TECHNICAL UNIVERSITY OF LIBEREC
Faculty of Economics

Implementation of lean management principles in a selected company

Master Thesis

Study programme: N0413A050030 International Management
Author: **Bc. Kateřina Postránecká**
Thesis Supervisors: Ing. Natalie Pelloneová, Ph.D.
Departmens of ussines Administration and Management

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Master Thesis Assignment Form

Implementation of lean management principles in a selected company

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3. Characteristics and presentation of the selected company.
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Consultant: Ing. Mojmír Mocek, Chief executive officer – CEO

Thesis Supervisors: Ing. Natalie Pelloneová, Ph.D.
Departmens of ussines Administration and Management

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L.S.

doc. Ing. Aleš Kocourek, Ph.D.
Dean

Ing. Eva Štichhauerová, Ph.D.
Head of Department

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Annotation

The Master thesis "Implementation of lean management principles in a selected company" deals with implementing lean management principles in the company CHOCOLAND a.s. The company is engaged in producing, importing, and distributing branded confectionery and food. The thesis aims to map the current state of the selected production process and propose appropriate measures to improve efficiency using lean management tools. The research part of the thesis is focused on the theoretical background of lean management. The application part of the thesis first introduces the company CHOCOLAND a.s., maps the current state, and analyses the selected department. Subsequently, the application part proposes measures to increase its efficiency of the department. In the final part of the thesis, the economic evaluation of the proposed measures is described in detail.

Keywords

Lean management, Waste of time, SMED analysis, 5S, Cycle time

Anotace

Diplomová práce „Zavedení principů štíhlého řízení ve vybrané společnosti” se zabývá implementací principů lean managementu ve společnosti CHOCOLAND a.s. Společnost se zabývá výrobou, dovozem a distribucí značkových cukrovinek a potravin. Cílem diplomové práce je na základě zmapování současného stavu vybraného výrobního procesu navrhnout za pomocí nástrojů lean managementu vhodná opatření ke zefektivnění tohoto procesu. Rešeršní část diplomové práce je zaměřena na teoretická východiska z oblasti lean managementu. Aplikační část diplomové práce nejprve představí společnost CHOCOLAND a.s., zmapuje současný stav a provede analýzu vybraného oddělení. Následně jsou v aplikační části navržena opatření ke zvýšení jeho efektivnosti daného oddělení. V závěrečné části práce je detailně popsáno ekonomické zhodnocení navržených opatření.

Klíčová slova

Štíhlé řízení, plýtvání časem, SMED analýza, 5S, doba cyklu

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5S	A method used to achieve and maintain order in the workplace
B2B	Business-to-business
CEO	Chief executive officer
CV	Curriculum vitæ
CZK	Czech crown
EU	European Union
HR	Human resources
ISM	world’s leading trade fair for confectionery and snacks
JIT	Just-in-Time
JITD	Just-in-Time Delivery
JITP	Just-in-Time Purchasing
LSS	Lean Six Sigma
NVA	Non-Value Added
PDCA	Deming cycle
PET	Polyethylene terephthalate
PLMA	Private Label Manufacturers Association
POUS	Point of Use Storage
SC	Soybean cutting machine
SMED	Single Minute Exchange of Die
SMEs	medium-sized enterprises
THP	Technical and economic worker
TPS	Toyota Production System
USA	United States of America
VA	Value Added
VSM	Value Stream Mapping

Introduction

Nowadays, conditions are changing dynamically, and customers are setting more and more conditions and requirements. Companies have to react quickly to this fact and ensure smooth and flexible processes, in which it is necessary to execute processes well concerning efficiency and economy. Each company aims to produce products that meet all customer requirements with their technical parameters and also seeks to increase efficiency, eliminate time wastage in the operations performed, and eliminate high error rates through adherence to work procedures. In order to achieve these goals, companies should use modern and ever-improving methods while keeping up with ever-changing trends. Lean management can be included in these improving methods. Lean management serves to identify activities that do not add any value to the business and are defined as inefficient activities.

The thesis on "Implementation of lean management in a selected company" focuses on applying lean management principles in a selected company. The theoretical knowledge that the graduate gained during the study of the literature was applied to the company CHOCOLAND a.s. based in Kolín. The company CHOOCOLAND a.s. is one of the leading producers and distributors of semi-finished food products and confectionery.

The thesis aims to evaluate the current state of the selected department in CHOCOLAND a.s., propose new solutions using lean management elements, implement the solutions, and perform an economic evaluation of the achieved results. Based on the analysis of the current state of the selected department, redundant and inefficient actions can be identified. New improvements can be proposed for these facts, and an economic evaluation of the recommended proposals and possible changes can be made.

The thesis is divided into two parts. The first part of the thesis focuses only on the literature search of the subject and characterizes the basic knowledge of lean manufacturing. This part outlines the basic definitions, history of lean management, and types of waste and lists the tools and principles of lean management. The last literature review outlines the general implementation of lean management and the factors for its successful implementation.

In the second part of the diploma thesis, the use of the principles of lean management in the company CHOCOLAND a.s. Specifically, the 5S method and the SMED method were implemented in the soybean department. The practical part first introduces the company, its history, its vision, mission, values, and strategic plans. Furthermore, this section maps the current situation in a selected department of soybean production. Subsequently, the 5S and SMED methods are introduced in the selected department. At the end of the diploma thesis, an economic evaluation of the proposed measures is prepared, and a summary of the acquired knowledge is made.

1 Theoretical framework

The research part of the thesis deals with the theoretical foundations of lean management. At the beginning of the research part, lean management is defined, then the history of lean management and its origins in the United States of America at Ford and in the Japanese car company Toyota are outlined. Subsequently, attention is paid to the principles, and some lean management tools are defined. The final part outlines the general implementation of lean management and its success factors.

1.1 Lean management

With a rapidly changing world, automation and increasing globalization, and rising living norms, the demands of increasingly demanding customers are rising. Today, customers are increasingly ordering everything online, have up-to-date online information, follow modern trends, and constantly increase their demands on manufacturers. All this increases the demand not only for manufacturing companies but also for their entire supply chains. Nowadays, companies must adapt their products to customers in the production process and respond immediately to any changes in demand.

Lean management is a philosophical way for process optimization throughout the value chain (Helmold and Samara, 2019). According to El Faydy and El Abbadi (2022), "*Lean management is considered a philosophy that aims to maximize customer value while minimizing waste*". According to Helmold (2020), "*Lean management is focusing on making inefficiencies transparent and on altering these into value-adding activities*". The Leanness of a business means doing precisely the needed actions, doing them right the first time, doing them quicker than others, and most importantly, spending less money. Nevertheless, no one has ever gotten rich by saving money. Leanness is about increasing the company's performance by producing more than competitors in a given area that, with a given number of people and equipment, produces higher added value than others and handles more orders at a given time, using less time for business processes and activities. The Leanness of a business is that we do precisely what our customer wants, with a minimum number of activities that do not increase the value of the product or service. So being Lean means making more money, making it faster and with less effort (Košturiak and Frolík, 2006).

Producing simply in self-controlled production is what Lean manufacturing entails. It concentrates on lowering expenses by striving for excellence with no compromises. The ideas of Kaizen activities, flow analysis, and Kanban systems are used every day in production. From senior management to manufacturing workers, everyone at the organization is involved in this effort. Lean manufacturing alone is not about reducing costs. The first is to maximize added value for customers. Downsizing is a way to produce more, reduce overhead costs and make more efficient production facilities and resources. Lean manufacturing cannot function without a solid link to product development and production, logistics, and administration technical preparation. The mistake e.g., is that many companies have physically separate production and product development processes. Leanness developed during the pre-production stages, and the logistics chain and administrative procedures significantly impact the characteristics of a Lean organization. Lean manufacturing is a concept that aims to minimize the time it takes for a customer to reach a supplier by removing waste in the supply chain (Košturiak and Frolík, 2006).

1.2 History of Lean management

Lean management is a fair word used to describe industrial process improvement operations, having been used for around 30 years. The desire to enhance industrial processes, on the other hand, dates back thousands of years. The author of the thesis presents examples of how process improvement approaches have been used throughout history in this chapter. The author describes the progression of manufacturing process improvement, beginning with Henry Ford's assembly line and progressing through Taiichi Ohno's waste-free manufacturing (Charron et al., 2015).

USA and Henry Ford

Relatively in the old days of modern management, the foundations of Lean occurred. As early as 1910, Henry Ford applied the industrial theories of Frederick Taylor and Frank Gilberth. Gilberth mentioned the above-developed standards and outlined procedures for working efficiently and in the best possible way in the work process while observing his workers on the construction site. This improvement of operations helped to streamline the entire work process. One of the first to use belt production in his mass production of cars, Henry Ford introduced a continuous supply of material. He thought that the specialization of workers, including technical workers, must be used. Through constant improvement, Henry Ford has reduced the Model T from $ 800 to $ 300, has dominated up to 50 % of the U.S. market (Hounshell, 1985).

Toyota Production System

After World War II., Japan suffered a significant loss of capital and could not buy more manufacturing technology in the West. The outside world has been flooded with carmakers, which were afraid to invest in Japan market, and wanted to protect their needs from Japanese exports. The difficult post-war situation caused considerable dissatisfaction among the workers, which was also to the detriment of the Toyota plant, where workers occupied the plant with disagreement with the forced austerity measures. In the end, they found a compromise; some workers were laid off and guaranteed the rest lifelong employment and salary increases. In addition, the reward system has been linked to bonuses in the company's financial results. A practical approach pioneer was Taiichi Ohno, who was production line manager at Toyota. Ohno chose a more straightforward method of exchanging mold to make the exchange much faster than in the West. Then he changed them every 2–3 hours using sliding rollers. Since there was a pause in this change and the workers had nothing to do, he ordered that change made by workers and not as specialized companies in the West. Ohno began to slowly reduce the time when adjusting the machine from the first 8 hours to only 23 minutes, thus eliminating the work of specialists. Concurrently he noticed that he reduced his cost per body by producing large batches on the presses (Váchal, 2007).

Only a designated manager can stop the line for American automakers when there is a shortage of vehicles. In Toyota, Ohno had a cable drawn to each worker, after which the line stopped immediately if a sudden problem arose. The whole team then had to deal with the situation quickly. At first, the line stopped very often, but the errors decreased considerably as the workers gained experience, and the line practically did not stop. Toyota today has virtually no room for end-of-line repairs. Many new in introduced similar methods at Toyota, and gradually the name Lean manufacturing began to be used for their assembly. An essential part of this new approach is portrayed as a building with some stability and standardization (see Figure 1). The walls are Just-in-Time and Jidoka. Inside the building, a flexible and energetic team is looking for continuous improvement, and the roof is focused on customer satisfaction (Váchal, 2007).

