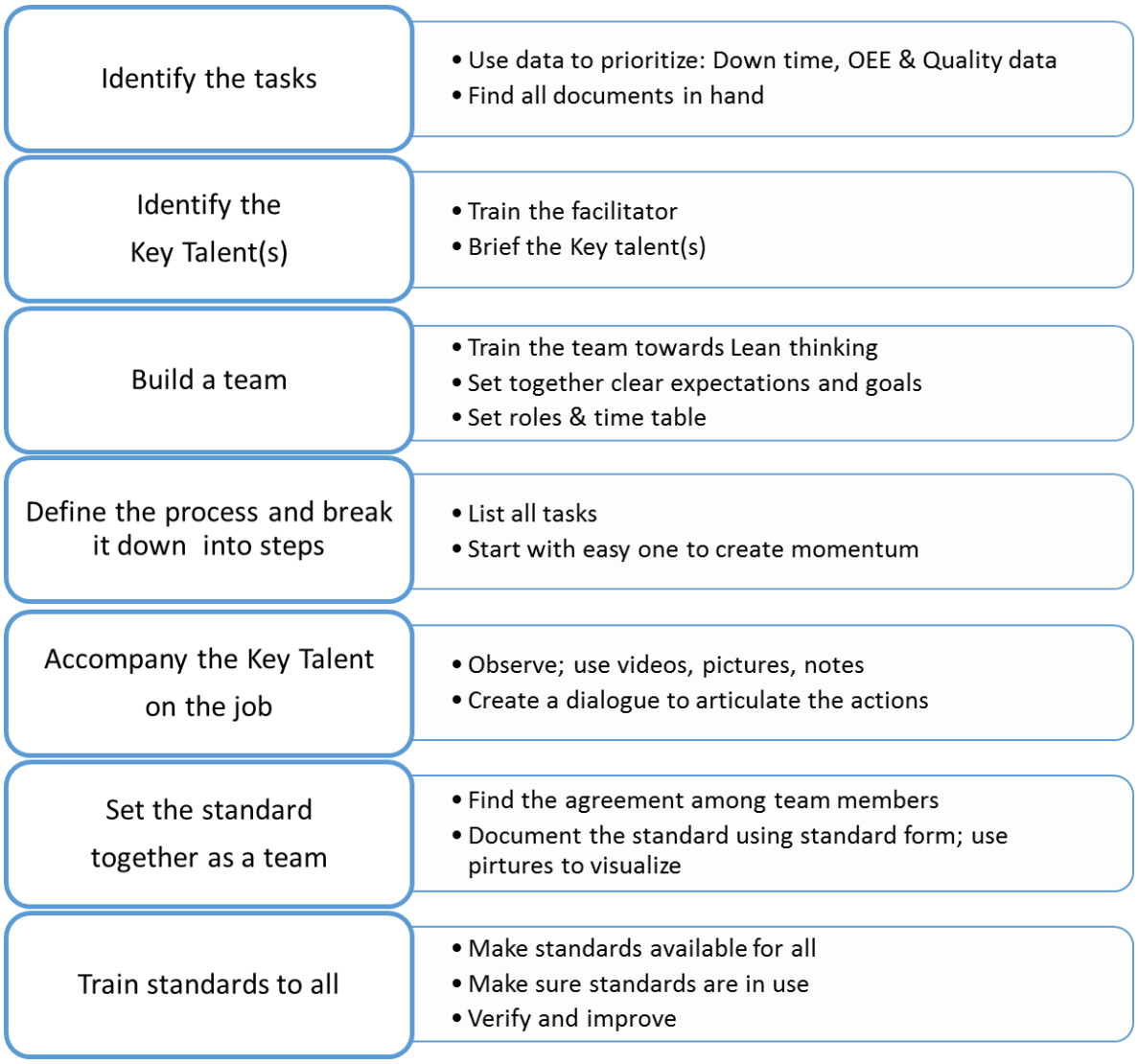

Figure 15. Steps for the standardization process

In figure 19 is displayed proposed steps for creating the standard. Next is explained in more detail all the steps for the standardization process.

4.1.1 Find the Key Tasks

Factors and tasks, which effect directly or indirectly on OEE, i.e. are causing time losses, was determined based on the data sources and interviews. These are the sources of the production variation. Standardized procedures is needed to implement for these key tasks and standards trained to all operators.

