School of Innovation, Design and Engineering

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The importance of standardised work in preventing wrong deliveries

Bachelor thesis work
15 credits, Basic level

Product and process development
Production and Logistics

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ABSTRACT

The purpose of this bachelor's degree work was to analyse a packaging station in a global manufacturing company in Sweden, and to provide an answer on why it is important with standardised work in preventing wrong deliveries. The purpose of the analysis was to come up with various improvement proposals in order to reduce and prevent wrong deliveries. The analysis of the packaging station was conducted by observing the station and understanding how the workers work and what kind of work procedure do they follow. The observations made it possible to conduct several conclusions on why the problems occurred, one of these conclusions was that the work procedure is not standardised which in turn increased the errors in the station. Through a clear problem description, it was possible to come up with improvement proposals by answering the following research questions:

Main RQ: ***Why is a standardised workplace important in a manufacturing company?***
To be able to answer the main research question, the question has been divided into two smaller sub-questions:

1. **How can a packaging area be standardised by using lean process improvement tools?**
2. **How can operating standards improve the efficiency in a packaging station?**

The approach applied in this study and project has been qualitative research with an inductive approach, by reviewing scientific articles and observing the work in the packaging station it was possible to analyse and compare the collected data in order to come with a conclusion to the problem. The data that was collected in form of interviews has been continuously analysed in order to have as relevant data as possible for the improvements work.

By comparing the collected data from the literature and the case findings it was possible to lay a foundation for the analysis where the proposed improvements came from and to conclude a final proposed improvements that reduces the wrong deliveries in the packaging station. In conclusion, standardised work is important in order to prevent wrong deliveries because it contributes to a more clear and sustainable structure that the workers follow. By having standardised instructions and methods that is being followed, the amount of errors is reduced in the packaging station. Wrong deliveries are reduced and prevented when there is a standardised work procedure that is based on the lean ideology in a packaging station.

Keywords: Standardised Work, Operating Standards, Lean Production, 5S, PDCA, VSM

SAMMANFATTNING

Syftet med detta kandidatexamensarbete var att analysera en förpackningsstation i ett globalt tillverkningsföretag i Sverige, samt ge svar på varför det är viktigt med standardiserat arbete för att förebygga felleveranser.

Syftet med analysen var att komma med olika förbättringsförslag för att minska och förebygga felleveranser. Analysen av förpackningsstationen gjordes genom att observera stationen och förstå hur arbetarna arbetar och vilken typ av arbetsprocedur de följer. Observationerna gjorde det möjligt att dra flera slutsatser om varför problemen uppstod, en av dessa slutsatser var att arbetsordningen inte är standardiserad vilket i sin tur ökade felen i stationen. Genom en tydlig problembeskrivning var det möjligt att komma med förbättringsförslag genom att svara på följande forskningsfrågor:

Huvudfråga: Varför är en standardiserad arbetsplats viktig i ett tillverkande företag?
För att kunna besvara den huvudsakliga forskningsfrågan har frågan delats upp i två mindre delfrågor:

1. Hur kan ett packningsområde standardiseras genom att använda lean process förbättringsverktyg?
2. Hur kan driftstandarder (metod standard) förbättra effektiviteten i en packningsstation?

Tillvägagångssättet som tillämpats i denna studie och projekt har varit kvalitativ forskning med ett induktivt förhållningssätt, genom att granska vetenskapliga artiklar och observera arbetet i förpackningsstationen var det möjligt att analysera och jämföra insamlade data för att komma fram till en slutsats till problemet. Data som samlats in i form av intervjuer har kontinuerligt analyserats för att ha så relevant data som möjligt för förbättringsarbetet.

Genom att jämföra insamlade data från litteraturen och fallstudien var det möjligt att lägga en grund för analysen där de föreslagna förbättringarna kom och att komma fram till ett slutgiltigt förbättringsförslag som minskar felleveranser i förpackningsstationen. Sammanfattningsvis är standardiserat arbete viktigt för att förhindra felleveranser eftersom det bidrar till en tydligare och mer hållbar struktur som arbetarna följer. Genom att standardiserade instruktioner och metoder som följs minskar mängden fel i förpackningsstationen. Felleveranser minskas och förhindras när det finns ett standardiserat arbetssätt som baseras på lean-ideologin i en förpackningsstation.

ACKNOWLEDGEMENTS

This bachelor's degree work was conducted in ABB Robotics Västerås during the author's studies in Mälardalens University. The motivation within the project has always been high to provide ABB with a complete report that covers proposed improvements that contributes to more value. Getting the opportunity from ABB to analyses a problem and propose improvements, has contributed to a valuable and much appreciated experience.

I would like to thank Robert Staff and Ken Huynh in ABB Robotics for providing me with this project. I would also like to thank Elin Douhan and Yaser Baloch in ABB Robotics Västerås for their continuous support throughout the project. I would also like to thank all the coworkers and departments in ABB Robotics Västerås for their contribution for the data collection. Lastly but not least I would like to thank Bengt Gustafsson who has been a great tutor for my thesis report and in helping me not getting stuck during the research phase.

Contents

ABBREVIATIONS

Hansei	A term from lean production that means *self-reflection*
Heijunka	A term from lean production that aims to level out the workload
IDT	School of Innovation, Design and Engineering
JIT	Just in Time
MDU	Mälardalens University
Nemawashi	A term from lean production that means *work around the roots*
PDCA	Plan-Do-Check-Act
TPS	Toyota Production System
VSM	Value Stream Map

1. INTRODUCTION

Error that occurs in the packaging area are often hidden and only discovered when the product is shipped to the customer. These errors add to the delivery costs, the bad reputation and the lost trust from the customer to the company. When an error occurs, it is important that it is solved as soon as possible to eliminate the possibility that the same error occurs again. The root cause behind these errors is not always the same but the common denominator of these errors is that the workplace is unorganised and that there is no standardised work procedure (Fin et al., 2017). To eliminate the possibility of the occurrence of errors, this study intends to analyse and evaluate errors in a packaging area and develop improvement proposals by utilising several improvement tools from lean production.

1.1. Background

This bachelor thesis was conducted in ABB Robotics in Västerås, ABB Robotics serves as the main hub in Sweden to manufacture robots that is delivered worldwide. ABB Robotics strives always to be as efficient as possible and provide their customers with high quality robots. Therefore, it is important that the entire organisation functions flawlessly from the start of production to the packaging of the product before delivery. With the high demands on efficiency and quality it requires constant improvements, which led to this thesis, where the task was to analyse and evaluate improvement proposals for the station.

The packaging station is a fundamental and important phase in the supply chain. That is because it is one of the last main steps before delivery to the customer. Therefore, it is important that the work is done strategically and accurately to avoid errors from occurring. If the instructions are not followed correctly, there is a great risk that there will be an incorrect delivery that affects both the customer and the company, but mainly the company due the high costs of wrong deliveries that often end up in rebuilding the product from scratch.

Companies that have implemented the lean production follows an ideology that is to maximise their value and reduce their waste in their production. The concept of lean production is to find an efficient way to increase the value in the best sequence of actions without any interruptions. The lean thinking provides the company of the possibility to convert their production waste into value while in the meantime building a stronger customer relation. (Womack & Jones, 1996)

Although lean production contributes to an increased efficiency and more value as well as reduced waste in the production (Arbós, 2002). Errors in the production can still occur, these errors are often hidden and only discovered when the product is shipped to the customer. These errors can happen in the last phase of the supply chain that covers the packaging area. The root cause behind these errors is often human error due to unorganised workplace and instructions that are not followed correctly.

1.2. Project directive

The task that was assigned by ABB Robotics was to analyse and evaluate the current work process in the packaging station of industrial robots that have been documented. The main take away with the project is to identify errors that have an impact on quality and efficiency, and to analyse these errors in more detail with the help of optional tools. Lean perspective would be used as a guideline for the improvement tools because the company works with continuous

improvement from the lean thinking. The student gets unlimited access to the process and the staff who work in it.

1.3. Problem statement

The main goal of a packaging station is that the product is packed correctly and labelled correctly for the destination. But when the working procedure in the station is not standardised, workers tend to use their own instructions. The problem with that is the risk of errors being increased because the listed instruction is not followed. Unorganised and unclear instruction can have a major impact on the company and the production therefore, it is important to improve the section and reduce the number of error cases.

To get an understanding of the errors that occur in the packaging station that leads into wrong deliveries it is important that the there is a current situation analysis over the station. The reason behind that is because with the current situation analysis it is possible to draw several theories on why these errors occurs and how it is possible to improve the faulty sections (Patchong, 2013).

1.4. Aim and Research questions

Standardised work plays an important role in the lean production ideology because it focuses on the continuous improvements (Jagusiak-Kocik, 2014). The purpose with this bachelor thesis is to analyse improvements of implementing a standardised working procedure by using three improvement tools from the lean production ideology. To fulfil the purpose of the thesis the following research question will be answered:

RQ: Why is a standardised workplace important in a manufacturing company?

To be able to answer the main research question, the question has been divided into two smaller sub-questions:

1. How can a packaging area be standardised by using lean process improvement tools?
2. How can operating standards improve the efficiency in a packaging station?

1.5. Project limitations

This bachelor thesis will only cover the packaging area in the manufacturing company therefore other stations that is included in the supply chain will not be analysed. The thesis will also only analyse three lean process improvement tools that can contribute to a standardised packaging station although there are more than three lean process improvement tools.

2. THEORETIC FRAMEWORK

This theoretic framework provides an overview of three different tools in lean production and a description of what lean production and Toyota Production System (TPS) is. The framework also provides an overview of standardisation.