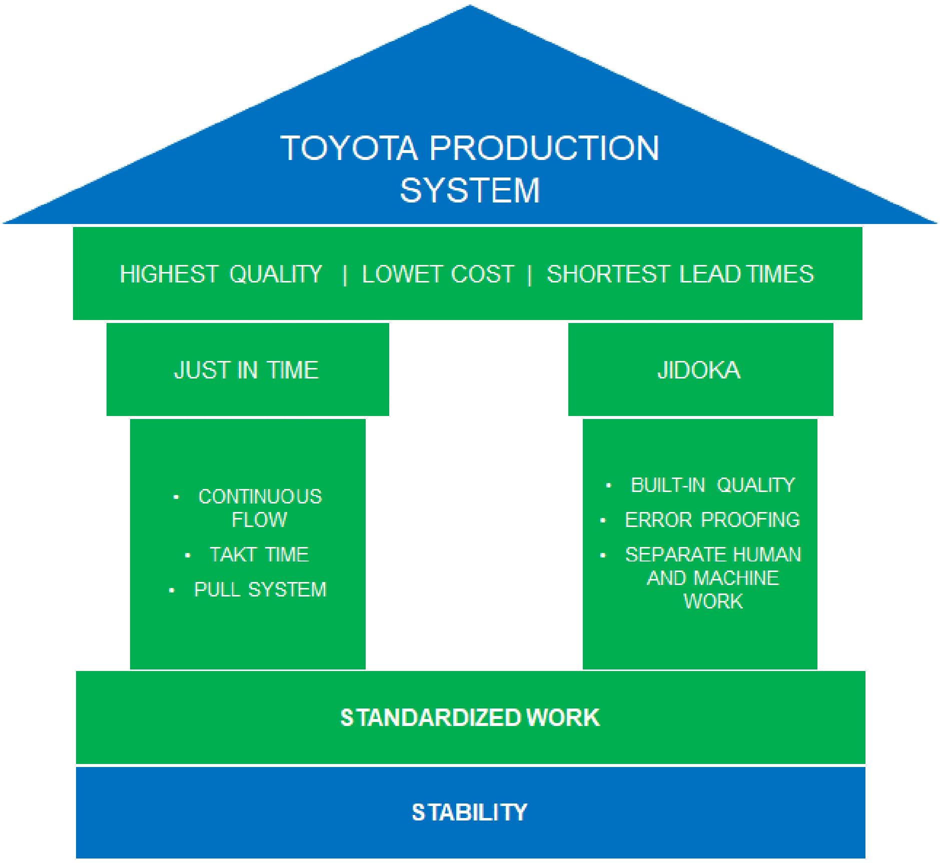

Figure 1: Schemes of Toyota Production System

Source: own processing according to Allerd, 2022

Another successor in process management was James Womack, who coined the exact term "Lean management". Although Womack has not been educated in this field, he was interested in a comparative study of industrial management systems in Germany, Japan, and the USA. His expanded book Lean thinking where recommends:

- **Value** – significant for the efficient operation of our customers' processes.
- **Value chains** – which steps lead to value creation, and which do not.
- **Flow** – Keeping the sequence of work activities constantly in motion is necessary and eliminates any waiting waste.
- **Demand** – avoid ordering more items than customers require.
- **Striving for perfection** – there is no complete perfection that can be finite or insurmountable (Womack and Jones, 2003).

Unlike Toyota, where built Lean step by step, Womack focused on individual parts of a unified system that included its manufacturing processes but consistent expansion throughout the company.

1.3 Lean Production and Lean Principles

For the management is heavily focused on the maximum satisfaction of individual customers, which is in direct contrast to the classical "Taylorism" principles of mass production. Womack and Jones' (1996) defined as elaborated on Lean thinking as an additional theoretical framework and principles associated with Lean production. Womack and Jones (1996) summarize the five main guiding principles of Lean thinking:

- Value;
- Value stream;
- Flow;
- Pull;
- Perfection.

For the management team to effectively select Lean Six Sigma (further LSS) tools and utilize them in any process, they have to have a basic knowledge of Lean manufacturing concepts and use them as a driving force in the Lean operations philosophy. Without this business philosophy, Lean will not randomly select process improvement tools to deliver the expected results that management wants to achieve through its process improvement plan (Charron et al., 2015).

1.3.1 Value

Why is it so challenging to begin in the right place to define value correctly? Somewhat most producers want to keep making what they are already doing, and partly many customers only know how to ask for a variation of what they are already getting (Charron et al., 2015).

They begin in the wrong place and end up in the wrong place. When providers or customers decide to reconsider value, they rely on simple formulas – lower cost, increased product variety through customization, instant delivery – rather than jointly analyzing value and challenging old definitions to determine what is genuinely required (Charron et al., 2015).

1.3.2 Value-Added Activities

Value Added (further VA) activity is essentially any employee's action for which the external client is prepared to pay. These operations are frequently defined as the actions necessary to turn raw resources into a modified and valuable product for the customer. In the service industry, VA actions often refer to any series of events that improve an external customer's experience or help them with tasks they would not complete independently. Imagine that in an external client's position to determine whether an activity is VA or not. If we can convincingly state that an external consumer would be willing to pay for the action we will perform, it is most likely a VA activity (Charron et al., 2015).

1.3.3 No-Value-Added Activities

No Value Added (further NVA) operations do not contribute to achieving external customer criteria. They might be discontinued without harming the product or service function or the company, such as inspecting parts, double-checking report correctness, reworking a unit, rewriting a report, and so on. NVA actions are classified according Charron et al. (2015) into the following two types:

1. Activities that exist because the process was poorly planned or is not performing as intended. It comprises moving, waiting, preparing for an activity, storing, and repeating tasks. These operations would be superfluous to create the process's result, yet they occur due to poor process design. These actions are usually referred to as part of the poor-quality cost.
2. Activities that are not needed by the external customer or the process and activities that might delete without compromising the external customer's output, such as logging documents.

Value can only be defined by the ultimate customer based on Womack and Jones (1996), with the customer encompassing all downstream operations. It can be used in the construction context, where end customers are numerous, and the construction client is rarely the sole ultimate customer (Jorgensen and Emmett, 2008).

1.3.4 Value Stream

Along with the value stream, the value stream analyzes three types of actions: first, activities that create value; second, activities that create no value but are unavoidable with current technologies and production assets; and third, activities that create no value but are determined to be avoidable (Gao and Low, 2014).

The value stream encompasses everything a firm needs to provide perceived value for the consumer. It includes materials, labor, facilities, and suppliers; in a fact, it encompasses everything that goes into developing an effective product or service that consumers are willing to pay for. All VA and NVA waste operations are included in the value stream. Necessary action for the Lean practitioner is to understand all value stream components, including VA and NVA (Charron et al., 2015).

Imagining the value stream is essential for every LSS process improvement approach. A Lean practitioner might attempt to depict the value stream in various ways. For instance, to visualize a facility layout, a Lean practitioner can create a value stream map that outlines all of the process stages, materials, equipment, facilities, personnel, and activities needed to provide value for the customer. It may also contain time or output measurements for such tasks. Determining the value stream is equally crucial in the service industry. As is customary in industrial activities, materials and equipment may or may not be present. A significant portion of the value stream might be information management, documentation management, or activity management. As a result, while attempting to identify VA and NVA activities in the service environment, difficulty is determining what activities must be performed, who must perform those tasks, and what accessories are necessary to give the client the excellent service has been established (Charron et al., 2015).

This shift from a waste reduction focus to a customer value focus, according to Hines et al. (2004), essentially provides an alternative perspective on value creation:

1. Value is created by reducing internal waste, as wasteful activities and associated costs are reduced, increasing the overall value proposition for the customer.
2. Value is also increased if additional features or services that the customer values are provided. This could imply a shorter delivery cycle or smaller delivery batches, which would not incur additional costs while increasing customer value.

In Lean construction Jorgensen and Emmett (2008) pointed out that value is either unaddressed or is primarily discussed during the construction process rather than the finished building (the product).

1.3.5 Value Stream Management

Regarding King (2015), to reduce or eliminate waste, you must first understand where it exists in your process, which is what a value stream map (VSM) is designed to do. Toyota created the material and information flow maps that serve as the foundation for the VSM format to understand waste and its causes. Waste, according to Lean, is defined as anything that consumes resources (materials, people, and equipment) but does not create value for the customer.

Value stream management is a comprehensive method to control all customer value production areas. A visual depiction (value stream map(s)) of the whole value stream is developed by defining all operations necessary from the time the client contacts company to when the customer receives product or service. This visual depiction often covers all of the operations necessary to generate value from the customer's perspective. The Lean practitioner attempts to quantify how those activities are currently carried out throughout the visual representation to design a technique to enhance those activities. Accordingly, how the organization defines its value stream is how to develop partnerships and relationships with vendors, the operational philosophy have within the facility, the methods used to transfer VA products or services to a customer, and how to measure performance. All of these are defined as value stream management. A compelling value stream management program, particularly for large service industry companies and government agencies, or even simple industrial processes, often necessitates the use of visual value stream mapping (further VSM) (Charron et al., 2015).

1.3.6 Continuous Flow

After reducing or eliminating waste and variation in a single process and streamlining the value stream, the next step is to make the remaining steps flow. It is the inverse of batch and queue. This principle's goal is for a product to move from concept to customer without interruption or delay (Gao and Low, 2014). Creating a continuous flow is not always as simple as it may appear. The ultimate goal of generating continuous flow is to connect all VA processes fluidly, providing no delay between phases. It might include automated production, manual assembly, general administrative work, warehousing, or shipping and distribution. The phases might involve order processing, service delivery, client engagement, or other VA tasks in a service industry setting. In manufacturing or service delivery, the continuous flow has been referred to as the "Holy Grail". It is partly because continuous flow refers to how the VA entity flows from genesis through delivery to the consumer. It is widely believed that when an organization maintains continuous flow, it reaches the best degree of product quality, productivity, and, eventually, firm profitability cost (Charron et al., 2015).

Applying flow to all aspects of human activity will not be automatic or straightforward. For starters, most managers struggle to see the flow of value and, as a result, the value of flow. Then, once managers begin to see, many practical issues must be overcome to implement and sustain flow fully (Gao and Low, 2014).

Continuous flow is vital because once it is implemented; it reduces one of the most significant wastes – the waste of waiting. Because up to 95 % of all lead time may be wasted, the value of the flow idea in reducing time to the customer cannot be emphasized. Creating flow removes the waste of waiting and, as a result, lowers product cost (Charron et al., 2015).

1.3.7 Pull System

This principle is closely related to the TPS's original "pull" system. The end users pull the production so that it is only produced to meet their needs (Gao and Low, 2014).

A pull system is designed to respond to client demand immediately. The idea is that the company will not spend any money until a consumer requests one or more VA goods or services. For instance, in a build-to-stock setting, if a firm manufactures items A, B, and C when customers make orders and these products are consumed from completed goods inventory, the manufacturing facility begins to replenish these orders based on this external consumer demand. Similarly, successive process stages inside a firm might be represented as suppliers and customers (Charron et al., 2015).

The system is based on the fact that the process's customer sends a signal to begin production of another product or set of products, replenishing the reduced inventory at the point of consumption. The planning capacity and flexibility of the traction system are determined by the length of the production cycle of a specific product or part thereof, or transportation to the point of the collection must be considered if it is part of the overall sequence (Svozilová, 2011).