- Technical issues
- Technical issue solving
- Quality defects
- Changeovers
- Raw material consumptions and follow-up (over consumption of ingredient)

Dudbridge (2011) suggests to start with listing all tasks that are to be covered. After all the tasks are listed, decide which are the curial ones and form a small team to scrutinize the task in detail and eventually create a standard. Several standardization projects can be running simultaneously, because the teams are small. These teams should contain people that have these tasks as part of their job.

4.1.2 Find the Key Talents

In the case company, all the production lines are different and there are one or two known key talents for each line. These talents commonly recognized in the factory. Although these key talents are making a good effort and doing a great job, there has been recognized some issues with these kind of talents in case company. The lack of discipline for standardized check-ups and lack of motivation is seen as areas of improve with these individuals.

Key Talents have to be motivated to take this important role and to create ownership of the standardization process and knowledge sharing. As referred in the next chapter, communication of expectations and goal is important to have motivation. In addition has to be taken together with Human Resource (HR), how this knowledge sharing can be rewarded. Giving points for every standard set and reward based on these points might be one option. The role of a Key Talent itself surely motivates and empowers the operator, being a part of improvement and training colleagues.

4.1.3 Creating the Knowledge Sharing Environment

In the literature review part of this thesis it was stated that knowledge sharing and externalization requires certain environment and conditions to be successful. There has to be trust and openness in the engaging environment. What could the case company do to create trust among the production team and its superiors to enable knowledge sharing? Here are the proposed actions for the case company to enable the creation of engagement environment; reward, communicate and invest in people. These proposals are presented in the next chapters.

Reward knowledge sharing not knowledge hoarding. In the case company, there is a reward system for the employee of the month. One operator is rewarded with a company product gift pack once a month for outstanding performance. The point is to reward someone for doing something special for the factory. Many times it is hard to reward for the right reasons. Rewarding should not be based on the personality of the operator, but on some special case, which has not anything to do his/her daily job description.

There are other rewards you can give to your employees; recognition with thanks and praises. It is so easy to forget to give thanks for doing a good job especially for those

employees which less vocal than the others. At the same time is easy to point out faults and errors people make. Treating everybody equally and showing example by praising for job well done creates trust and motivation. Some people may even be more motivated after receiving praise than a gift pack or money.

Respect, develop and challenge your people and teams is the 10th principle of Likers. Using cross functional teams you can improve quality and flow and people usually feel empowered when using company´s improvement tools and being engaged in improvement processes. Engage people and let them be part of the decision making to empower them.

Proposal for the case company is to set up new reward system, beside the *Employee of the Month*, based on performance. Set up indicators for the key areas required to improve. Some can be team rewards and some personal. Here are some examples:

- Start-up/Shut-down check list, how well filled
- Hygiene percentage in start-ups
- Start-up on time
- Shift team´s weekly/monthly OEE in target

A reward system has to be set carefully, not to create situation where the environment of trust and openness is lost due competing. There might be temptation to cut corners to get the reward. Targets behind the reward system should be fair and achievable for all.

Communicate Goals and Invest in People

According to Liker (2006), managers can create strong and stable culture by communicating company´s values and conception. Train outstanding individuals and teams, who carry out company´s philosophy for outstanding results. This culture has to be boosted continuously. An engaging environment creation includes managerial effort on two areas, based on the theoretical review of this thesis: communicating expectations and goals and providing appropriate working conditions for the operators. In the case company, improvement of the basic safety and technical conditions has been on focus for the past two years, and set up on these focus areas has been significant, thus the creation of environment of trust and engagement is already started.

As all the operators work in two or three shifts, the training days are the only time the operators are all together. During the training days, there is a good opportunity to communicate company goals and train the whole staff at the same time. At the case company, there are small teams cross-train hubs, which takes 10 to 20 minutes per training session after which the team moves on to the next session. This is a good way to cover multiple trainings in one day and this has been praised by the blue collar workers. Beside these

training days it is proposed to train people actively during the production, even though it is not always convenient. Set learning target of a week or month and make it something positive and fun. These trainings should drive towards the company goals and emphasize company values.

As the case company way is to operate with high skilled own operators and cover high season with temporary staff, the induction process have to be excellent. To improve the induction process the following is proposed: Induction videos of different situations – what to do, when somethings goes wrong in the line and set clear expectations from managers and line leaders for those who are joining. By improving induction process, stability of the production can be maintained.