2.1. Lean production

Lean production is a philosophy that have its roots in Japan from the automotive manufacturing company Toyota, and their development strategi of Toyota Production System. The aim with lean production is to eliminate waste in the production as much as possible, reduce the lead time in the production by minimising the rework of a process, minimising the non-value-adding processes in the production and achieve fewer hours per output. (Huxley, 2015)

There are several lean production improvement tools that are used to improve different things in a workplace. It can vary between improving the flow of the processes to reducing errors in a workstation. (Womack & Jones, 1996)

According to Liker (2003) the main purpose of lean production is to create and implement a process of continuous improvements. Problems must first be identified for it be able to improve the process. Not only problems must be identified, the mindset of the company must also be changed because it is not possible to work with new changes and improvements in an organisation that do not accept changes. Therefore, it is important to implement these changes to be able to adopt the lean production philosophy.

There are 14 different management principles that is covered by the lean philosophy and must be understood in order to implement the lean production thinking (Liker, 2003). These 14 principles are divided in four sections, where each section contains of several principles that is described by Jeffrey K. Liker in the book *the Toyota Way (2003)*. The four different sections and its principles will be presented down below.

2.1.2 The 14 lean principles

The four sections and 14 principles according to Liker (2003)
Section 1: The Long-Term Philosophy

Principle 1: *Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals*

- An important aspect that needs to be in mind is patience, with patience it is possible to implement the long-term thinking because results will not be directly achieved.
- It is more important to strengthen the trust and satisfy the customer demands than just earning money on the short-term. Because these two aspects would lead into a more responsive market and better feedback that can improve the production.

Section 2: Right Process means Right Results

Principle 2: *Create continuous process flow to bring problems to the surface*

- Work process needs to be adjusted for it to be able to include value-adding process, therefore an undisturbed flow is important.

- Management needs to reduce waste (Muda) in different activities, these activities cover areas such as pending projects and inactive processes.

Principle 3: *Use pull systems to avoid overproduction*

- Manufacture and produce only when the customers need a product, produce only the right quantity of products.
- Introduce a storage that only store small quantity of products

Principle 4: *Level out the workload (Heijuka)*

- Important to eliminate overload on machines and workload on the workers
- important to eliminate irregularities in the production to reduce waste

Principle 5: *Build a culture of stopping to fix problems, to get quality right the first time*

- The quality for the customer is the driving force a company's value proposition
- If possible, it is necessary to use modern quality assurance methods
- Make it easier for the company to support quick fixes on problems

Principle 6: *Standardised tasks are the foundation for continuous improvement and employee empowerment*

- It is important that the management implements a stable and repeatable method for the workers because it can help maintaining the predictability, regular timing and regular output. It can also minimise errors from occurring in a workstation due human factor.

Principle 7: *Use visual control so no problem is hidden*

- In some workstations, computer screens should be avoided because it can distract the workers
- Implement simple visual indicators that can help the workers and other operators to determine if they are in a proper phase according to the production or not.

Principle 8: *Use only reliable, thoroughly tested technology that serves your people and processes*

- Companies tends to use technology that replaces the human labour, companies should instead use technology that helps the human labour
- Important to conduct several tests to ensure the safety of the new technology

Section 3: Add Value to the Organization by Developing Your People and Partners

Principle 9: *Grow Leaders Who Thoroughly Understand the Work, Live the Philosophy, and Teach It to Others*

- It is better to grow a leader within the company rather than buying leaders from outside the company.
- It is important that the view of the leader is not that the leader only accomplish task etc, instead the view of the leader should be that the leader is a helping hand to the workers.

Principle 10: *Develop exceptional people and teams who follow your company's philosophy*

- It is important to create a great and strong culture in the company which makes every worker's opinion matter
- Individuals in the company must learn to work in a team together

Principle 11: *Respect your extended network of partners and suppliers by challenging them and helping them improve*

- Important to solve problems by observing the issue and understanding why it occurs rather than just thinking of different theories based on what one worker says or what the computer screen shows, because it is not always 100% correct.
- Workers must learn to speak and think on the verified data, it can lead into new ideas and improvements

Section 4: Continuously Solving Root Problems Drives Organizational Learning

Principle 12: *Go and see for yourself to thoroughly understand the situation (genchi genbutsu)*

- To get a better understanding over a problem it is better to go there and observe it
- Observing a problem opens the possibility to analyse it directly

Principle 13: *Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (nemawashi)*

- It is important to discuss problems and potential improvement with all the sections that is affected by the problem, this process is called *Nemawashi*. This is a proper process because it covers the point of view of all those affected sections and not only the ones that are solving the problem.
- If possible, pick more than one direction during the planning, because if one direction did not work, then there is another direction that can be used as plan B.

Principle 14: *Become a learning organization through relentless reflection (hansei) and continuous improvement (kaizen)*

- When a stable process is established, it is proper to implement continuous improvements to that process, because it can minimise errors from occurring but also determine the root causes of these errors that might occur
- Do not promote workers that does not have any knowledge about the section that they are getting promoted to, it can increase the rate of errors due lack of knowledge

2.2. Toyota Production System (TPS)

Toyota Production System or shortened to TPS is a philosophy that comes from the Toyota Motor Corporation. Toyota production system uses a framework of several different tools that is used to identify and eliminate wastes in the production. TPS contributes to lesser waste in the production leading into increased productivity and efficiency, better quality, and better customer satisfaction by meeting the customers' demands in time. TPS strives after delivering high quality products to the customer without having to hold large amount of inventory, making it more efficient and cost saving when it comes to storage costs. (Liker & Meier, 2005)

There are some small differences between TPS and Lean production although both these methods is based on the similar principles and objectives, the small difference between them is who the practitioners are and the scholars' adaptions of the principles. According to Womack & Jones (1996) TPS is based on two main pillars *jidoka* which means autonomation in Japanese and strives after making problems visible, and the model just-in-time (JIT).

The autonomation (*Jidoka)* part was introduces back in the year 1902 by the Japanese entrepreneur Sakichi Toyoda, Sakichi invented a unique way to detect a broken thread that could stop the automatic loom immediately. Sakichi's invention provided the operators with the ability to control several functions in the automatic loom. This invention led to an increased quality in the products because it was possible to detect a faulty thread before it ruined the product. (Chiarini et al., 2018)

Because *Jidoka* strives after making problems visible in order to solve them with continuous improvement, the 5-Whys tool becomes an important tool to find the root cause behind a problem. 5-why is a tool that contributes to root cause analysis by asking ''*Why*'' five times in order to find the main root cause behind a problem. It is important to find the root cause before beginning with the improvement work otherwise the problem would occur again. (Wong & Wong, 2011)

The second pillar of the TPS is Just in time (JIT), this pillar reduces the overproduction that can happen in a manufacturing company. The overproduction can lead into expensive and unnecessary storage costs and a limited capital. When following the JIT model, the company would only produce products after the demand, the right quantity at the right time, without reducing the value. (Htun et al., 2019)

It is important to understand and keep working after the lean production principles that is based in the TPS, to be able to convey these value adding methods, Toyota decided to create a house that is based on the lean principles. This house is called TPS House and illustrates the structure of a lean production philosophy. (Liker, 2003)

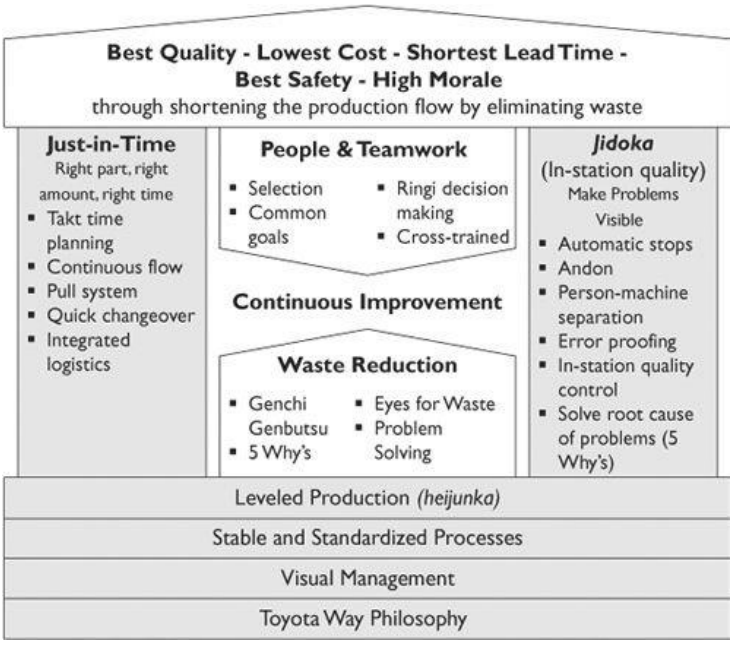

Figure 1: TPS House (Liker, 2003)

Just in time and Jidoka serves as the two pillars of the TPS house, see figure 1, analysing how the TPS house is built, it is possible to see that the two pillars lay over the standardisation's method. This means that the standardisation method must be established before beginning with the two pillars. This can be interpreted as the standardisation method adding the foundation of the TPS house. (Liker, 2003)

2.3. Lean Productions Relation to Standardisation

The standardisation in the TPS house can be seen as the foundation of the house itself, this is because there must be a connection between the principles that is covered in the house. In order to get the best quality, shortest lead time at the lowest cost. The whole model must interact together for it to work. Therefore, it is necessary to start with the foundation and continue with the work upwards. In this case, the standardisation is the base for the two main pillars. (Petersson et al., 2015)

Standardisation work can be used to describe how a specific work should be done and what is the best way to maintain high quality in the production. It also contributes to a levelled production which is important to improve the takt time. (Petersson et al., 2015) According to Petersson (2015) it is hard to achieve high resource efficiency if in a clocked flow, the reason behind that is because in a clocked flow there is stops that the takt time need to have in mind which in turn requires more resources. To solve that, a levelled production is required and can be achieved with standardisation. Levelled production contributes to a continuous flow which in turn increases the efficiency of the flow in the production.