In its most basic form, pull means that no one upstream should produce a good or service until the customer requests it, but following this rule in practice is more complicated. The best way to understand the logic and challenges of pull thinking is, to begin with, a real customer expressing a demand for an authentic product and working backward through all of the steps required to bring the desired product to the customer (Gao and Low, 2014).

1.3.8 Pursue perfection

This principle refers, according to Womack and Jones (1996), refers to *"the complete elimination of Muda so that all activities along a value-stream create value"*. Kaizen, a Japanese word translated as continuous improvement in the West, is the Lean concept associated with perfection. Each time the organization applies the previous four principles, it gains more and discovers more hidden wastes that can be eliminated.

1.3.9 Waste

Waste is commonly described as any action for which a consumer is reluctant to pay. It is frequently characterized in terms of value-added (further VA) and no-value-added (further NVA) activities. During the literature, waste is classified into eight types. These categories are overproduction, excess inventory, waiting, flaws, excessive processing, underused personnel, motion, and transportation. Every one of our everyday actions either adds value to our external customers or creates one or more of these wastes in the organization. The major goal of an LSS practitioner is to understand how to identify where these wastes arise, how they occur, and what core causes result in the waste manifesting in business. Once we know what these wastes are and how to detect them, we can completely utilize concrete Lean ideas and methods to eradicate them from processes (Charron et al., 2015).

Waste identification

The capacity to perceive something that others cannot is referred to as waste identification. It is referred to as learning to see in Lean. It is not that Lean practitioners perceive things better or worse than others do; it is just that they see things differently and have a different set of assumptions and preconditions. In an LSS company, waste identification is a continuous process. Once we learn to perceive, our viewpoint on how waste negatively influences our product quality or performance from our customers' perspective changes forever. This waste identification approach, which employs Lean principles and Lean technologies, may be applied in two ways. We can find primary waste using qualitative methods, which implies employing a methodology that does not always include measuring anything. This is the major underlying strength of LSS's Lean component. Identifying waste from a Lean management concept, such as point of use storage (further POUS, see chapter 1.3.10) or source quality, is an example of this qualitative strategy. For example, if we grasp the Lean idea of POUS, we can quickly identify places in our business where the concept may be applied to supplies, equipment, instruments, documentation, or other critical components utilized in the VA process. More vital, we can observe the management attitude that led to lousy material storage in the first place. Second, it may use quantitative data tools to identify waste (Charron et al., 2015).

Waste elimination

The operational ideas about managing these controlling-process inputs determine how much waste there will be in operation, where it will be found, what will be done to reduce this waste, and what instruments will be required to eradicate the waste (Charron et al., 2015).

Waste is defined as anything that consumes resources but adds no value (Womack and Jones 1996). Ohno (1988) identified seven wastes or "muda", namely (1) overproduction, (2) waiting, (3) transportation, (4) over-processing, (5) inventory, (6) movement, and (7) defect products, and emphasized that identifying wastes ultimately is the first step toward applying the Toyota Production System. Liker (2004) added a new waste: (8) a waste of unused employee creativity, which resulted in the loss of time, ideas, skills, improvements, and learning opportunities due to a failure to engage or listen to employees. Employees in any industry can benefit from this (Druker et al., 1996).

At first, eliminating waste seems like a straightforward application of Lean tools in a given situation. However, it is not that easy. Much of the waste that enters organizational processes do not come from a simple mistake in the process itself; however, this is rooted in management's beliefs or operating philosophy regarding managing all process inputs. The truth is that by leveraging employees' creativity, businesses can eliminate the remaining seven wastes and continuously improve their performance. Womack and Jones (1996) asserted that Lean is an effective antidote to Muda (waste). Similarly, Koskela (1992; 2000) proposed that the fundamental principle based on the flow concept of production is eliminating NVA activities from production.

1.3.10 Point of Use Storage

POUS is a term use to describe how to manage the materials and equipment to utilize to provide value to clients. It is a notion that is as described (POUS) implies putting those materials or equipment where value-added personnel will utilize them. We may remove a lot of wastes or NVA operations by using this idea. For example, if we have supplies for a particular stage in a process located in a warehouse several hundred feet away from where they are utilized, we must expend resources to get those goods to the point where they are used. This adds expense to goods or services but offers no value to the client. Furthermore, in this case, a material located a long distance away that it is used introduces the wastes of waiting, motion, transportation, and extra processing into process only to retrieve it and transfer it to the point at where to produce value for our client. POUS is a highly effective waste identification and removal concept. It can be found in some form or another in practically every habitat (Charron et al., 2015).

1.4 Lean Manufacturing Tools and Techniques

Once organizations have identified the critical waste causes, tools like continuous improvement, just-in-time production, production smoothing, and others will assist them through corrective actions to eliminate waste. In the following chapters are a description of these methods is given below (Peash, 2012).

1.4.1 Cellular manufacturing

Cellular manufacturing is a manufacturing technique in which a single line or cell of machines creates families of parts, with machinists working only on that line or cell (Curry and Feldman, 2011). A cell is a small-scale, well-defined production unit within a larger plant. This unit is responsible for the entire production of a family of similar parts or a product. Organizing people and equipment into cells has a significant benefit in achieving Lean goals. One of the benefits of cells is the one-piece flow concept, which states that each product moves through the process one unit at a time without interruption, at a rate determined by the customer's needs. Another advantage of cellular manufacturing is the ability to broaden the product mix. This will also shorten the time required for product changeover, encouraging production in smaller lots. Other advantages of cellular manufacturing include the following:

- More efficient transportation and material handling.

- More efficient use of space.
- Decreased lead time.
- Determination of the causes of defects and machine malfunctions.
- Increased productivity.
- Improved collaboration and communication.
- More adaptability and visibility (Peash, 2012).

1.4.2 Continuous improvement

Lean manufacturing also emphasizes continuous improvement as a basic premise. Continuous improvement is, according to Van Tiem, Moseley and Dessinger (2012) "*an ongoing, systematic process to assure, maintain, and improve processes, products, and services based on predetermined standards and customer satisfaction*". Kaizen, a Japanese phrase that means "constant striving for perfection", has gained popularity in the west as a critical concept in excellent management. Kaizen is a method for achieving steady, methodical, and continual improvement. Improvements in manufacturing environments can take many forms, including inventory reduction and the elimination of defective items. The 5S system, the foundation for a successful Lean firm, is one of the most potent instruments for continuous improvement. 5S is a basic, modular approach to waste reduction. The Japanese terms *Seiri* (Sort), *Seiton* (Organize), *Seiso* (Shine), *Seiketsu* (*Systemize*), and *Shitsuke* make up the 5S acronym (Standardize). The 5S philosophy is based on the concept of looking for waste (Peash, 2012). The 5S method will be described in detail in the following chapter. Kaizen exactly means "continuous improvement". Kaizen is the Japanese word for continuous improvement; it translates as "change for the better" (Peash, 2012).

1.4.3 5S

The five Japanese words that describe the five steps are the "5S". A component of Lean manufacturing is 5S that helps to reduce waste and improve quality and productivity by cleaning up and getting organized. Although 5S is based on common sense principles, implementing a 5S program requires changing employee work habits, which can be difficult. 5S is a fundamental, systematic approach to improving productivity, quality, and safety in all businesses. The 5S program emphasizes visual order, organization, cleanliness, and standardization. A 5S program should increase profitability, efficiency, service, and safety. 5S is a system for reducing waste and increasing productivity by maintaining an orderly workplace and employing visual cues to achieve more consistent operational results (Peash, 2012).

In the 1970s and 1980s, when Americans made pilgrimages to Japanese plants, the first reaction was invariable. The factories were so spotless that they could eat off the floor. This was simply a matter of pride for the Japanese. Their efforts, however, extend beyond making the factory appear clean and orderly. In Japan, there are 5S programs that consist of a series of activities for eliminating wastes that contribute to workplace errors, defects, and injuries (Liker, 2013). The 5S pillars give a system for organizing, cleaning, developing, and sustaining a productive work environment. Routines that preserve structure and orderliness are critical to the smooth and efficient flow of operations in a company's daily work. This Lean strategy motivates employees to improve their working conditions and teaches them to eliminate waste, unexpected downtime, and in-process inventory:

1. **Seiri – Sort**: The initial step in Leaning up and organizing stuff. The first step in making a work environment neat is sorting. It makes it easy to find the items we desire and frees up extra room.
2. **Seiton – Organize**: Organize, identify, and organize everything in a work environment. This includes putting the proper supplies in the right place for easy access and disposal. This results in improved material organization and a more pleasant work environment. Seiton saves time in accessing and disposing of resources for production. As a result, productivity increases
3. **Seiso – Shine**: Regular cleaning and upkeep. Seiso leads to machinery in excellent condition, a friendly and clean workplace: fabric and clothes that are not soiled or spoilt, less working and rework, and a good environment.
4. **Seiketsu – Standardize**: Make it simple to maintain. Simplify and standardize. The fourth phase is to simplify and standardize to ensure that the -Shine, Set In Order, Sort program remains successful. Avoiding previous work patterns is one of the most difficult challenges. Use standards to assist individuals in developing new behaviors as part of 5S program.
5. **Shitsuke – Sustain**: Keeping what has been achieved. Training enables employees to attain better levels of skill and quality: more devotion and motivation, improved work habits, increased worker performance, productivity, and quality (Peash, 2012).

Implementation of 5S

This outline is merely a synopsis. The following chapters will go through implementing each of the five pillars. The pillars are generally implemented in the order listed, with one pillar coming after the other. When a company decides to implement 5S, it is critical to plan ahead of time. These are a few things to think about, for instance, choosing the right project leader, 5S champion, team members, the size of the area to address, timeframe, and ultimate goal.

The first one is a **project leader**, and it is critical that the project leader understands 5S and has significant experience managing and implementing process change. Otherwise, a **5S Champion** is usually the person in charge of the area. They will be in the trenches while also providing leadership and direction to the team.

The following **team members** make sure to include everyone who works directly in the area in the 5S implementation. It is also good to bring in one or two people from outside the department to provide "fresh eyes" on the situation.

In terms of the **size of the area**, some businesses choose to implement 5S throughout the entire plant at once. In general, this is a bad idea. It is far more efficient to select an area of around 1000 square feet to complete all of the necessary work. Choose an area where a series of work processes begins and ends. 5S should aid in the flow of work through this set of processes.

There are two options for the initial 5S event's **timeframe** concerning a timeframe. Option 1 is to close down the area for three to four days and dedicate the entire team to this event. Option 2 is to implement it for a few hours or one day per week until the event is completed. Many businesses prefer this option because it is less disruptive to operations.

As a matter of **ultimate goal**, it is critical to determine the overall objective before proceeding with any process change. Some businesses use the first three pillars, Sort, Set in Order, and Shine, to clean up the workplace (Visco, 2016). Also not forget that people are an essential aspect of the change process. It is critical to "engage" them and present them with appealing options. Then it is necessary to keep people "on fire," support them, and provide them with a certain amount of freedom, thus the possibility of fulfillment and self-fulfillment. Every day, it is necessary to monitor the efforts to demotivate them, the risk of burnout, and cultivate them like flowers in a garden (Bauer, 2015).