As the case company works closely with various suppliers and other 3rd party partners, Liker (2006) principle number 11 is also relevant: Respect, challenge and help your suppliers and partners, and treat them as part of the company. Challenge them to improve and help them achieve the goals. Drive for excellent communication and openness to improve the relationship with 3rd party partners.

4.1.4 Setting the Standards through Knowledge Sharing

As the Liker´s (2006) first principle of Lean says, base management decisions on a long-term philosophy, even at the expense of short-term financial goals. Standardization will take time and cause costs in short-term, but making standards the benefit is long-term and production costs should decrease by time, when ways of working are harmonized and non-value adding activities (NVA) are cut away from the processes by setting standards. Here is a proposed standardization process for the production of the case company based on theories of Nonaka & Nishiguchi and Ungan (2001).

After the Key Tasks and Key Talents are determined and prioritized, the teams are set up. The facilitator has been trained for this process and he/she starts to train the team in Lean thinking and the types of waste it is aimed to eliminate. The Key Talent starts working and the team members observe and communicate with the Key Talent and try to articulate how he/she is performing the task. The team members help each other to articulate their knowledge and errors can be corrected immediately by providing feedback, during experience sharing. Shared mental models, metaphors and artefacts sustain meaningful dialog. After the agreement is achieved, the Key Talent has to verify the articulated actions. The dialogue continues until the Key Talent verifies it, and the conversion is achieved.

Before this process starts the goals and expectations are made clear for each member of the team. Nakano et al. (2013) found that engagement and shared concerns regarding efficiency help to maintain and share tacit knowledge on the shop floor. Data and field observations revealed to Nakano et al. in the study that communicating clearly to blue-

collar workers both their responsibilities and the importance of good practices, engaging environment can be created. Each member has his/her own objectives of observation. This ensures, that all aspects are covered. The goals are determined together with the team to engage everybody in the process. Video cameras and cameras are provided for the team to make observation easy and the tasks can be followed also afterwards.

During this process, tacit knowledge is transferred and the team members, also the Key Talent, can learn to conduct the task more efficiently, and any NVA activities can be determined and eliminated. Together they can have consensus about the standard method and they can also discuss ways to improve the task in terms of safety, quality, efficiency and cost. In SECI model this is called socialization, in which apprentices learn their tasks by observing and imitating the work of their masters, not by spoken words or written procedures and tacit knowledge is formed. The new standard should be recorded so that it is available for others to learn the method. Examples for standards are presented in table 1.

Table 1. Examples for setting standards.

Examples for standards	Examples for actions
Adjustment values, receipts	Update & Set Follow-up on settings
Manual adjustment	Set Adjustment points & Visual standards for set-ups
Best practices for each product	Create a best practice for each product further improving product cards and create adjustment cards for each product.
Visual standards for quality	Which defects are yellow, amber and red. This is based on operator own evaluation. To make it more clear use pictures of the actual product.
Check-act list for quality defects	Issue: Sauce distribution defect. Action: Check temperature. Indicates that the temperature is too high. Adjust temperature.

A good practice according to Dudbridge is to record the standard in writing and use photographs or videos to clarify the method. This is called in SECI model externalization, in which tacit knowledge expressed into explicit concepts. It is a characteristic knowledge creation process, where tacit knowledge is transformed to explicit knowledge in such forms that can be understood by others, such as metaphors, analogies, concepts and models. Externalization process is usually triggered by dialogue or collective reflection. Thus

the case company has multicultural staff, the procedures should be made more with visual standards rather than written language.

Several standardization projects can be running simultaneously in small teams. In these teams should be people that has these tasks as part of their job. Together they can have consensus about the standard method and they can also discuss ways to improve the task in terms of safety, quality, efficiency and cost.

5 CONCLUSIONS

Evaluation of the success of the study and evaluation of the success of implementing the results in the case company are presented in this final chapter. Additionally evaluated are challenges, reliability, validity and generalization of the results of the study. The conclusions and the improvement road map for the case operations are presented in this chapter together with a proposal for a further study

5.1 Evaluation of the Success

The research problem was presented in chapter 1. The production targets are not reached, because of the variation in performance of different teams. The following research questions were set:

Main research question is:

What kind of elements should the improvement road map consist of?