As mentioned before, lean production strives to improve the flow but for it to be improved it is important that a predictability regarding the time consumption is created, this is possible with the implementation of standardisation work in a work cell. (Petterson et al., 2015)

2.4. Operating Standardisation

Standardisation originates from the lean ideology because of its continuous work on improvements and therefore makes it a fundamental element of the lean manufacturing. Standardised work aims to reduce costs, time, and improve the efficiency and quality of the production. Its aim is also to make it possible to do the job right from the beginning without any errors occurring. This can be achieved when the instructions are standardised and the possibility to choose different instructions is eliminated. (Mihova & Alexieva V, 2017)

There are two standards in standardisation where each has its own purpose depending on what is desired. These two standards are *Management standards* and *Operating standards*. The difference between these two is that *Management standards* is implemented when there are improvements that are necessary for the administration purposes. An example of an administration purpose is administrative regulations that have changed. The second standard is *Operating standards,* this standard is used when analysing how the employers are working and how they should work. (Mihova & Alexieva V, 2017)

Operating standard is the most suited standard for this thesis, because the main purpose of the thesis is to analyse how the workers are working at the current state in a packaging station and how it can be standardised making the operating standard as the best suited standard to evaluate. This standard is structured to make it possible to define potential risks that can occur in a station and as well as predefine solutions for the risks. (Mihova & Alexieva V, 2017)

According to Petersson (2015) to be able to create and implement a standard for a workplace there must be working standards to begin with, this is possible to implement by using the 5S method that will be described under the *Lean Process Improvement Tools* section. Because this thesis is conduct in a packaging station where the work is manually performed the operating standard is best suited. In order to have a proper standard in the station, the operating standard must describe three important aspects. (Petersson et al., 2015)

- What should be done?
- How should it be done?
- How long time would it take?

This process describes what kind of standards will be used and where it can be used. For instance, it describes what the work at the packaging station contains of. Operating standard do not only contribute to the best working method it also contributes with important aspects that have an impact on the organisational structure. (Petersson et al., 2015) Operating standard can improve the following aspects.

- Safety and Ergonomics
- Quality
- Efficiency

It is important to have a standardised workplace because it contributes to a higher safety and reduces errors in the workplace, by having a standardised workplace, the workers cannot perform a process on their own way, they won't be able to use a machine wrong because everything is standardised in a way to make it as safe as possible and minimise error occurrence. (Petersson et al., 2015)

2.5. Documenation of Standardisation

When a workplace is standardised, it is important that there is documentation of that work, the documents make it possible for new workers to follow the instructions and begin working without making any errors. (Liker & Meier, 2006) According to Liker & Meier (2006) there are three types of documents that is used when documenting a standardised work.

1. *Standardised Work Chart*
2. *Standardised Work Combination Table*
3. *Production capacity Sheet*

Only *Standardised work chart* and *Standardised work combination table* will be described because of the relevance to the thesis and project that was conducted on site.

To get a better understanding over a workstation and discover errors, standardised work chart is a proper choice. With the use of a standardised work chart, it is possible to detect several wastes such as unnecessary movements. The chart makes it possible to be creative and redesign the layout of the station to identify possible improvements. In figure 2, it is possible to see an example of how a standardised work sheet can look like when used in a workstation. The figure illustrates the movement of the operators in that station. (Liker & Meier, 2006)

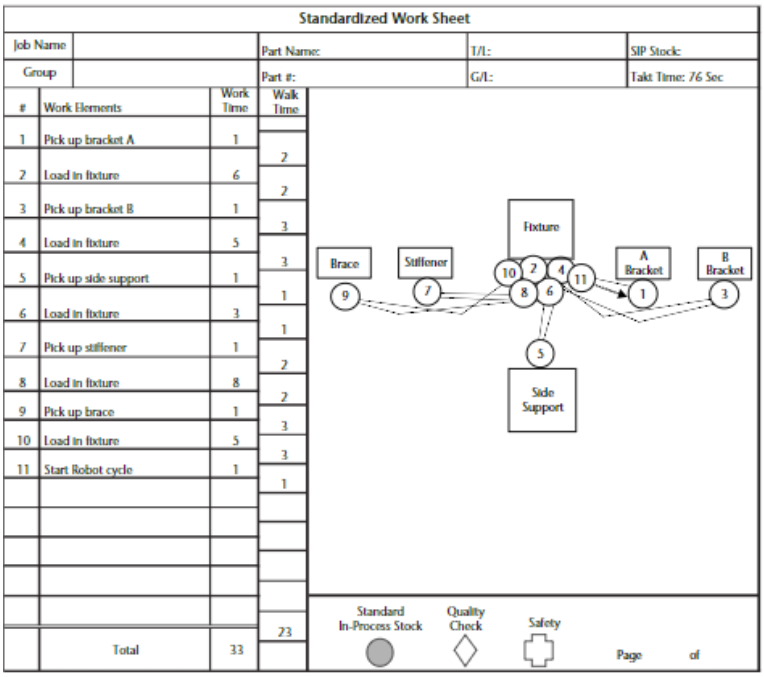

Figure 2: Illustration of a Standardised Work Sheet (Liker & Meier, 2006)

There is more than one operator that works in the workstation, to get a better understanding on how two operators that work in the same station, standardised work combination table is used. This type of documentation documents when there are interactions between the operators and machines. (Liker & Meier, 2006) Standardised work combination table illustrates the takt time it takes for the whole work in that station, it also shows how long one process takes and the walking time operators make from one process to another process. (Liker & Meier, 2006)

In figure 3 down below, it is possible to see an example how a standardised work combination table would look like when implemented in a station where two operators are working simultaneously. The table documents the takt time for each process. (Liker & Meier, 2006)

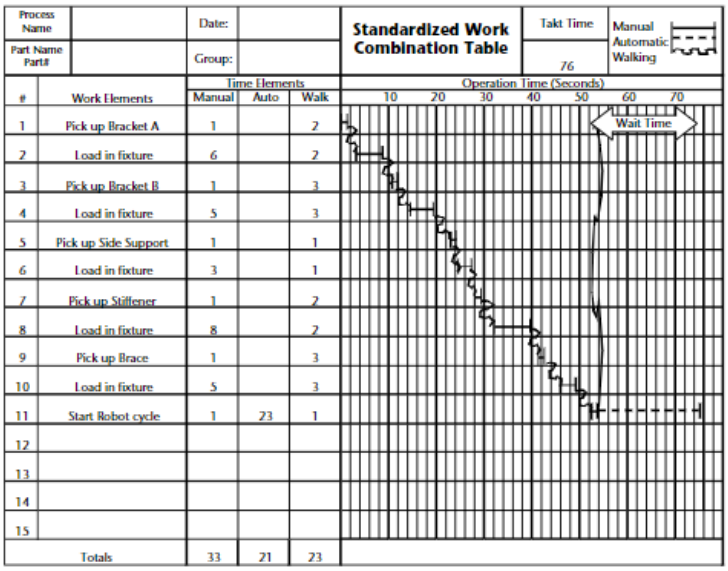

Figure 3: Illustration of a Standardised Work Combination Table (Liker & Meier, 2006)

2.6. Lean Process Improvement Tools

In this section, three different lean process improvement tools that originates from TPS will be described, these tools are based on the lean ideology and can contribute to standardisation of a workplace. There are more than three tools that that originates from TPS, these three tools that are described are the most relevant to thesis.

2.6.1 5S

5S is a lean improvement tool that comes from the TPS philosophy. 5S is a method that focuses on improving the organisation within itself, it focuses on areas such as organisation, order, cleanliness, standardisation, and discipline. For 5S method, all these areas are essential in order to achieve a proper workplace that is organised, high efficiency and as low waste as possible. 5S method strives to achieve its own principles one of these principles is that it is important to have a clean and organised workplace because only then it is possible detect hidden errors and reduces wastes in the production. (Mihova & Alexieva V, 2017)

Because 5S method is originated from the TPS ideology, the method builds on continuous improvements to maintain high quality and efficiency. In the 5S method the human factor is the contributing factor for the improvements in the production, the human factor is important because the implementation of the improvement will directly impact the human labour and therefore it is important that the human factor understands the improvements and follows the 5S ideology to gain as much value as possible. (Khamis et al., 2009)

According to Liker (2003), 5S stands for five different S where each one of S is important in the improvement work.

1. **Seiri** (Sort): It is important to sort through the items and material in a workplace, because according to Liker (2003), when everything is sorted it is easier to find what is needed. Only relevant and important material and items should be placed on the workplace.
2. **Seiton** (Systematise): It is important according to Liker (2003), that each item is placed on their own desired place. This will eliminate the time spent on looking after a specific tool.
3. **Seiso** (Shine): According to Liker (2003), the workplace must be cleaned every day and be ready to be used all the time, by cleaning the workplace the net shift wont waste time on cleaning the waste that occurred during the work.
4. **Seiketsu** (Standardise): According to Liker (2003) by developing work routines that every employee follow it minimise the error occurrence but also makes the workplace safer.
5. **Shitsuke** (Sustain): According to Liker (2003), it is important to keep following the method and stabilise a workplace that works after the method to continue with the improvements.

2.6.2 PDCA Cycle

PDCA cycle is a method that is based on continuous improvement, by using a PDCA cycle there will always be work on improvement, PDCA strives after finding the better methods that can be implemented to the improvements. A common name for the PDCA is Deming's cycle named after Deming, W. Edwards who constructed the model. (Sokovic et al., 2010)

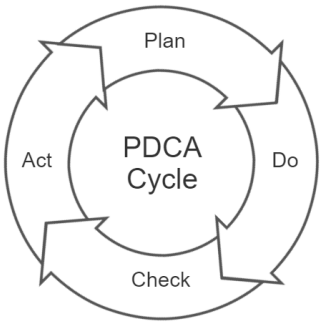

Figure 4: Illustration of PDCA Cycle (Liker, 2004)

According to Liker (2003) the PDCA cycle stands for Plan – Do – Check – Act, as shown in figure 4, because of its continuous work on improvements, the model is essential when it comes to standardisation and operating standards. Because of its counties improvement work.