1.4.4 PDCA

PDCA is an evidence-based participatory problem-solving approach that is an effective tool for quality improvement. PDCA is used to solve problems and improve things daily by utilizing existing facilities' facilities. The PDCA method is also referred to as the PDSA (Plan-Do-Study-Act) cycle (Hasan et al., 2017).

The PDCA cycle is a continuous quality improvement model that consists of four repetitive stages for continuous improvement and learning: Plan, Do, Check, and Act. The four-step cycle allows for changes in implementation, problem-solving, and continuous improvement of work processes. Because of its cyclical nature, it can be used for continuous improvement. It is a participative approach in which all staff members participate in the process. To monitor progress and generate evidence, continuous data collection is required. This approach is appropriate for countries with limited resources. The PDCA cycle must be rotated continuously to improve things (quality of care) day by day. These small changes compound to make a significant difference in how it works (Hasan et al., 2017).

The individual steps are described below:

- **Plan**: Identifying and gathering information about the organization in the areas where improvement will significantly impact the organization's performance, preparing detailed essential work to improve all aspects of the organization's operations (Policy Deployment).
- **Do**: Assuring that management understands the goal and methodology of TQM and is ready to implement them continuously.
- **Check**: By involving management and supervision in a proper training and communication scheme, identifying quality issues, and resolving them through management-led improvement activities.
- **Act**: Launching a new initiative with new goals and extending the entire improvement process to everyone, highlighting supplier and customer links in the quality chain, obtaining progress information, and consolidating success (Kanji and Asher, 1993).

1.4.5 Just-in-Time

In today's market, particularly in the face of a fiercely competitive environment, businesses are seeking ways to save costs while also producing higher-quality goods (Deuse et al., 2018). A lack of resources delays the growth of such businesses. Consequently, Lean manufacturing toolset result in less work, less space occupied, shorter lead times, fewer faulty goods, and less waste (Gandhi, Thanki and Thakkar, 2017). In this perspective, the ultimate purpose of every industrial system is to create profit. Just in time (further JIT) is no different. It is a market-oriented manufacturing system that attempts to meet the client's needs (Botti, Mora and Regattieri, 2017).

According to Hirano (2009), JIT is an operational concept that attempts to satisfy objectives while providing flawless quality and zero waste. Regarding to Keřkovský (2012), JIT must be seen as an essential strategic plan, which must be based on and consistent with both the overall and especially the company's manufacturing strategy. As a result, in each more competitive environment, and as a minimum condition for existence, manufacturing businesses should develop their capability to manufacture maximum quality goods at the lowest cost and within the specified time frame (Thomopoulos, 2016).

However, this is not a simple process because it necessitates the dedication of all corporate collaborators and their intense attention to their respective duties (Garca-Alcaraz and Maldonado-Macas, 2016). Inventory and material flow systems are often divided into push (conventional) and pull (just-in-time). JIT manufacturing is a tool that allows a company's internal processes to respond to rapid changes in demand patterns by creating the correct product at the right time and in the right quantities (Monden, 1998).

Furthermore, JIT delivery is essential for managing a company's external operations like purchasing and distribution. It comprises three components: JIT production, JIT distribution, and JIT purchasing. More information is provided in the following sections for each.

JIT Manufacturing. The goal of Lean manufacturing is to eliminate waste wherever it exists. JIT is important and an essential stage in the deployment of Lean manufacturing. JIT production, according to Monden (1998) and Levy (1997), is the foundation of Lean manufacturing. Just-in-Time manufacturing entails having no extra raw materials, work in process, or finished goods necessary for smooth operation.

JIT Delivery. JITD is a method of distributing goods that are JIT effectiveness is primarily reliant on strategic collaboration between customers and suppliers. Businesses may focus on their core skills and areas of expertise by utilizing a third-party logistics distributor, leaving logistics to logistics companies (Simchi-Levi et al., 2000; Quinn and Hilmer, 1994). Third-party logistics (further 3PL) refers to utilizing an outside entity to undertake all or part of a company's material management and product distribution tasks (Simchi-Levi et al., 2000). 3PL can help with JITD by offering on-time delivery to consumers or distributors, technology flexibility such as Electronic Data Interchange (EDI), and geographical flexibility (Simchi-Levi et al., 2000; Raia, 1992).

Purchasing JIT. JITP is defined by Ansari and Mondarress (1986) and Gunasekaran (1999) as the purchase of products so that their delivery immediately anticipates their demand, or as they are required for usage. The concept of JITP contradicts typical purchasing procedures in which items are brought in advance of their use. Supplier selection, product development, and manufacturing lot-sizing become crucial under JITP.

1.4.6 Kaizen and Kaikaku

Kaikaku is for innovation, and kaizen is used for constant improvement. Kaizen and Kaikaku are Japanese manufacturing philosophy principles. Both have their roots in the Toyota system. The phrase Kaikaku refers to all changes that bring about innovation and kaizen little modifications or improvements offered regularly. Let begin with kaizen, the most widely used procedure. It derives from the Indian Buddhist School, followed in China, Korea, and Japan, and aims to improve people's lives (Gómez, 2008).

Kaizen

Kaizen is a Japanese term that translates to "improvement." However, it did not come across the term "continuous" until Western corporations embraced its concepts. In Japanese culture, everyone is clear (by tradition) that when discussing improvement, they talk about ongoing changes. Although in the West, there is a tendency of articulating what is required, thus now we all identify the notion of kaizen with "continuous improvement" (Gómez, 2008).

Kaizen is a continuous improvement approach that can be applied to a production line. Kaizen is a Japanese term that combines the words Kai (change) and Zen (good or better). It is based on the impromptu adaptation of existing tools and procedures to achieve the final output.

One of the techniques that many businesses use to increase their competitiveness is implementing continuous improvement, or kaizen, in their organizations (Teece, 2007). The definition of kaizen is "improvement via change" (Coimbra, 2009). Kaizen also refers to continuous development collaboratively by including everyone in a company, such as management and workers, without investing much money (Imai, 1997). It means regarding to (Imai, 1997) that everyone in the organization should search for better methods to do their duties by finding and removing Muda (or non-value-added activities) to simplify work processes (Pinto et al., 2018).

Kaizen is a powerful way to make improvements at all levels of the organization, and today it is practiced by leading corporations around the world. Its primary utility lies in its gradual and orderly application, which implies the joint work of all the people in the company to make changes without making significant capital investments. Kaizen should motivate employees to enhance the workplace and promote self-reliance and self-control. Kaizen's primary goal is to improve three parameters: quality, cost, and delivery time. The kaizen idea emphasizes standardization and the development of processes for sustaining the degree of change. In practice, the definition of standards refers to their ongoing improvement as a result of kaizen operations. However, it is essential to note that using this technology does not exclude the introduction of radical innovations that may be supported and addressed through the use of kaizen. To understand the power of continuous improvement, we must ask ourselves how many improvements each of us brings to the organization he works. For example, if each worker contributed only ten proposals a year, that would be 10,000 improvements in a company of 10,000 employees. Consequently, it will have permanent changes and new opportunities to be more productive. It does not need dramatic changes, but greater than 1 %, but it has it to do them every day (Pinto et al., 2018).

A kaizen event is a series of actions carried out by work teams to improve the outcomes of existing procedures. Process owners and operators may significantly enhance their work through these activities, which will result in productivity (and hence profitability) gains for the organization (Pinto et al., 2018).

According to the authors concluded that two manifestations of the kaizen philosophy emerge among the Japanese people:

- In daily life, where kaizen refers to improvement and ingenuity;
- in industrial settings, kaizen refers to management's commitment to the pursuit of business excellence through the interplay of enterprise-side profit and competition and employee-side skills, creativity, confidence, and pride. In addition to human characteristics, kaizen entails the tools and processes required to function and the ability to produce and implement improvement (Pinto et al., 2018).

Combining these two elements the company/employee side and tools and methods creates an energy that pervades the organization and fosters a common mindset among workers to accomplish proactive change and innovation. More than just continuous improvement, as it is commonly referred to in Western literature, kaizen is the method and consequence of management demands and the management of human and non-human resources in the organization's pursuit of business excellence (Macpherson et al., 2015).

In Burton and Borders (2003), there is a distinction between project kaizen events and process kaizen events. The authors describe project kaizen events as "events that focus on value stream improvement activities, boosting value across many functions within a value stream". These project kaizen events often involve cross-functional teams and project-based continuous improvement efforts. These events are crucial for the business, suppliers, and customers, and they take place across several weeks to complete the kaizen effort. On the other hand, process kaizen events are focused on the reduction of waste in activities with limited definition. The primary focus is on waste reduction, workplace effectiveness, and job uniformity. These kaizen events are established as staff initiatives to achieve quick-hit process changes. These sorts of events are called kaizen blitzes or kaizen super blitzes. Kaizen blitz events are short-term continuous improvement initiatives that the last one to five days and involve a cross-functional multilevel team working tirelessly to design, test, and polish solutions to issues while leaving a new process in place. Kaizen super blitz events should last one to eight hours and are frequently triggered by discovering a fault, failure, or safety problem. During this sort of kaizen event, a cross-functional team works tirelessly to identify the underlying source of the problem and take short-term remedial steps. The three categories of kaizen events are Kaizen Super Blitz (1–8 hours), Kaizen Blitz (1–5days) and Kaizen Project (2–4 weeks) (Pinto et al., 2018).

Kaikaku

The Japanese word Kaikaku can be translated as "systemic innovation." Kaikaku is frequently carried out at the request of firm management, as the modification and the resulting conclusion will have a substantial business impact. It is about implementing a new strategy, a new method, new manufacturing procedures, or new equipment. Its cause can be traced back to external reasons or to the conclusion that the kaizen approach is no longer practical. Different sorts of Kaikaku projects can be classified based on their level of innovation:

- Low innovation: techniques or technology already well-known in the market or the business sector are used, but not in the firm. The price is modest, but the profit is excellent.
- High innovation: new technology or procedure previously unknown in the market is produced within the firm.

The impact of changes affects the entire organization; the Kaikaku method is used to run many projects concurrently. All in all, it is a good idea to be aware that the results will not be apparent right away. This situation is very different from kaizen actions, in which a project is completed, and an immediate improvement is observed. In addition, there must be a set of indicators in place to track the progress of the project and the improvements that have been made. A graphical representation of kaizen and Kaikaku actions allows for recording the strengths and weaknesses of previous projects and how to improve plans (Gómez and Reato, 2019).

1.4.7 Kanban system

Overproduction, which is never enough, is one of the most dangerous types of waste in business. Overproduction is a just-in-case rather than just-in-time risk due to the constant changes in the production plan associated with an increasingly unpredictable market. Kanban (literally "label") is the main method for success in avoiding overproduction while adhering to the takt-time. Kanban specifies the quantity and type of products that must be produced by various processes. Excellent organizations saw the following benefits after implementing Kanban:

- Overproduction has been eliminated;
- the ability to respond quickly to customer demands;
- smaller mixed-lot production;
- simplification of the production information system;
- increased process integration, all the way from the supplier to the customer (Chiarini, 2013).