The sub research questions are:

1. Which are the key tasks for hitting the operational targets in the case company?
2. Which are the key talents with tacit knowledge of these critical work stages?
3. How to transfer tacit knowledge of the key talents to explicit knowledge so that it is available for everybody?
4. Which factors have to be taken into consideration when implementing work stage standardization?

The main research question was answered through reviewing the theory of standardization, Lean Manufacturing and Knowledge Management, and presenting the elements for standardizing work stages and capturing tacit knowledge. These elements were reflected to the case to find the factors, which should be taken into consideration developing feasible improvement road map for the case company. The most important element for improvement was found to be the engaging environment, with open communication, trust, collegiality and good management practices such as clear goal setting and rewarding. An engaging environment enables knowledge sharing, which is the key for transforming the tacit knowledge of the key talents to explicit knowledge and making it available for all. Setting standard operational procedures for the key tasks and teaching them to all operators, production stability can be improved, thus variation in ways of working and in talents are minimized.

The sub research questions were answered through finding the factors causing the variation in production performance by interviewing operators and engineers, and collecting

and analyzing data from production performance. For the case company, the factors causing variation include elements such as technical issue solving, quality defects and variation in material consumptions. The improvement road map and steps for the standardization process are answering the sub research questions on knowledge sharing and factors effecting on implementation of standards. Standardization process starts with engaging the people and setting goals for the process; the goal is to have verified standard for the task, which can be trained for all. Training the team adapting the Lean manufacturing principles for eliminating the waste is important, thus all the members have the same mind-set starting the project. The standardization process, team members observes the key talent working on a task and they create meaningful conversation trying to explaining the work stages and finally writing the standard.

5.2 Evaluation of the Success of the Implementing

As the result of this thesis is a proposal for an improvement road map, the success of the implementing leans heavily on the people implementing it. Motivating the Key talents to share they knowledge and equally important is to motivate other operators to be willing to join and learn. The facilitator have to be clear on communicating the expectations and goals. If the facilitator believes the process, it most likely he/she can inspire operators to believing it too.

The progress of the standardization process should be closely monitored and if needed, make changes in the process based on the feedback of the operators. Engaging the operators from the beginning and making sure they are on board during the way is the key, and it cannot be overemphasized here.

5.3 Evaluation of the Reliability and Validity

The construct validity and reliability of the research can be verified by using multiple sources of evidence (Yin, 2009). It this thesis evidence was gathered by analyzing data, interviewing people and observing the topics from different points of views.

Materials, both electric and printed articles and books, were reviewed for the theoretical framework of this thesis. A large amount of electrical material may effect on the scope, narrowing it down, and some aspects may not be reviewed thoroughly. However, several references of literature were reviewed in order to find the most referred and accepted points of view concerning the subjects in the scope of this thesis.

If the research can be repeated with the same results, the research is reliable. Reliable research might not be valid, if for example the same measurement error is made repeatedly. The proposed improvement road map can be found valid and thus reliable, because

all operators in scope were interviewed and observed, and if repeated the similar answers can be expected.

This study leans on the researcher's own observation, researcher being part of the case organization, thus has a strongly subjective approach on the study. The findings cannot be generalized directly outside of the case context, although thus the nature of the results being general improvement road map, it might help other similar organizations to implement improvement plans for their operations based on findings of this study.

5.4 Challenges and the Future Research

In this research, all the factors effecting on the performance of the case company are not included. Production processes can be standardized, but all the factors cannot be influenced. There will be always some variation in production performance based on unexpected occurrences and factors that cannot predicted or avoided.

The engagement of the operators was not measured during this research, but it is proposed to do so before implementing the model. In this thesis it is assumed that operators can write down their observations and ideas, which might be challenging in this environment with various languages. In addition the communication might be a challenge for the same reason.

Before implementing the improvement road map, further research is proposed for the case company. Thus, the environment plays a big role in knowledge sharing; it is advised to make a survey on degree of engagement, trust and collegiality of the environment in the case company. Follow the progress by making surveys during the way and alter the process according to the feedback. Evaluate the results based on the data and the results of these surveys. In additional it is proposed to implement new performance indicators to find out more clearly, where the improvement areas are. Implement meters for performance of the teams and on areas which are not working that well, to set a focus on the areas which make the biggest difference in the performance of the case company.

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