As stated before, PDCA cycle is divided into four sections, the four sections stand for according to Liker (2003):

- **Plan**: This section is the first phase in the cycle, here it is important to analyse and understand what the problem is and why a solution is needed. According to Liker (2003) by understanding and analysing the problem from the beginning it is easier to plan the improvement work
- **Do**: This section is the second phase in the cycle, in this phase a small test of the planned improvement is made. By evaluating the improvement before being implemented it will contribute with valuable information such as if the improvement works as intended or not. According to Liker (2003) The *do* phase can contribute with more data and knowledge about the improvement work and furthermore improve the planned work
- **Check**: This section is the third phase of the cycle, here it is important to check whether the proposed improvement proposal works as intended and if it contributes to a solution. According to Liker (2003) it is important that the results meet the criteria that was defined in the first phase, otherwise the work must start again from phase 1 in order to meet the criteria
- **Act**: This section is the fourth phase of the cycle; Act can be seen as the most important phase because it is here where the improvement work will be implemented and used. The new improvement work becomes the new baseline for another PDCA, that is because according to Liker (2003) PDCA is loop and therefore there is no end in a loop and that's why PDCA contributes with continuous improvements.

By using the PDCA cycle it enables two types of different corrective measures, temporary and permanent. The difference between these aspects is that the temporary action focuses on results that is based by the actions regarding solving the problems. In other words, temporary action contributes to a short-term solution for the problem that occurred. Meanwhile the permanent action is more based on the root cause of the problems. Here it is important to analyse and understand the root cause of a problem in order to eliminate it. This means that the permanent action contributes to a more long-term solution that may take time to implement but makes sure that the problem will not occur again. (Sokovic et al., 2010)

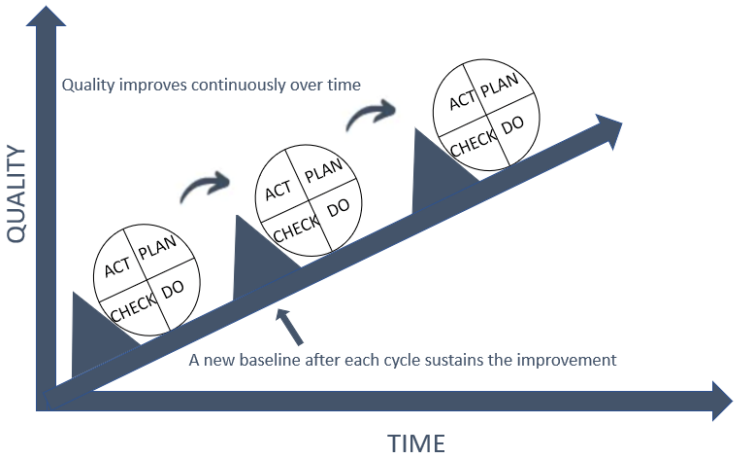

Figure 5: Illustrates a continuous improvement by utilising PDCA-cycle several times. Remodified figure by (Sokovic et al., 2010)

According to Sokovic et al., (2010) PDCA cycle can be seen as a concept rather than just an improvement tool, this is because PDCA contributes to changes that can affect the organisation culture. The last stage of the PDCA cycle ‘’*act*’’ is one of the most important stages in the model. The reason behind that is, when a PDCA cycle is done it will restart again to improve furthermore, which can be seen in figure 5. Therefore, it is important that the ‘’*act*’’ stage is precisely done in order to unlock new hidden improvements when the cycle starts again. (Sokovic et al., 2010)

By creating a purpose towards improvement, it is possible with PDCA to define a repetitive work process. This work process can be standardised in order to make the work as efficient as possible. The repetitive work process would also make it possible for the workers know what to do without having to search for help. (Sokovic et al., 2010)

2.6.3 Value Stream Mapping

Value stream mapping is a lean process improvement tool that is used to map all value adding and non-value adding process in a specific area in a *‘’single picture’’* as shown in figure 6. Value stream mapping or shortened to VSM helps the organisation to visualise the entire production flow process, this enables the possibility to detect bottlenecks in the flow that increases the lead time. (Singh et al., 2011)

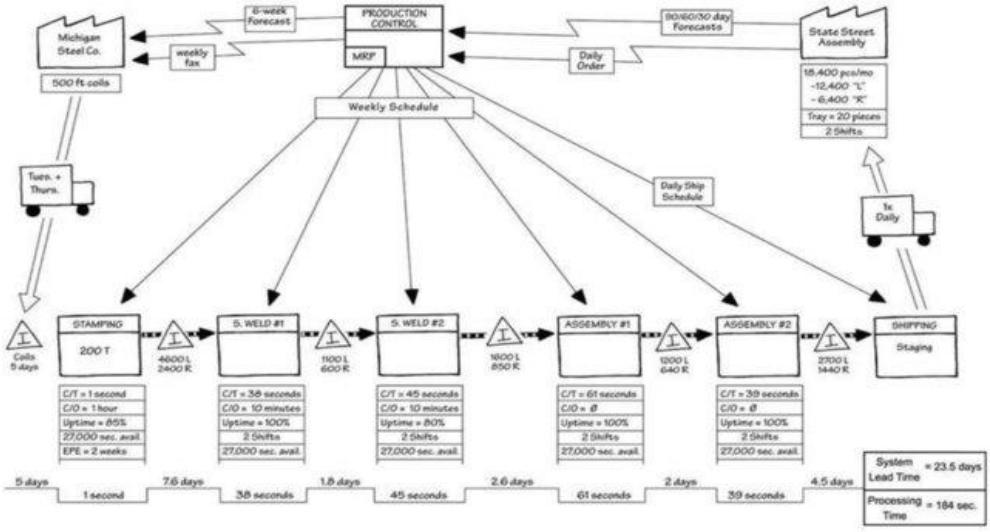

Figure 6: Illustrates an example on how a VSM can look like according to Liker (2003)

According to Rother & Shook (2009), VSM is an essential tool because of its wide mapping of the production flow process it makes it possible to detect sources that leads into waste in the production, by identifying them and eliminating them, only value adding process would be left in the stream. It is also essential when it comes to visualising more than one process, with VSM it is possible for instance to visualise several processes simultaneously in order to understand the stream of information (Braglia et al., 2006).

VSM allows the company to have an insight on how the current state map looks before an improvement work is implemented. This helps the company to identify bottlenecks that slows the process flow and increases the takt time. The VSM would also contribute to a future state map on how the process flow would look like when the improvements are implemented, and the bottlenecks eliminated. (Womack & Jones, 1996)

One of the most important aspects in a VSM is that it documents the links between manufacturing process and the controls that is used to manage process in the production. These processes cover areas such as scheduling and therefore is a critical aspect in the VSM. The reason it is important is that over tools do not document the relationship and can therefore not find hidden wastes in the flow. VSM provides also with information on processes that other process mapping tools does not, this information that is provided by the VSM analyses how the flow of information within the company is constructed, this process provides the organisation with the information on how and where the materials are stored and where the triggers actions of the movement between these processes. (Sing et al., 2011)

When the VSM is done and the processes that contributes to a value in the flow is identified, an attempt to redesign the flow to make deviations visible is made. The new created flow can be called as a deviation driving flow. To make it possible to implement continuous improvements to the new flow, the deviation driving flow is standardised. This type of standardisation entails describing all the aspects of the new flow that may have an impact on the performance of the process flow and the production. (Petersson et al., 2015)

3. RESEARCH METHOD

*This research method initiates with a brief description of what **Qualitative research** is, providing the reader with general knowledge about the research method. The research method section will also describe methods that were used for the data collection in this thesis and how they were conducted. The research method will also cover the **Analysis of data** and the **development of the framework,** lastly a brief description of the thesis **Quality criteria***

3.1. Qualitative research

A qualitative research method was conducted in this thesis for the data collection. Qualitative research is a method that prioritises the data collection and analysis over quantifications. For this project, qualitative research method was the best suited method. That is because in Qualitative research the researcher is close to the subject that is being researched conducting interviews and observations, while with the quantitative research the researcher is more distant from the subject that is being researched and conducts surveys. (Bryman, 2012)

Because this report is based on qualitative research method the approach for the theory outcome was through an inductive approach. Inductive approach is when the theory is based on the outcome of the research. In this case, the theory is based on the outcome of the observations and interviews that were conducted in the company. (Bryman, 2012)

3.2. Unstructured interviews

With the use of unstructured interviews, qualitative data collection could take place in the packaging station. The interviews were conducted onsite and with operators who worked during the shift on which the observations were performed. The interviews that took place were aimed at those who work in the selected workstation, this means that the information that was collected was relevant and more valid for the projects purpose. The information based on the interviews was documented in the form of notes where the most important data was picked and documented in a notebook. According to Bryman (2012), unstructured interview is a proper and flexible interview method, because it gives the interviewer the flexibility to lead discussions while getting answers for the interview questions. These discussions can lead to new questions appearing and being answered on the spot.

3.3. Semi-structured interviews

Semi-structured interviews were also conducted, the aim with the semi-structured interviews was to obtain information about a specific subject such as different problems that have occurred previously. Semi-structured interviews give the interviewer more flexibility to ask further questions that is not stated in the interview guide. By having the possibility to ask further question regarding the form of the interview, the interviewer can obtain new information. (Bryman, 2012)

These semi-structured interviews were conducted in a way to obtain information about a specific subject and answers from specific questions from the project manager and other higher-ranking managers. The questions that were asked in the interviews had a general structural and was asked to obtain a specific information about different problems in the workplace. (Bryman, 2012)

Both unstructured and semi-structured interviews provided with great in-depth information which made the analysis of improvement proposals possible. The interviews provided also with reliable information and relevant information for the researched area. Because of the semi-structured questions, the interviews where recorded.