In the case of two consecutive process areas (e.g., two cells) separated by a WIP (work in progress), the pull system requires that the cell at the beginning of the process only produce when requested by the cell near the end. Kanban is a method for communicating between supplier and customer cells. Kanban is essentially a link between two adjoining processes that move continuously around the different areas, including those of raw and unfinished material suppliers. Kanban is essentially a work order that moves materials and saves production information; the work order is based on Kanban labels that list specific information and are applied to product containers. The pull system works on the same principle as supermarkets: customers buy the products on the shelves, which are then replenished as they empty. Kanban connects processes and cells in order to enable demand-driven production. When Kanban is applied to only a few cells, the waste within the remaining cells becomes immediately apparent. Workshop teams will then be required to work on the areas mentioned above. Kanban is a visual management system that follows strict rules and raises awareness, which should be introduced as part of a basic 5S implementation (Chiarini, 2013).

Kanban types and application methods Kanban has traditionally been divided into two types:

1. Transportation or movement Kanban, which entails moving products to a cell or productive process.

2. Production Kanban, which entails granting permission to produce a specific product (Chiarin, 2013).

Supplier	To
A*** P***	Beta – AS6 cell – Entry 2
Part number and name	
654BF-S6 – Pump body	
Bar-code	
Location	**# Kanban**
AS6-Entry 2	3/6
Container	**Container capacity**
European container 600 x 400	50

Figure 2: Kanban cart of supplier

Source: Chiarini, 2013

Transportation Kanban can be further subdivided into two subcategories:

1. Supplier Kanban, which serves as an order to external suppliers.
2. Internal Kanban, which is used to communicate between internal processes.

The supplier Kanban acts as a purchase order to suppliers, typically for components for a customer establishment (typically assembly lines/cells). Kanban suppliers can take on a variety of shapes and sizes depending on the type of product or process involved. Figure 2 depicts an example of a Kanban label (the company name has been omitted). Internal Kanban connects processes within an organization, providing the data required withdrawing components from the upstream process. This type of Kanban is typically used in upstream and downstream assembly processes. Depending on the product, it can be used in various ways:

- One Kanban for each product.
- One Kanban that serves as a request for a container containing a specific number of products with the same code.
- A Kanban-box or a Kanban-trolley that transports products with different codes to the appropriate assembly line.

The barcode on the label in Figure 2 allows the worker to check whether the product he or she removed from the shelves was in the correct location (by comparing the product's barcode to the barcode on the shelf): a poka-yoke (foolproof) system (Chiarini, 2013).

1.4.8 Single-Minute Exchange of Die

The manufacturing industry is progressively being led by solid and rising rivalry among firms competing on a global scale, compelling them to shift their attention to components related to innovation, competitiveness, intangible assets, and product quality (Vrontis, Tardivo, Bresciani and Viassone, 2016). Enterprise competitiveness is becoming increasingly dependent on cost reduction and control of the engineering of production processes, intending to optimize the activities or stages of the processes that add value to the final product, which the customer appreciates (Cheung, Song and Zhang, 2017; Holtewert and Bauernhansl, 2016). Improving process understanding among small and medium-sized firms (SMEs) can be a critical step toward economic success in the future (Pinto et al., 2018).

Shigeo Shingo invented SMED (Single-Minute Exchange of Die) to allow smaller work batch sizes in early Toyota factories. He was so relentless in rethinking how machines worked that he was able to cut changeover times from hours to less than ten minutes. He accomplished this by reimagining and restructuring the work that needed to be done rather than asking employees to work faster. Every investment in better tools and processes resulted in a corresponding benefit in work batch size reduction (Ries, 2011).

The Single-Minute Exchange of Die (further SMED) technique translates to "tool change in under 10 minutes" (Karasu et al., 2014). This strategy aims to fundamentally minimize series change times by employing a system of progressive reflection that progresses from workstation organization to automation (Boran and Ekinciolu, 2017). The time passed from manufacturing the final valid part of a series to the manufacture of the first correct component of the following series is described as tool changing, which includes not only the time for the change and physical adjustments of the equipment (Carrizo-Moreira, 2014). It is stated that in order for this strategy to achieve its goals, it is required to include the organization's various activities (Braglia and Gallo, 2017). Thus, miraculous solutions should not be expected, nor can it be expected that someone would come up with a creative concept to address problems that are thought to be difficult to solve (Lozano, 2017). In the specific case of applying the

SMED method, financial resources are frequently required to achieve the desired goal. However, it is usually possible to achieve significant improvement only by setting up an operational mode with simple but effective layout modifications or creating a well-defined flow through which operators and materials can circulate (Chiarini, 2013). Regarding to (Karasu et al., 2014) mentioned that the use of this technique allows for shorter reference change times by predicting tool preparation and synchronizing and simplifying activities for all participants (Pinto et al., 2018).

Implementation of SMED

The methods used are separated into two sections. The first relates to the approach that underpins the SMED methodology, separated into five components. The outcomes of the methodology's **implementation** are shown in the second section. The following steps are included in the method analysis:

- Step 1: Material supply and exchange.
- Step 2: Prepare Tools.
- Step 3: Modification of the manufacturing tool.
- Step 4: Product control and acceptance.
- Step 5: Prerational synchronization (Pinto et al., 2018).

The individual steps are described in detail in the text below.

The first step in the implementation process is the supply and exchange of material. Many handlings occur throughout the supply and exchange of raw materials and the raw material travels a great distance before reaching its destination; various mishaps may occur.

During the second step, the tools are prepared. Tool preparation should be handled by specialist personnel who must adhere to standard procedures shared by several individuals or processes. This step can be further divided into two sub-processes. The first one is **Tool standardization**. Implementing standardized processes reduces several needless motions that result in time lost. Standardization is critical; not only does it eliminate many redundant motions, but it also reduces internal and external activities, enhancing operator autonomy. The second one is an **Identifying a particular mode of movement.** Typically, the methods utilized for the reference change are also employed for other processes and are not always accessible when required. As a result, specific mechanisms should be provided whenever feasible, not just for reference change but also for all operations (Pinto et al., 2018).

Further in step third, **modification of the manufacturing tool** is modified by altering the tool or shaping the machine parts. After making changes, the ultimate position is generally attained. To shorten the tools' final modification time, it is required to move from changes to production without utilizing "zero keys." These steps are divided into 2 subparts. The first part is **adjustment analysis**. The adjustment entails acquiring the final location of the tool or other part of the machine through successive approximations – integrated placement. In the second part, the pieces **are placed in pre-defined places in integrated placement**. If a part must be tightened, for example, instead of using a key suited for the operation, a threaded fastening device is inserted in the thread itself, removing the need for a key (Pinto et al., 2018).

In the course of step fourth, **Product inspection and approval Control points, acceptability limits**, and control measures are defined throughout the product development process and are never changed or improved. These issues are also examined when using the SMED technique because:

- The acceptance time is also part of the reference exchange;
- lowering the lot size improves the performance of these activities (Pinto et al., 2018).

In the final step fifth, operational synchronization – the synchronization of actions is critical. If just one person operates reference exchange, unnecessary displacements will be implemented; when two or more persons perform the same activity, these same movements are decreased. However, each operator must be aware of his or her role in the reference change to avoid issues (Pinto et al., 2018).

The production time per unit decreases as the lot size increases. The primary goal of SMED is to separate external and internal activities from the process and convert external operations to internal ones to increase productivity. Yves De Groote Freelance used this technique to cut changeover activity time in the packaging line by 20 %. The extra time can be used for flexible production and other activities that do not require a significant investment. Because of increased demand for product variability, shorter product life cycles, and the need to reduce inventory, SMED, and fast changeover programs are more popular than ever. It has numerous advantages, such as lowering the work in progress attitude, which causes delays in the delivery of goods to customers and increases the machine's return on investment through better utilization (Burji et al., 2018).

The external setup consists of operations performed while the machine is running and before the changeover begins; the internal setup consists of activities performed after the machine has been stopped. This may also result in non-essential activities/operations. SMED can eliminate non-essential tasks, carry out external setup, and simplify internal setup. Mr. Shigeo Shingo invented and used this method in the Japanese auto industry. During implementation, it was discovered that there was a significant problem with the manufacturing of pressed car parts such as doors, boot covers, etc. The machine had to be shut down for 24 hours while the press was changed over to produce another part. SMED enabled the reduction of change over time to a few minutes. Currently, this method is widely used worldwide to reduce setup time and has been used successfully in a variety of industries. Where setup time changes are critical, the method and procedure's validity are validated. Saving time is accomplished with a lower investment. With the help of SMED, improvements are significant, with data indicating a reduction in setup time of 25 % to 85%. This contributes to increased production flexibility, allowing for a more frequent product mix at a lower cost (Burji et al., 2018).

1.5 Lean management implementation

Lean implementation necessitates a paradigm shift. Its goal is to achieve the culture excellence sought after by proponents of emergent change through sustained continuous improvement (e.g., Burnes, 2005; Sashkin and Burke, 1987; Tsoukas and Chia, 2002; Weick and Quinn, 1999). Much of a lean business's benefit or power is attributed to its transformation into this dynamic, learning organization (Hines et al., 2008; Liker, 2004). The currency in such an organizational culture is cash and a true defendable competitive advantage (Spence, 2012). This is how a company progresses toward its goal of perfection (Ohno, 1988; Womack and Jones, 1996).

Figure 3: Nine relevant factors to achieve lean transition

Sources: own processing based on Mostafa et al., 2013

According to Rivera and Frank (2007), a typical lean implementation begins with value stream mapping to define the journey of improvement and then uses 5S to organize the workplace. The 5S method is a common first step in implementing lean. It is simple to see how organizing the workplace can improve efficiency. Following that, specific tools are usually recommended to improve the processes. Standard work, (SMED), total productive maintenance and Jidoka are examples of these (intelligent automation). Pull of inventory with (JIT) systems and heijunka would be a higher level of implementation.

A business that a consultant supports can quickly embark on a lean journey with these readily available tools and an understandable process. Unfortunately, if the underlying principles of lean are ignored, an over-emphasis on tools and quick fixes is unlikely to be successful (Womack, 2007). Hines (2010) highlights the strategic perspective and a culture of sustainability. Failures in implementation create negative experiences, contribute to the perception that the tools were fads, and stymie future attempts at continuous improvement. Bordia et al. (2011) confirms the resistance that results from dissatisfying experiences, as does the high failure rate for change. The use of consultants must also be considered, which also highlights Pearce and Pons (2017). Consultants are frequently used to achieve temporary success by applying specific tools to specific processes, but their overall effectiveness is limited. This failure is defined as a lack of a company's actual understanding and assimilation of what lean is all about, as well as a failure to become a learning organization (Hines et al., 2004; Dahlgaard and Dahlgaard-Park, 2006; Liker, 2004; Gino and Staats, 2015).