3.4. Observations

To be able to obtain as specific data as possible, structured observations were made in the researched area. With structured observations a chosen workplace and its workers were observed. It is important that it is clear what and who is being observed to obtain as specific data as possible. (Bryman, 2012) It is important to have these two aspects ready to observe is because the observer can focus on who, where and what to observe and document. (Bryman, 2012)

With observations it is possible to understand and analyse the behaviour in the area that is being observed. (Bryman, 2012) The observations in the packaging station lead into a deeper understanding of the operator's behaviour in the station, answer questions like, how do they work? Are they following the listed instructions? Is it possible to change their behaviour?

In this case, the packaging station and the operators that work in that station was the main aim of the observer. The observations lead into a clearer mind on how the current state is and what error may occur because of the operators. The structured observations also made it possible for the observer to understand the movement in the station which made it possible to detect moves that were waste in the station.

3.5. Secondary data

By using databases such as MDU library, ProQuest, ASCE library and IEEE Xplore for the secondary data and search engines such as Google Schoolar, it was possible to obtain relevant and reliable information that contributed to the theoretical framework. Keywords for the research have been *Standardisation, Lean and TPS, 5s, fishbone diagram and Value Stream Mapping (VSM).* Bryman (2012) necessitates that continuous work on the problems during the work will rule out irrelevant data that do not contribute to the theoretical frame.

3.6. Collection of documentation (existing documentation)

During the observations and interviews, documentation such as old cases that covers wrong deliveries, transport cost, labour costs, CAD floor plan etc, was collected. The documentation was provided by the project manager and the supervisors at the company. Bryman (2012) emphasises that the collected data should not affect any interest. This was possible because the research is linked after the robots have been assembled and delivered to the packaging station, data such as takt times and standardisation of instruction have been documented and analysed in way that it does not affect any interest.

3.7. Analysis of data

The internal validity of the thesis could be strengthened by linking the literature review with the case findings using the pattern matching as the analysis method between these two sections. According to Yin (2009) internal validity can be used to understand how one event led to another event and what the reason behind that event is. This is possible by a pattern matching. The pattern matching was possible to perform by comparing the theoretic framework with the

case findings that was documented during the observations and interviews in the company. With the analysis of the data that is collected it was possible to compare its reference to the literature review to define the similarities and differences between them.

3.8. Quality Criteria

Quality of the research is important and must be reliable. One basic criterion that describes the quality of a qualitative research is trustworthiness. The concept of trustworthiness contains four sub-criteria: *Credibility, Transferability, Dependability, and Confirmability.* (Bryman, 2012, p. 390-393)

3.8.1 Credibility

Credibility is the aspect that describes whether the research findings are reliable or not and if it is correct. According to Bryman (2012) it is important to follow these steps to ensure high credibility for the findings. To fulfil this criterion, a documentation from the observations and interviews have been documented in form of recordings and notes which have been used to support the findings. During the interviews follow-up questions were asked to ensure the answers were correctly given by the one that is being interviewed. The interviews have been carefully transcribed to provide with an increased reliability to the context.

3.8.2 Transferability

Transferability describes whether it is possible to implement the findings of a research work into another environment. (Bryman, 2012) For it to be transferrable it is important that the findings contain a thick description that provides with the necessary data that makes it possible to implement in a different environment. (Korstjens & Moser, 2017)

To fulfil this criterion, a deeper description on the lean improvement tools, improvement proposals and root cause of the errors was documented. By having a deeper understanding on how a lean improvement tool works and what kind of root cause is behind a problem, the operator will have it much easier to analyse and implement a proposed improvement.

3.8.3 Dependability

Dependability is an aspect that is parallel to reliability in quantitative research (Bryman, 2012). For a report to be as dependable as possible it is important that findings, process-problem formulation etcetera is registered and being accessible throughout the study (Korstjens & Moser, 2017). This is important when it comes to following up with the improvement proposals to see where in the current state the procedure is and if the proposals have been followed up as stated in the report.

3.8.4 Confirmability

Confirmability is the aspect of ensuring that the findings and results of a research is not affected by any personal values etcetera (Bryman, 2012). According to Bryman (2012) it must be shown that the researcher has acted in a proper faith when conducting the research in the specified area. To fulfil this criterion, the observations, interviews, and research have been conducted in a proper faith, that is to reduce the wrong deliveries by proposing improvement based on the lean ideology. By not taking any personal value in mind, it is possible to come up with improvements, analyse human error without damaging the findings of the thesis.

3.9. Triangulation

The use of different methods such as unstructured interviews, case findings and observation etc for the data collection has led to a degree of triangulation. According to Bryman (2012) triangulation can be ensured when there is more than one method used to collect data. The aim with the triangulation is to ensure that the qualitative research process is enhanced by using several methods (Korstjens & Moser, 2017)

4. CASE-FINDINGS

4.1. Current situation analysis

A current situation analysis was conducted in the packaging station in ABB Robotics, it was important to conduct it, in order to understand the main problem, which is wrong deliveries that happens because of errors in the packaging station. In the current situation, employees are working from simple instructions in the shape of pictures with guidance on what should be done at each task.

Because the packaging station is not standardised there is no instructions that instructs how the employees should work, this process increases the rate of errors. The reason behind that is because some employees tend to work on their own way and not what should be recommended.

Wrong deliveries have a big impact on the company but also the customer that ordered the product. The customer can lose large sums of money in case the customer has hired an external party to assemble the product or demonstrate the product. When a product does not reach the desired customer, the customer would stand empty-handed. It is also possible that the customer does not trust the manufacturing company anymore and instead switch to another company that is competing in the same business market.

The company can be affected from the wrong deliveries in terms of production costs and transport costs. Worst case scenario for the company is that it needs to rebuild a new product from the beginning and ship it again to the desired customer.

4.2. Packaging station

The packaging station as stated before is a fundamental station and section in the supply chain, it one of the last phases before the customer gets their product. Errors in the packaging station can lead into several problems such as wrong deliveries, faulty packaging, scratches on the product and missing parts. In the packaging station it is important to be as organised and accurate as possible.

In the packaging station employees works in three shifts morning, afternoon and night, there are always two operators that work simultaneously in the same station, one operator loads the product on the conveyor and sends it further down the station. The operators work together to package the product correctly and label it. The second operator begins the data work and registers the product in the system, at the mean time the other operator finalises the last tasks in the packaging before sending the product to the last phase in the station.

From the observations that were conducted in the packaging station, there are some bottlenecks in the process flow that can be eliminated in terms of a change in the instructions. Human factor is the main factor that needs to be improved in order to reduce the errors. It was possible during the observations to understand how the work differ between the shifts.

According to the observations, employees with more experience worked according to their own way and what suited them best. If workers continue to work after their own method, it would be an obstacle for the standardisation of the packaging station. It is important that there are instructions and work procedures that are standardised in order to eliminate the possibility to choose other working procedures that is not standardised.

The layout of the packaging station is simple and does not have any operating machine other than the conveyor. During the observation of the packaging station, one thing that stood out the most, was that the instruction board with several instruction was located almost at the end of the station. The instruction board should not be hidden, the board should be either in the middle or in the beginning of the station, so it is visible for every operator.

4.3. Standardised work

As stated before, there is no standardised instructions or work procedures in the packaging station which opens the possibility to work and not follow the instructions. Therefore, it is important that there is an implementation of standardised work procedure that is based on the lean perspective that eliminates the ‘’*Chose*’’ thinking. An operator should not have possibility to choose what kind of method will be used for the instructions and work procedures. The operator must only work from the instructions that are listed and provided from the company.

Because there are no listed instructions on how to do each task, there is several waste movements in the packaging station that does not contribute to any value, see figure 7.

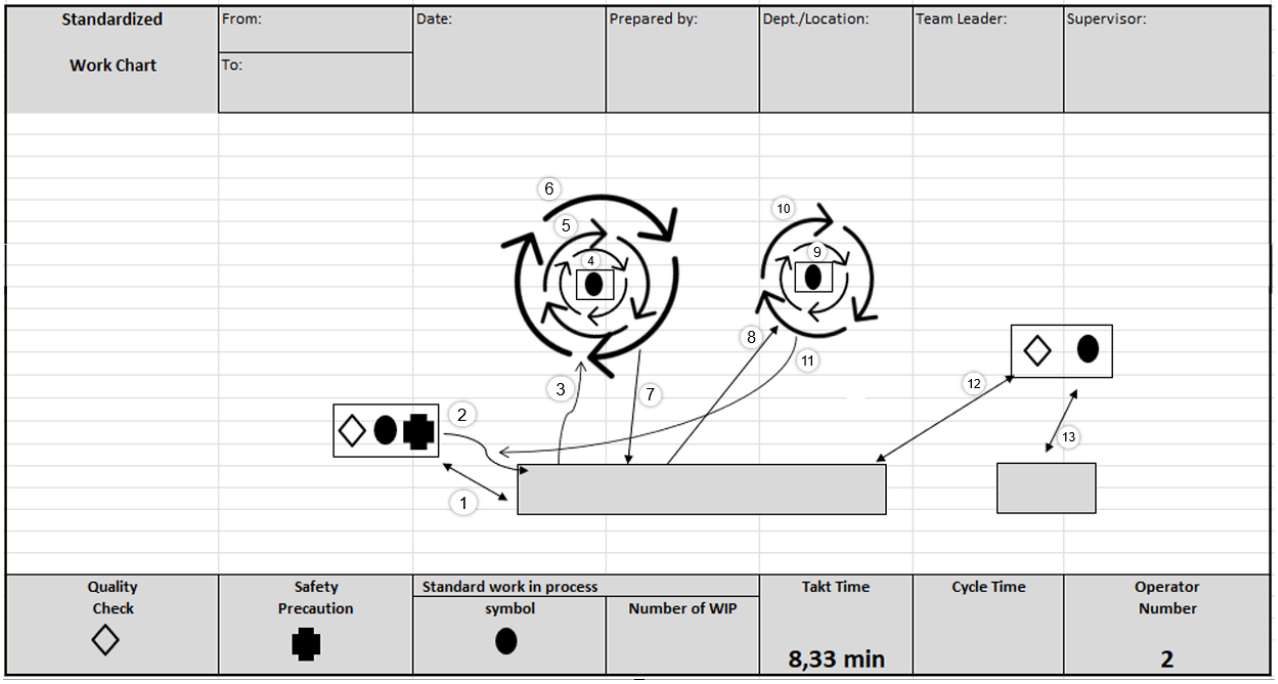

Figure 7: Illustrates the current movement in the packaging station in form of a standardised work sheet

Standardised work contributes to improvements and according to the project leader, improvements are necessary in order to reduce the errors from occurring in the packaging station which in turn would reduce problems such as wrong deliveries.

4.4. Customer

As mentioned before, ABB Robotics serves as the main hub in Sweden to produce robots that is delivered worldwide. This means that ABB Robotics have a wide customer base that it delivers products to. Depending on where the customer is located the transport can vary from trucks to shipping to air freight. Because of the wide range of customers, it is therefore important that there are no wrong deliveries. If a product is destined for a country based in Europe but a wrong transport label made the product shipped to Australia, the transport cost

would be high for the company. It would also affect the customer because the product that where ordered did not arrive to the right destination.

4.5. Current State Map (VSM)

A VSM was conducted to gain knowledge on how the information flow of the process looks like in the station. The VSM was conducted to illustrate the current state in order to map all process that adds value and non-value adding processes. The VSM provides with the total lead time it takes for one robot to be packaged and sent to the unloading. Because there are no operating machines in the station that can be classified as a process, the station where divided into five different processes, these processes define the work procedure in the packaging station as shown in figure 8.

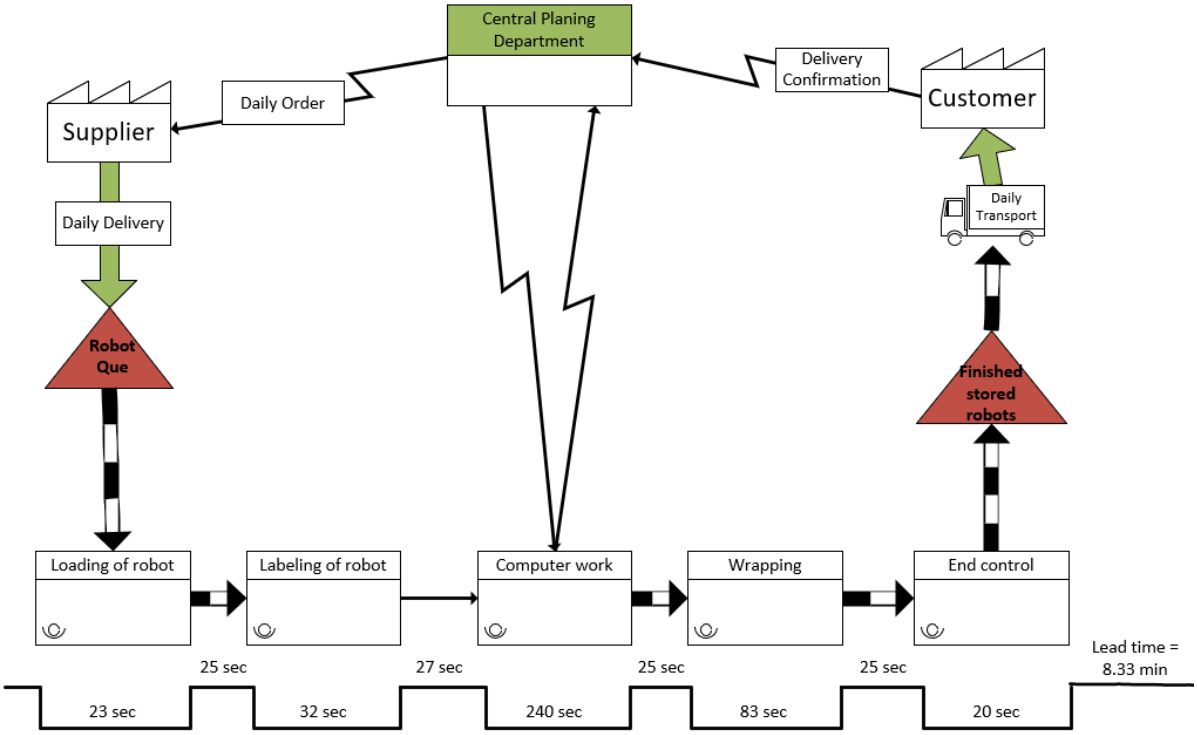

Figure 8: Illustration of current state map (VSM)

5. ANALYSIS

The analysis chapter is divided into two sections, the first section covers RQ1: ***Packaging area*** *and the second section covers RQ2:* ***Operating standards****. The aim of the analysis chapter is to analyse the collected data from the case findings and the theoretic framework to be able to answer the main RQ:* ***Why is a standardised workplace important in a manufacturing company?***

5.1. Packaging area

This section will cover the Packaging Area and is divided into smaller sections: Economical factors of wrong deliveries, and Standardised work procedure

5.1.1 Economic factors of wrong deliveries

An analysis of the case findings from the company and the theoretic framework identified similarities regarding the economic factors of wrong deliveries, this similarity can play a significant role when it comes to decision-making regarding changes and improvement work in the packaging station.

Errors in the packaging station can lead into problems that cost time and money to solve, often these problems lead to wrong deliveries which in turn lead into expensive transport costs. It is also important that a current situation analysis is conduct in the beginning to get an understanding what a wrong delivery may cost in terms of materials, labour, and transport.

The choice of improvement plays a significant role to the company because not all improvements work as intended, Liker (2003) argues that it is important to analyse and plan a proposed improvement before implementing it. Here comes the PDCA cycle in as a lean process improvement tool that is used when planning an improvement. With the use of PDCA cycle it enables the possibility for the company understand where and why an improvement is needed in order to reduce the costs of wrong deliveries. According to Liker (2003) the first phase (Plan) is important because it opens the possibility to answer hidden questions regarding a problem. By being able to analyse a proposed improvement before implementation it reduces the risk of failure. It also improves the economic factor by not having to spend money on material and labour.

The PDCA cycle makes it possible for the management to get answers on questions regarding the economic factors of an improvement but also economic factors regarding a problem, see figure 9 down below.

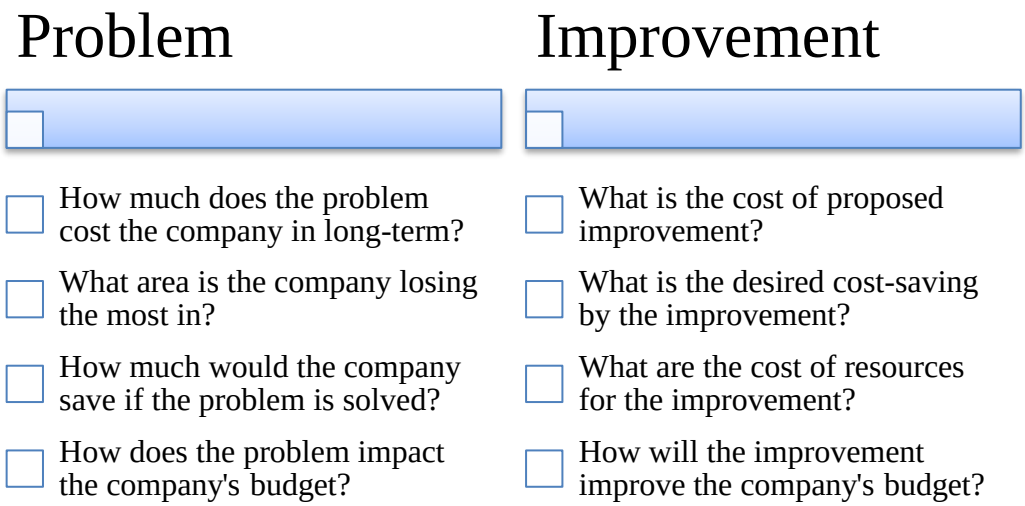

Figure 9: Questions to get answered during the Plan phase in PDCA

Even though Liker (2003) considers that the *Plan* phase is important, Sokovic et al. (2010) argues that the *Act* phase is the most important phase in a PDCA. The reason it is important is that because it would be used as the new baseline for future improvement work. If the implemented solution did not meet the desired cost-saving, the new improvement work would be costlier to meet the cost-saving goal.

To understand where and how the problem occurs a VSM is necessary. Braglia et al. (2006) necessitates the importance of a VSM and how it can help the organisation to detect nonvalue adding processes in the production. By mapping all processes in a production flow, it is possible to understand the flow of information and its relation to other processes and departments. Womack & Jones (1996) argues that constructing a VSM opens the possibility to detect bottlenecks that are hidden otherwise, it also enables the work with standardising the workplace which Petersson et al. (2015) agrees with.

Petersson et al. (2015) believes that a VSM is an important method that contributes to the standardisation of workplace by redesigning the current flow in order, for the new flow to detect and make deviations possible. A VSM constructed over the packaging station can therefore help ABB in detecting bottlenecks that are hidden but also understand how the flow of information is distributed in that station, because often the lack of communication is the start of a problem.

By improving the station to reduce the errors ABB would have an increased savings because of the reduced wrong transport costs and material costs by rebuilding a new product from scratch again. ABB would not risk losing its customer because of wrong deliveries, instead it may expand its customer base furthermore due its trustworthiness and collaboration between ABBs customers and suppliers.