According to current research (e.g., Boyle et al., 2011; Hines, 2010; 2008; Liker, 2004; Womack and Jones, 2003), for lean to truly have an impact, there must be an enterprise-wide understanding that is embedded in the company culture, beginning with leadership, in order to build a learning organization. The extent to which lean thinking in an organization reaches this level of understanding, influencing internal and eventually external supplier cultures, indicates how lean benefits will be seen in that organization. Boyle et al. (2011) emphasizes that in order to truly comprehend the scope of lean adoption, it is critical to document the piecemeal application of unique lean techniques (e.g., SMED/setup time reduction, 5S). The presence of the higher-level strategic orientation and philosophy represents lean thinking. Schmidt (2011) states that it is crucial to understand the basics of methods and systems rather than to adopt them.

The next step is to determine which parts can be adopted or modified to fit the situation and, most importantly, what can be improved. There is a problem when lean is misunderstood as a set of tools in and of itself or when the tools are adopted in part in the name of a lean implementation. The actual value of lean is seen when deeper thinking is used to ensure that value is understood and flows with as few wasteful actions as possible when customers pull it from the system (Womack and Jones, 1996; 2003). Furthermore, this way of thinking should pervade the entire organization. Unfortunately, seeing, applying, and maintaining this is not always easy. The process of implementing piecemeal tools and techniques is much easier to grasp. For example, it is easy to see how housecleaning and organizing work accomplished with the 5S system will benefit a business. According to Hines et al. (2008), it is also relatively simple to plan for and carry out such an implementation, and any typical mass production organization would most likely benefit from it.

However, another level of thought is required to define value from the customer's perspective and discover how to flow value to the customer. Establishing and sustaining the internal culture of strategy, leadership, employee behavior, and employee engagement required to embed a culture of continuous lean improvement at all levels is even more challenging. This is confirmed by many (e.g., Boyle et al., 2011; Hines et al., 2008; Liker, 2004; Womack and

Jones, 2003; Womack et al., 1990). To summarize, the relative ease with which the tools can be implemented and understood, as opposed to higher-level strategic and cultural thinking, has influenced the approach to lean implementations. While the typical tool-focused approach provides immediate benefits, long-term sustainability may be more challenging to achieve, resulting in a high failure of lean implementations.

Success factors for lean implementation

A lean concept is a set of principles for eliminating all forms of waste within a company. According to Womack and Jones (2003), the five general principles of lean are as follows:

- Defining the value from the customer's perspective;
- mapping the value stream process to achieve the predefined value;
- creating flow along the value chain;
- establishing a pull system;
- pursuing perfection.

A lean manufacturing system is a collection of tools and techniques for identifying and eliminating waste (Anvari et al., 2010). Lean tools are implementations of lean principles. Each lean implementation initiative's goal is to provide guidelines or discuss the steps required for lean transition.

Some organizations face challenges when implementing lean initiatives (Anvari et al., 2010). These challenges could be related to lean initiatives or a lean initiative-related organizational practice. Lean initiative challenges include the category and elements of each initiative. Organizational challenges include all roadblocks to lean implementation, such as executive, cultural, management, and technical issues (Taleghani, 2010). To successfully overcome these obstacles, some critical factors about the implementation process must be considered (Anvari et al., 2010).

2 Characteristics of the selected company

For the diploma thesis, the author of this thesis chose the company CHOCOLAND a.s. (further Chocoland), which is based in Kolín. The company deals with the production of confectionery, semi-finished products, roasted almonds, hazelnut kernels, coffee, and soybeans, as well as the production of non-chocolate confectionery and dia-confectionery. The author of the thesis sent a CV to the HR department and requested the opportunity to write a thesis in their company. The HR employee immediately granted her request, and she sent the thesis author the contact details of the CEO. Their agreement to work together was swift and easy, with each party expressing their conditions to begin the collaboration. Chocoland will be introduced in detail in the following section, including its history.

2.1 Basic information about CHOCOLAND a.s.

Chocoland a.s. is a manufacturing company founded in 2009 in Kolín. The company has the legal form of a joint-stock company. The company has 1 000 registered shares in certificated form with a nominal value of 10 000 CZK. The share capital amounts to 10 000 000 CZK and is 100% paid up (MS ČR, 2022).

Trading company:	CHOCOLAND a.s.
Date of registration:	October 16, 2009
Residence:	Kolín, Ovčárecká 305, ZIP 28002
Number of employees:	200–500
Identification number:	28972503

The Administrative Board has one new member as of 2 February 2022, the Chairman of the Administrative Board, Mr. Ing. Petr Minařík, representing the company externally independently. There is also a proxy in the company who signs by adding his signature to the company's name and the information indicating the proxy. The proxy does not include the power to alienate or encumber the immovable property. In Chocoland, the proxy is Ing. Mojmír Mocek. The company has a sole shareholder, SENSA FOOD s.r.o. with its registered office in Kolín. The company employs 200–or500 employees in 2022. Considering the company's size concerning the number of employees, it is a large company (MS ČR, 2022).

According to the CZ-NACE, the subject of Chocoland's business are rental and lending of movable property, accommodation services, trade and service intermediation, wholesale and retail trade, research and development in the field of natural and technical sciences or social sciences, waste management (except hazardous waste), advisory and consultancy services, preparation of expert studies and reports, testing, measurement, analysis and inspection, warehousing, packaging of goods, cargo handling and technical activities in transport, freight forwarding and representation in customs procedures, manufacture of food and starch products, manufacture of animal feed, compound feed and feed additives and premixes (MS ČR, 2022).

Chocoland's one of the Czech and Slovak markets' leading producers and distributors of confectionery and food semi-finished products (for instance chocolate creams, chocolates, soybean and coconut bars, candies, and a massive selection of seasonal candy for Christmas, Valentine's Day, and Easter). It builds on a more than a century-old tradition of food production, which is now carried out in a modern plant in Kolín and the entire area of the company's headquarters is shown in Figure 4. In the chapter 3.2 and 3.1 the individual buildings are marked and described (Chocoland, 2022a).

Figure 4: Company headquarters in Kolín

Sources: Chocoland (2022a)

Chocoland distributes sweets to renowned foreign producers in the Czech and Slovak markets, providing its customers with a comprehensive portfolio of sweets. Chocoland collaborates closely with its customers, developing a wide range of products in collaboration with individual retail chains and other customers who require innovations, customized recipes, or exclusive products. As a result, a diverse range of sweets is distributed under customers' private labels worldwide (Chocoland, 2022a).

Chocoland's most important clients are large foreign chains, domestic retail networks, and independent wholesalers. Products are marketed to customers under their brand names, such as Chocoland or Dianella, and under private labels imported by Sorini or The Belgian. Private label customers include multinationals such as Nestlé and the most significant European chains (Chocoland, 2022a).

Indeed, Chocoland has significant international business partners; they not only export products to EU countries (Germany, Italy, England, Portugal, Sweden, and Lithuania), but also to other countries (USA, Canada, Japan, New Zealand, and others). Chocoland is very important in the Slovak market; since 1998, the daughter company Chocoland s.r.o. based in Bratislava, it has represented all of its activities in Slovakia and Hungary (Chocoland, 2022a).

2.2 History of Chocoland

Chocoland is more than a century long history began in 1894, when its predecessor, the Kolín Factory, began producing coffee substitutes – Kolín chicory, popular throughout Austria-Hungary. Kolín chicory products were popular until the 1950s, when the company, like many others in Czechoslovakia, was nationalized and absorbed by the food conglomerate Čokoládovny (Chocoland, 2022b).

Soja Kolín was a company that specialized in the processing of soybeans and the production of food semi-products, particularly for other Čokoládovny plants. Since the 1960s, the Kolín plant has had the largest capacity in Central Europe for processing soybeans preparation for human food products as is shown in Figure 5 below. The Figure 5 shows the huge factory on processing soy (Chocoland, 2022b).

Figure 5: Company in 1960
Sources: Chocoland (2022b)

Following the entry of Nestlé and Danone's foreign partners into Čokoládovny, a major restructuring occurred in the 1990s, and Soja Kolín was sold. ALTIS Kolín became the representative of the 100th tradition and the holder of the long-standing experience with high-quality food production (Chocoland, 2022b).

It later merged with Chocoland Beri from the Beroun District, the leader in the seasonal chocolate market and the only ice chocolate maker in the Czech Republic. Production was concentrated in the Kolín plant, and processes were established to benefit both companies' customers due to the merger. The product line was expanded, production and distribution were improved, and customer service was enhanced. At the turn of the years 2013 and 2014, there was a significant shift: both cooperating companies Altis Kolín and Chocoland Beri merged into one – CHOCOLAND a.s. (Chocoland, 2022b).

The Chocoland brand combines over a century of food tradition with the most recent confectionery trends. It is based on a history that dates back to the nineteenth century, but it also uses modern technology and equipment. The company relies on its employees' craft and skills, a professional relationship with its business partners, and a wealth of experience in the field. Chocoland has a keen understanding of the customer's needs (Chocoland, 2022b).

The latest milestone for Chocoland is the newly created acquisition of the Liberec company Mocca Holding, s.r.o. with Chocoland, which took place on February 2, 2022. Mocca Holding, s.r.o. is a family-owned Czech company based in Liberec. The company invested in production and machinery equipment and started to produce compresses and dragees. This continued a tradition of more than a century of confectionery products in the Liberec region. The products are commonly sold in all retail chains in the Czech Republic but also in Europe, America, the Middle East, and Australia. The company participates in many trade fairs every year, for example, at the ISM in Cologne (Mocca, 2022).

2.3 Organisational structure and staff

The following Figure 6 shows the entire organizational structure that runs across the company. At the head of the whole company is the CEO. Below CEO is the sales department, export department, production and maintenance of the machine, then at this level is the marketing department, purchasing department, quality department, and research and development department. Last but not least, at the end of this line is the finance department. The organizational structure is further broken down into other positions. These departments also have their heads/masters who support and inform the employees about essential changes in the workplace.