5.1.2 Standardised Work Procedure

Standardisation is an effective and important method to make a process as efficient as possible. Petersson et al. (2015) and Liker (2003) sees standardisation as the main foundation of TPS house. According to Petersson et al. (2015) the outcome of a standardised workplace is higher efficiency, shorter lead time, lower cost and better quality.

Mihova and Alexieva V (2017) brings up that there are two different standards that can be used in order to standardise a workplace, management and operating standards. The best suited standard for ABB Robotics is the operating standards. Petersson et al. (2015) agrees that to be able to improve the efficiency in a workplace it is important to begin with the standardisation that covers these areas. Operating standard is therefore the best suited because it analyses how the work in the packaging station is conducted and analyses the instructions.

Operating standard according to Petersson et al. (2015) aims to answer question such as

- What should be done?
- How should it be done?
- How long time would it take?

Mihova and Alexieva V (2017) agrees with that and describe it as a necessary method to understand what should be standardised and why it should be standardised. When ABB Robotics understands the importance of a standardised packaging station it would be easier to analyse and evaluate the root causes behind the errors that occurs. By standardising the packaging station, ABB would not only reduce the lead time and lower their costs. ABB would have an increased safety in the packaging area because of the clear instructions that have been standardised. The quality of the products would also be improved because the new standardised packaging station eliminated methods that could results in damaged products. Petersson et al. (2015) strengthens the argument by explaining that when there are clear instructions on how a specific work procedure shall be done, the operators cannot choose their own methods, in this way the risk of wrong labelled product is minimised.

Petersson et al. (2015) suggests that implementation of the 5S method is necessary to standardise a workplace and work procedure. Looking at the current state of the packaging station there is no working method that covers one aspect of the 5S method. Khamis et al. (2009) argues that it is important to begin analysing the human factor first when working with the 5S method, because the human factor is the main actor in the improvement. Mihova and Alexieva V (2017) agrees with Khamis et al. (2015) and describes the importance of having an organised workplace that is clean and easy to find tools in.

If the 5S method is implemented in the packaging station it will contribute to more organised station with clear instructions on where each tool is placed and for what the tool is used. The packaging station would also be cleaner which reduces the risk of a transport label swap from occurring. Liker (2003) argues that the fourth S (**Seiketsu**) is important because it standardise a work routine by repeating it. Work routines such as not leaving unfinished orders, not ripping labels of the pallet, and not working on more than one order can be repeated and standardised using the 5S method with the help of the operating standard. When these work routines are standardised, it would be easier for ABB to focus on improving the station furthermore due the standardisation and lean characteristics which builds on the continuous improvements.

5.2. Operating Standards

This section will cover the Operating Standards and is divided into smaller sections: Importance of standardisation, and Improved Efficiency and Quality

5.2.1 Importance of Standardisation

An analysis of the case findings from ABB and the theoretic framework identified similarities regarding the importance of a standardised workplace. In this case the packaging station needs

standardisation to reduce the errors from occurring in the station that leads into wrong deliveries and other problems.

Petersson et al. (2015) believes that it is important to have a workplace that is standardised because it can contribute to an improved safety in that workplace. The packaging station is safe because there is no automated work in the station, the only thing that is automated is the conveyor that moves the pallets. Even with a safe workplace Mihova and Alexieva V (2017) necessitates the importance of standardisation.

Standardising the packaging station in ABB will improve the safety by having clear instructions on how the pallet should be onloaded, how to handle with fragile products and how to work simultaneously in the station with more than one product together with another operator. Safety will be improved by standardising a work procedure that describes how the operators should move in the station. Liker and Meier (2006) believe that a standardised work sheet is a great method do standardise the movement in a workplace. With the implementation of a standardised work sheet in the packaging station it is possible for ABB to analyse the movement of the operators during work. It enables the possibility to detect waste movements and helps improve the layout of the packaging station by moving objects to a more value adding position.

Standardising the movement in the packaging station can also help ABB in creating instruction sheets that describes the movement the operators should make in the station. These sheets can be used during the training of new operators. These steps are important because it can save ABB money by not having to plan further training lectures. It would also save ABB time and improve their efficiency by not having to reschedule operators for training purposes.

For ABB be able to standardise the packaging station it is important to find the root cause behind the errors that occurs. Wong and Wong (2011) believe that with the use of 5-Why tool it is possible to find the main root cause behind the problem and must be solved before implementing an improvement. By finding the root cause of a problem in the packaging station ABB can analyse it and begin planning how to eliminate it with the use of PDCA. The root cause analysis plays a significant role in standardisation according to Petersson et al. (2015) and can be utilised to improve the standardisation work.

To reduce the number of wrong deliveries that comes from different problems with different root causes, it is important to have the packaging station standardised. Standardisation helps ABB in reducing their wrong deliveries by making standardised work instructions and routines that the operators must follow, it would also reduce the choices operator can make during the work and only work by the listed and standardised instruction, reducing the risk of an error occurring because of a wrong instruction move.

5.2.2 Improved Efficiency and Quality

Improved efficiency and quality are what standardisation of a workplace aims for, efficiency and quality are two aspects that are important to maintain at a high level for ABB. In the packaging station the efficiency and quality are important because bad efficiency can lead into delays and bad quality can lead in dissatisfied customers. Petersson et al. (2015) believes that when a workplace is standardised using operating standard there is an increase in safety, efficiency, and quality. When the work routine the packaging station is standardised, the efficiency is increased. It is increased in terms of minimised waste movements in the station

that contributes to reduced lead time in the station. Liker and Meier (2006) believe that the use of standardised work sheet and standardised combination table sheet can improve the efficiency and quality in the workplace. The implementation of a standardised work sheet improves the efficiency by detecting what movements are waste movements, it enables the possibility for ABB to analyse the layout and redesign it to increase the efficiency in the packaging station. It also contributes to an improved quality because there will be more time added to the quality control sections in the packaging station when the nonvalue adding movements are eliminated.

ABB should not forget the importance of quality. Mihova and Alexieva V (2017) agrees that with the implementation of operating standards an increase in quality is provided. Petersson et al. (2015) strengthens that argument by stating that standardisation is the foundation of continuous improvements that contributes to an increased efficiency and quality without increasing the lead time and the costs.

Petersson et al. (2015) believes that in order to increase the flow in the production it is important that the flow is levelled and not clocked. With the use of standardisation combination table and VSM it is possible for ABB to analyse the flow to find improvements that contributes to an increased efficiency. The VSM can eliminate nonvalue adding processes and bottlenecks in the station, by removing them the lead time would be reduced and an increase in efficiency happening because of the reduction of nonvalue adding processes.

Reduced errors lead into more efficient flow and higher quality in the packaging station, the quality of the packaging plays a significant role for ABB, if the product is not packaged correctly there is a risk of it being damaged during the transport to the customer. When the operators follow the standardised instructions on how to package and label the product the risk of it being a wrong delivery is low, because the standards are made to reduce errors that leads into wrong deliveries.

6. CONCLUSIONS & DISCUSSIONS

This chapter aims to answer the main research question and the two sub questions, the chapter will begin with answering the two sub questions and lastly answer the main question

6.1. RQ1: How can a packaging area be standardised using lean process improvement tools?

There are several ways to standardise a workplace using lean process improvement tools depending on what is desired with the standardisation. In this thesis the aim with the standardisation of a packaging station was to reduce number of wrong deliveries that occurs because of errors in the packaging station. The root cause behind the errors is mainly the human factor. The operators do not follow the instructions that have been provided by the company. Some workers tend to use their own methods in the packaging station which can results in errors such as transport label switch and wrong scanning of barcodes.

In order to reduce the errors in the packaging area the proposed solution is to standardise the packaging station using lean process improvement tools. The reason behind that proposed solution is because standardisation aims to continuously improve the packaging station but also implement a standard work procedure that includes instructions and methods. These instructions will be the new listed instructions that the workers must follow, the listed instructions are provided in a way to reduce errors from occurring.

With the help of lean process improvement tools, it is possible to standardise the packaging station, the lean improvement tools are the following:

- 5S
- PDCA Cycle
- Value Stream Mapping

These three tools have several aspects in common and the main aspect is that they all work towards continuous improvement in order to improve the efficiency and quality by reducing errors and waste.

6.1.1 5S

The 5S method can contribute to standardisation by making the packaging station more organised and cleaner. It is important that the station is organised in order to make it easier for the operator to find where the tools are located, where to place the transport label during the data work, how to use a tool and where documents with instructions are located. By having it easier to find necessary documents and tools, the risk of errors is minimised because there won't be any uncertainty regarding the instructions and the methods.

When an improvement is implemented, there is changes in the workplace, with the use of the fifth S (***Shitsuke***) the management of ABB can be prepared that there will not a result that is achieved instantly because it may take time for the operators to accept the change. The management can together with the operators build a structure using 5S to implement improvements that succeed and reach the goal.

6.1.2 PDCA

The PDCA cycle is an important tool that contributes to standardisation in the packaging station by planning, analysing and evaluating a proposed solution before implementing it. The management of ABB can use PDCA as an improvement tool in order to reduce the errors in the packaging station and find instructions to standardise. PDCA provides ABB with a clear structure over the problem and the proposed solution. With the help of 5-Why method it is possible for ABB to understand why wrong deliveries happens and where the errors happen.

After using the PDCA cycle and an improvement is implemented ABB can utilise the PDCA furthermore by making the improvement the new baseline for future improvements, because PDCA is a loop there is no end, therefore it contributes to continuous improvements. The new improvement is standardised and used as the foundation for new improvements. By using PDCA ABB can redefine a work process and make it repetitive in order to standardise it.

6.1.3 Value Stream Map

Value stream mapping is an essential tool that contributes to standardisation and improved flow of information in the packaging station. By having the possibility to map all the process from value adding process to nonvalue adding processes and how the share of information between process is. ABB can eliminate detected bottlenecks and improve the lead time by either reducing it or increasing it. The lead time can be increased in order to improve the quality of their products. Efficiency and Quality is important for ABB, with the use of VSM, ABB can standardise a new flow that is used for making deviations visible and able to solve them.

The new proposed VSM will help ABB make the flow of information more efficient by eliminating nonvalue adding process, bottlenecks and combining processes together, see figure 10.

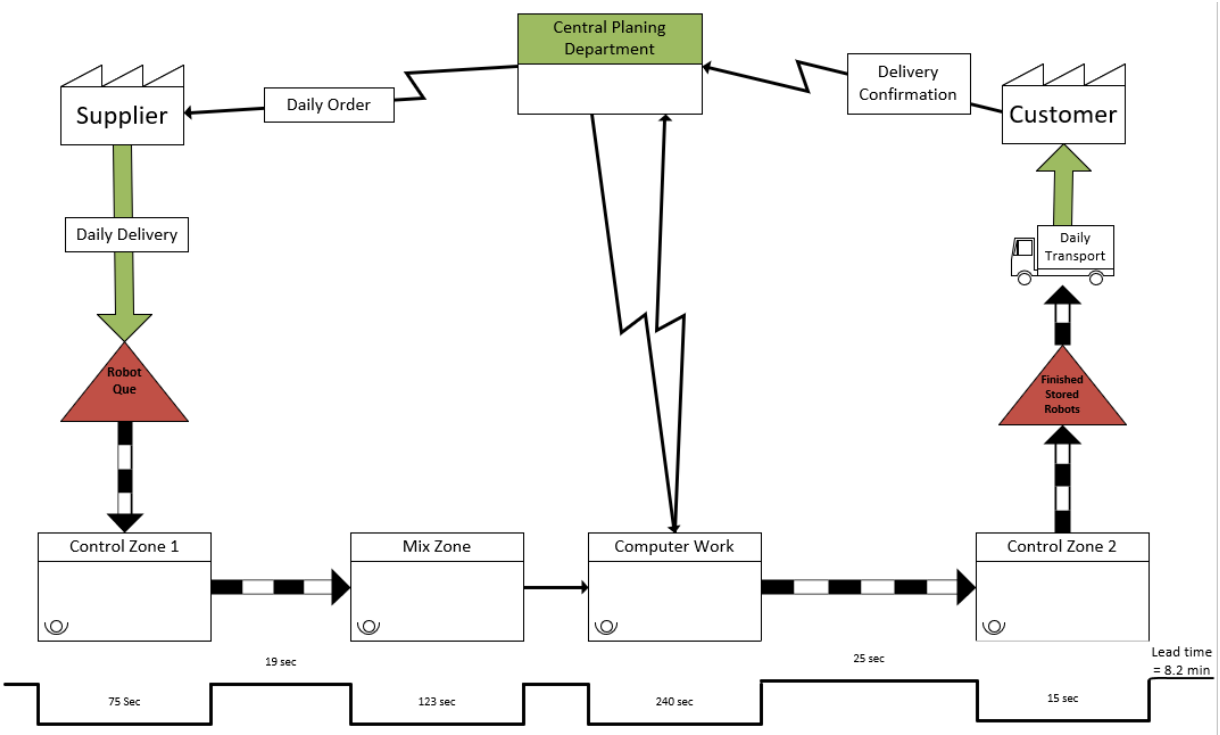

Figure 10: Illustration of the new state map (VSM)

6.2. RQ2: How can operating standards improve the efficiency in a packaging station?

Operating standards is aimed to improve the packaging station by analysing how the work is done and what can be changed in terms of work methods and instructions. The implementation of an operating standards helps ABB in understanding how the operators work in the current state and how they should work in order to minimise the errors. Using this method ABB can get answers for questions regarding the work procedure such as:

- What should be done in order to minimise the error?
- How should the operators work?
- How long would it take for operators completing their work with the new instructions?

By combining the operating standards together with standardised work sheet, it is possible for ABB to analyse the movement of the operators and propose a new layout on how the operators should move during their work in order to improve the efficiency.

Implementing operating standard in the packaging station can improve the efficiency by having to list new standardised instructions that minimise the risk of errors leading to wrong deliveries. The new operating standards would also improve the safety and ergonomics in the packaging station by listing new work methods that covers aspects such as movements and how the tools should be used. With the use of operating standards in the packaging station ABB can implement the best working method for the operators.

The proposed standardised work sheet help ABB in improving their efficiency and quality in the packaging station by minimising the waste movements during packaging of the product and elaborate a new work procedure that will increase the quality control, see figure 11.

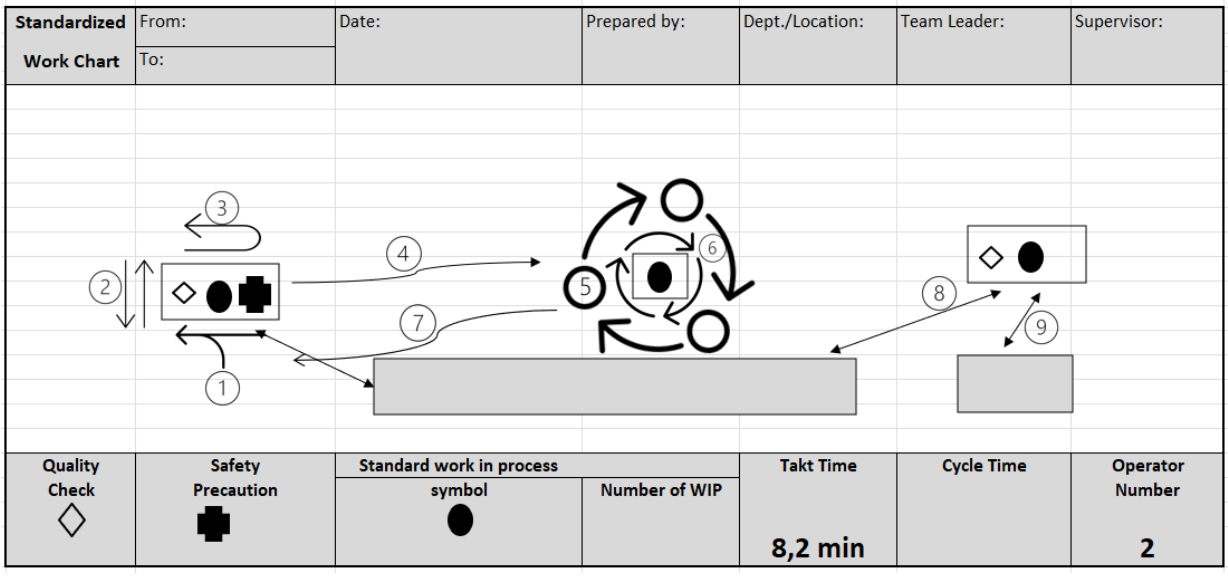

Figure 11: Illustrates the new proposed movements in the packaging station in form of a standardised work sheet

6.2.1 Main RQ: Why is a standardised workplace important in a manufacturing company?

In order to draw a conclusion about the main question it is important to understand the given results that have been achieved from the two sub-questions. Both of the sub-question strengthens the argument on how a standardised work procedure can contribute to an improved workplace.

Standardised workplace is an important aspect for a manufacturing company because of its contribution to an improved efficiency, quality, safety and reduced waste/errors in the workplace. Standardised workplace makes it possible for the workers to work the same way which makes it easier for the new workers to understand the work procedure, because there is no variation on how to do a task. Because of the relationship to lean production, standardised workplace would contribute to an increased work on continuous improvements, this enables the possibility for ABB to continuously improve the workplace and reducing the errors in that workplace furthermore.

Standardised workplace is important because it makes it easier and more efficient for ABB to train its new workers if the workplace is standardised. This is because when the workplace is standardised there is a standardisation on work instructions, that provides the workers with the needed information on how to perform a task and perform a quality check. This enables the possibility for ABB to reduce its training time for new workers, it also makes it possible that the new workers become independent more quickly and in turn lead to an increased efficiency and quality in the workplace. It also provides with cost savings improvements by reducing the errors in the packaging station which can lead in wrong deliveries and damage to the products.

6.3. Suggestion for future research

This thesis and project were conducted in order to understand the importance of how standardised work can prevent wrong deliveries. Analysis on the current work procedure, methods and the human factor made it possible to conclude an answer. For future research, it is possible to broaden the work so it covers areas such as the unloading site where problems can occur. By covering these problems, a more sustainable solution can be achieved by the standardisation work.

6.4. Recommendations to the Company

Recommendation to the company would be to document all the cases in one place in order to have as much data as possible for future improvement work. A second recommendation would be to follow up the improvement work both during the improvement work and after the work is done, in order to be able to analyse whether the desired result is achieved by reducing the amount of wrong delivery cases in a one-year period and if the workers follow the new standardised instructions.

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8. APPENDICES

In this section, the interview guides used during the observation of the study is presented

Appendix 1

- What kind of instructions is there today that the workers follow?
- What was the root cause behind the most recent problem?
- How much info is available regarding old cases?
- How often is there a rotation regarding workers?
- Who has the most experience among the workers?
- Any previous improvement works?

Appendix 2

The purpose of the work is to analyse the packaging station and propose improvements that contributes to reduced wrong deliveries. I am studying my fifth year of the engineering program in production and logistics at MDU.

Is it okay to record? The interviewed personnel will be anonymous, the respondent have the right to cancel the interview at any moment, for your information the report will be published on diva.

- Can you tell me what your role at the company is?
- Tell me how do you act when a wrong delivery case occurs?
- How is a wrong delivery case solved here? What is the process
- How much does this problem cost the company?
- Any idea on how it can be improved from your own perspective?