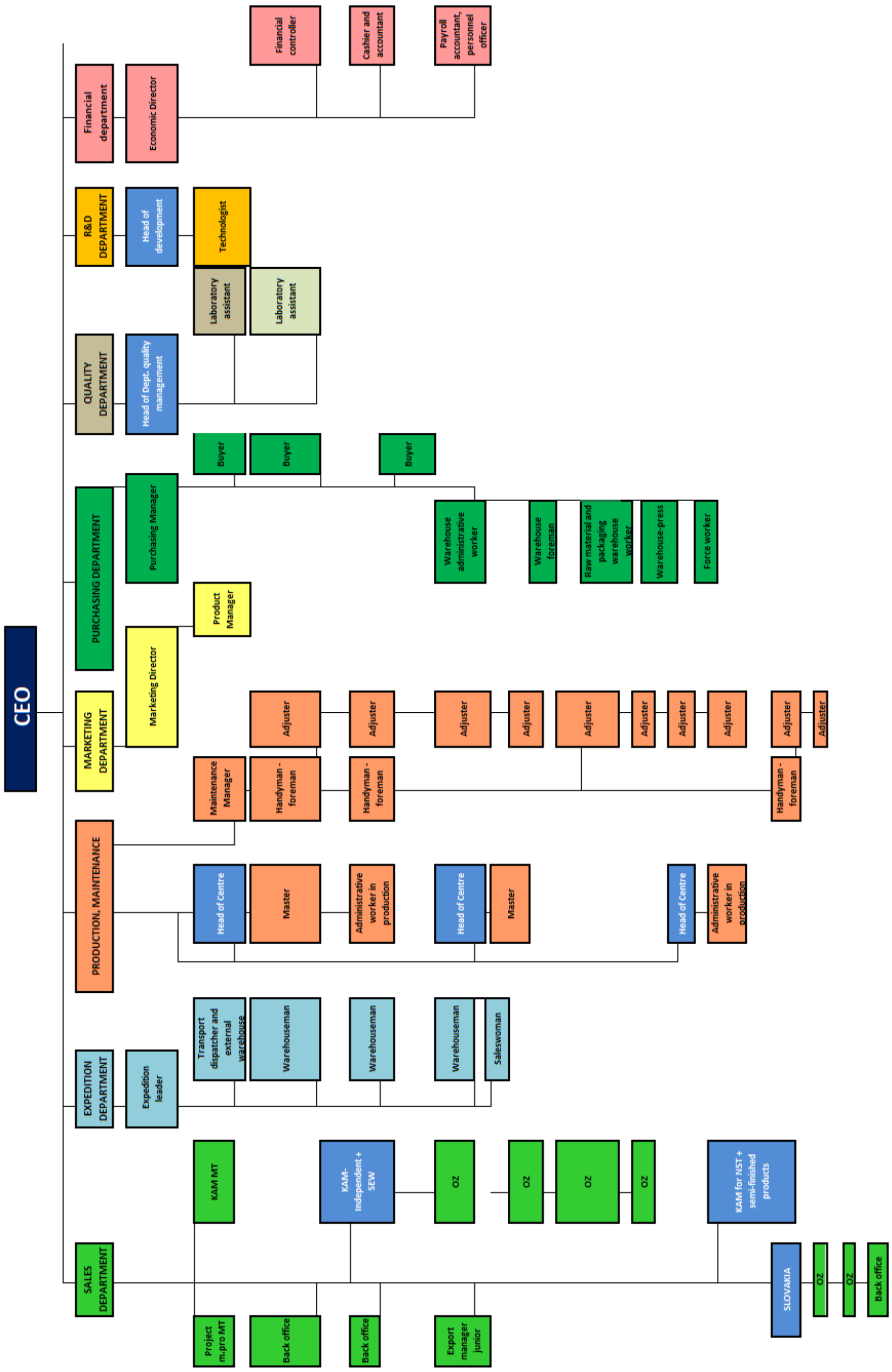

Figure 6: *Organisational structure of Chocoland*

Sources: Chocoland (2022c)

2.4 Product portfolio

Chocoland is a traditional producer of chocolate, soy knots, coconut bars, and other confectionery with more than a century of tradition in the Czech and Slovak markets. The wide assortment also includes a wide range of seasonal sweets – for Christmas, Valentine's Day, and Easter. In addition to its products, the Chocoland company distributes sweets from renowned foreign manufacturers and thus offers its customers a complete portfolio of confectionery in the Czech and Slovak markets. Thanks to the acquisition, the market has expanded to include dragee, chewing gum, jelly, and sugar-free tablets (Chocoland, 2022c).

Figure 7 shows the primary distribution of the year-round assortment. The range of chocolate spreads includes hazelnut, cocoa, and peanut spreads. These products are packaged in glass, in a cup, in a bucket, and in a tub. The sugar-free subcategory will find all types of sugar-free chocolates from the Dianella brand. There are also chocolate bars from Chocoland, which offers chocolate with almonds, hazelnuts, and dark and milk chocolate. The well-known iced treats in a cone are in the range in supermarkets or shops. Chocoland also produces iced treats with chocolate lentils, nuts, or milk filling. The main products in the children's range are Smurfs and Magic Unicorn. For children, bags or boxes are created that contain milk chocolate with a unicorn wrapper and a cuddly Magic Unicorn inside. The biscuit category features the Smilies biscuit, which is filled with various milky creams, caramel, or coconut and is characterized by the ribbons found on the surface of the biscuit. Subsequently, the range is divided into chocolates from Sorini, The Belgian, and lastly, Chocoland makes its own chocolates. Sorini offers a mix of chocolates from its range, sold in different motifs in a tin box. On the other hand, the Belgian offers chocolate seafood in several flavors, Truffles with a nutty flavor, and DIA chocolates of various kinds. The last category is Chocoland's chocolates (Chocoland, 2022c).

The company's goal is to surprise its customers with the best quality sweet treats continuously. Chocoland's latest confectionery is crispy pralines filled with milk cream dipped in milk chocolate, which is specially wrapped in Provance-inspired motifs. It differs from other chocolates in its quality and its completely original design; it is a tin box (Chocoland, 2022c).

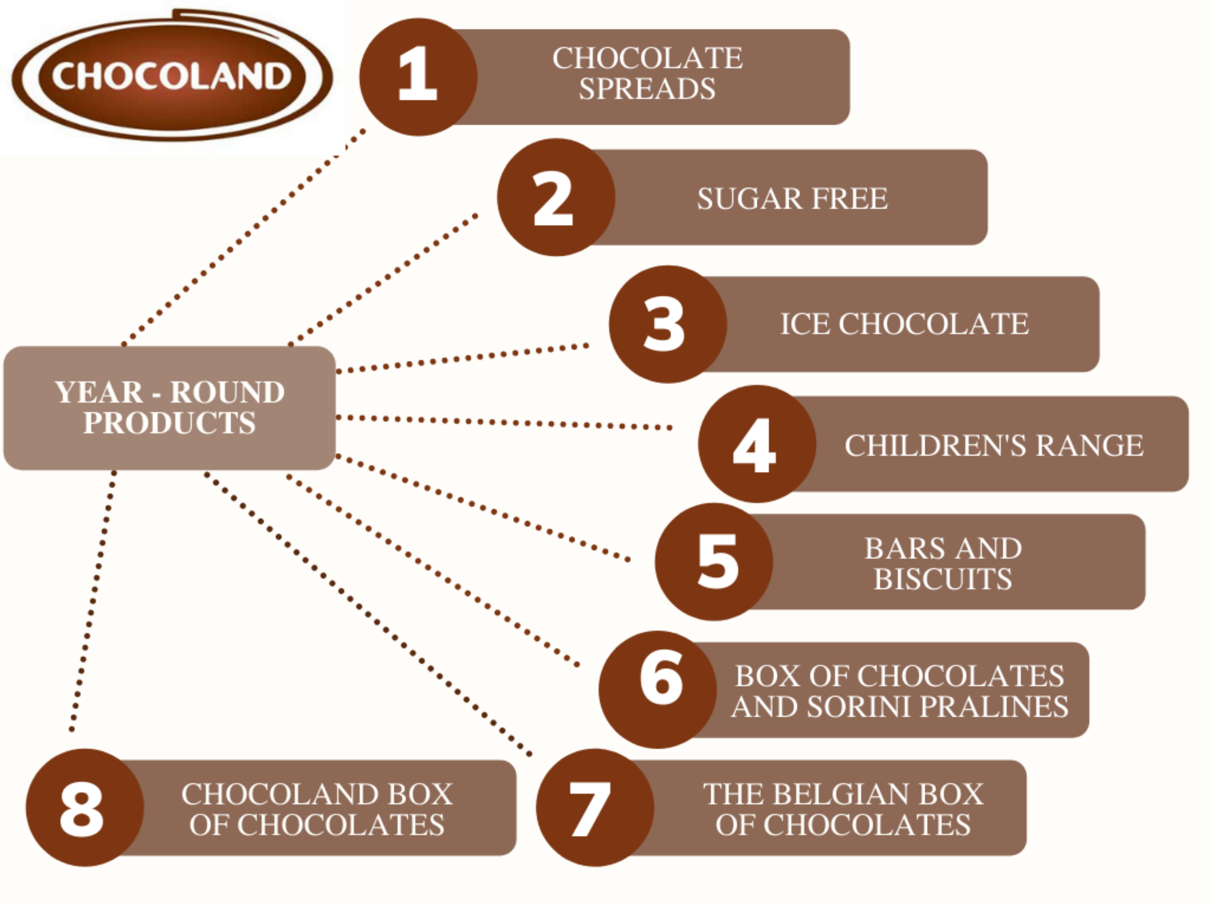

Figure 7: Product portfolio

Sources: Own processing based on internal documents

The company has traditionally participated in one of the largest trade fairs in Europe in 2020 and 2021. European Union funds supported the project. Thanks to this fund, customers could see Chocoland's standard products and upcoming innovations at ISM 2020/21 in Cologne, Germany, and PLMA 2020/21 in Amsterdam (Chocoland, 2022).

2.5 CHOCOLAND's vision, mission, and values

In this chapter based on internal documents of Chocoland, the author of the thesis will describe and outline the company's vision, mission, and values as provided by the company from internal documents.

Chocoland defines the future direction of the company in its **vision** presented below. It has defined it through its products and aims for a satisfied customer.

"All our activities are aimed at making products under the Chocoland brand the preferred choice of consumers in the confectionery segment and also the preferred choice of professionals in the gastronomy, semi-finished food sector."

Chocoland strives to fulfill what it wants to achieve and how it wants to achieve the ideal state. Chocoland's **mission** is more focused on the present.

"Chocoland continues the traditional production of confectionery and food semi-finished products, which dates back to the last century. We combine many years of experience with traditional recipes with quality raw materials and high quality of their processing in order to meet the expectations of our consumers and business partners as much as possible."

Chocoland prides itself on **three core values** that determine the direction of the company, they should be constant, and the company fully identifies with them. The company's individual values are described below.

- **Tradition**: the company draws on a centuries-old history of confectionery manufacturing, which translates into today's trends.
- **Quality**: a key parameter that translates not only into the quality of our products but also into the quality of the company's processes.
- **Responsibility**: the company perceives its responsibility toward a functional corporate culture as well as towards the community in which it operates.

2.6 Strategic goals and plans

Based on internal documents of Chocoland, the highest goal of an organization is to define the company's strategic goals correctly and clearly, which should be focused across the entire company and not just on one area within the company. Following the defined corporate mission and vision, Chocoland also defines strategic objectives. The company has defined the following goals below:

- 2020–2021: Stabilization and development of the company.
- 2020–2022: Reduction of operating costs.
- 2020–2023: Improvement of product quality and packaging.

- 2021–2023: Growth of the Chocoland brand in the domestic and international market.

The first strategic plan concerns the **stabilization and development of the company**. The company is committed to creating a functional incentive system based on KPIs across the company. It also wants to introduce systematic training for new employees and subsequent training and development planning for all other employees. The company's third plan is to create a functional, accurate organizational structure and fill critical positions with competent people across all levels. The final plan in this section is to create an investment plan that will be directed not only to technical development but also to brand development. Furthermore, the investment plan will be woven into the setup of functional processes across the company. Key company processes will be clearly and distinctly described in the form of internal directives, organizational rules, and regulations.

The second strategic plan is to **reduce operating costs**. The company wants to introduce capacity planning in the business, regularly evaluating production data, possible downtime times and reasons for downtime, internal non-conformities, or material losses. It also wants to introduce a smooth material flow on crucial production processes, introduce complete care and maintenance of machines where repair analysis will be done, and preventive maintenance will be carried out. The company is very keen to reduce inefficient production times and improve the organization of production shifts while reducing unnecessary overtime and overhead hours. The company wants to improve work safety and production quality in this area.

In the third strategic plan, which concerns the **area of quality**, the company is committed to complying with the applicable internal product standards during each process. It then sets itself the task of finding packaging with less plastic, implementing regular internal audits or avoiding possible non-conformities and complaints, and introducing defect prevention. In this quality area, the company is preparing to educate and motivate all its employees and set up and follow project management principles.

The last defined area of the strategic plan is the **growth of the CHOCOLAND brand**. First, the company plans to conduct market research to identify the exact target group of consumers within the retail sector. Identify the carrier products and develop more year-round and seasonal editions such as Christmas, Easter, Valentine's Day, and Halloween. The company also undertakes market research to determine the size of the B2B market and its market segments, determine the saleability of semi-finished products by type, and then increase the distribution share of these products. Subsequently, in the context of exports, make a systematic offer of seasonal goods and take advantage of attractive formats of current design trends in export markets.

Conversely, within imports, **maintain loyal suppliers** or find new ones that meet the criteria of affordability and attractiveness to end customers. The company must also undertake a more in-depth analysis of the product portfolio of its products to determine the actual volume of sales and their profitability. Then remove products that sell below the minimum production batches that are not worth importing as import items.

Furthermore, in the area of **strengthening its own brand** in the market, the company has set to diversify its sales prices, which must not only reflect the reality of the market but must primarily adhere to the planned gross margin value in order to ensure the free economic operation and development of the company. As a revolutionary element, the company plans to provide a functional digital communication platform, for example, through social networks, by using Facebook push ads. The company wants to continue strengthening its internal and external E-commerce position.

In 2020, significant personnel changes were made to essential, critical technical, and business personnel (THP) positions **to increase the efficiency of the company's management**. Despite the negative influences, Chocoland has continuously improved work efficiency and maintained a good business policy in procuring raw materials and packaging. As for the company's vision for the future years, the company is mainly focused on the upcoming investments in machinery to increase automation and reduce dependence on labor, which is in short supply in the market.

In 2020, the company used the Helios Orange information system and currently uses a partial implementation of the management system. This system has moved the company to quality data availability, detailed analysis, better knowledge of customer needs, and optimized the entire company's management.

From the area of company-defined strategic plans, the author of this thesis has assessed that the company is in dire need of assistance in the area of lean management. Accordingly, the thesis decided to focus on the second strategic objective, i.e., **the area of reducing operating costs.** The first suggestion related to the area of Lean management is to implement the 5S method in production, in which the department is organized to be safe and ensure the easy flow of quality production. Subsequently, the author of the thesis further evaluated that she wants to help the company reduce inefficient production times by using the SMED method.

3 Analysis of the current state

Chocoland does not currently use any modern methods to streamline production management or maintain an organized, efficient, and clean department. Unfortunately, permanent employees take the established work environment for granted. They do not think about the possibility of improvement or a better-organized workplace, which creates a problem for new employees who are adapting rapidly to the old work environment. The company's current state does not reflect today's modern trends, even for the company itself, as not using modern methods prevents the company from achieving a more efficient and much better market position.

3.1 Description of the Chocoland area

The Chocoland area is located on the outskirts of the town of Kolín, near the train station and the main road that runs through Kolín towards the D11 motorway. The main road is an excellent strategic advantage for Chocoland in terms of logistics.

As part of the work at Chocoland, the author was moving only to the three buildings shown in Figure 8. In the building, which is marked in green, has a gatehouse and a hostel for employees. The company's management is located in the yellow-marked building. The author

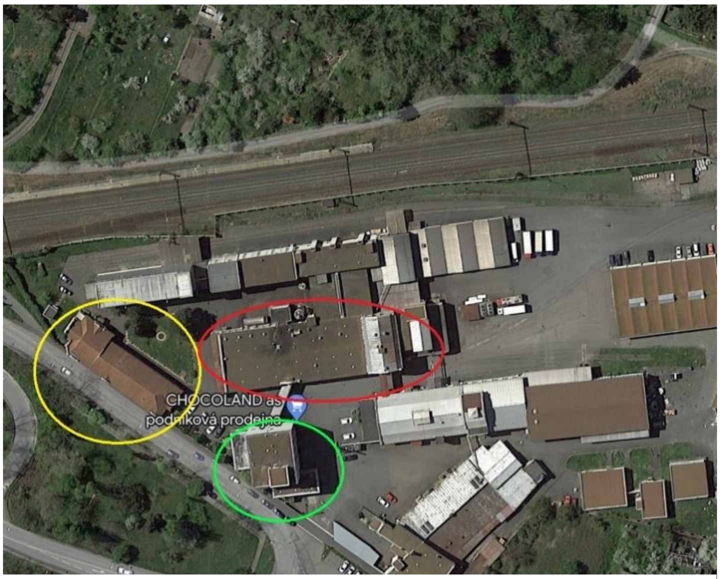

Figure 8: Description of the Chocoland site

Sources: Screenshot from (Google Maps, 2022) of the work had a small background in this building. There is a production building in the building marked in red. The production building is described in detail below in chapter 3.2.

3.2 Production building

As Chocoland is in the food industry, strict hygiene conditions must be observed. The first hygiene check is carried out immediately upon entering the building. Employees are adequately dressed when entering the production department. Each worker must wear a white shirt, white trousers, and safety shoes. On the other hand, the maintenance workers wear black shirt and black and red work trousers with "overalls." In the case of a visitor, the visitor should get a white coat and disposable hair net. The visitor covers his civilian clothes with the white coat, puts the net on his head, in which he hides all his hair, and is then obliged to clean the soles of his shoes on a cleaning machine. The hygiene corner and protective equipment are shown in Figure 9.

Figure 9: Hygiene corner in Chocoland

Sources: Own photo

If the employee is an internal employee, he/she is also required to put on a white coat and hairnet and clean his/her shoes when entering the production process. If an internal employee leaves the production area, he/she is required to wear a blue coat. Before fully entering the production area, it is necessary to visit the hygiene corner. Whether a permanent employee or a visitor, it is always mandatory to visit this corner. In the hygiene corner, everyone will find all the necessary protective equipment that must be used in production, and everyone is also obliged to use disinfectant after the washing process.

3.3 Description of the department

The optimization subject is the soybean department, which is located in the production building. There are a total of 4 departments in the building. On the ground floor, there is the production of chocolate bars; on the first floor, there is the storage of raw materials and the production of nougat spread; on the second floor, there is the production of traditional soybean bars. The opposite department produces soya-filled bars with coconut-rum flavor, cocoa filling, caramel, vanilla flavor, and eggnog filling.

Figure 10 shows the layout of the workplace. In this compartment, the nougat spread (No. 1) is mixed in the left part near the main entrance, and the soybean dough is mixed in the right part of the department (No. 17) near the main entrance. This dough is then put into metal trolleys and taken to the open space by the windows, where the dough's temperature must fall below a specific temperature. The department still has the old machine (shown in blue in Figure 10), which new machines have recently replaced.

From the first observation, the author of the thesis assessed many deficiencies in the workplace. Many objects are located in hard-to-reach places that were left after the old machine was shut down. For example, there are three hangers behind the shut-down old machine used to store work tools. These tools are not used during the production process. Subsequently, if a worker needs to check the grammage of a given soya bean during production, he has to go around the whole machine. This task takes about 20 seconds. There are also cupboards used to store work tools, documents, and spare items in the workplace. These cupboards are not clearly arranged. For example, there are old technical components from a new machine in one of the cabinets. These unnecessary items must be eliminated and removed. From these problems, the author evaluated that it would be most advantageous to start by applying the 5S method, which is described in detail in Chapter 4.

During the workflow observation, the author found one tiny improvement in placement. From a workplace safety perspective, a portion of a dangerous bolt protrudes from one machine and is located in the aisle. The problem arises in the passage aisle, to which the bolt mentioned above protrudes from one side, and a metal cabinet is built on the other side. The danger arises in the small space for the passageway, which creates a risk of injury for the employees.

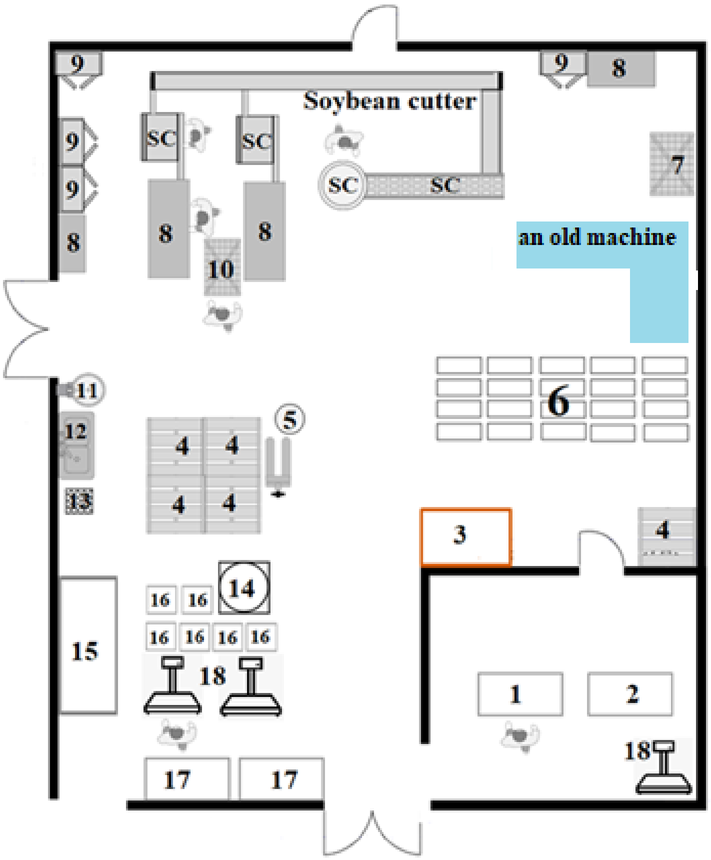

Figure 10: *Layout of department*

Sources: Own processing based on internal documents

Legend to figure 10 Layout of department

1	Peanut hopper	10	Pallet for boxes with goods
2	Bulk raw material hopper	11	Water dispenser
3	Container for used boxes	12	Washbasin
4	Plastic crates	13	Basket
5	Stone pillar	14	Hopper for soybean
6	Soybean carts	15	Raw material shelves
7	Wooden palette	16	Raw material barrels
8	Table	17	Mixers
9	Cabinet	18	Scales

4 Own proposal for the 5S method

This chapter focuses on the application of the 5S method and its implementation in Chocoland. No team or designated staff was assembled to implement the 5S method into the company. The CEO entrusted this task only to the author of this thesis. The author of the thesis must point out that she implemented the whole process of implementing the 5S method all by herself and had a consultant as the CEO. The management set a target to achieve 1S and 2S by 04/2022.

4.1 Application of the 5S method in Chocoland a.s.

The company's management is well aware of the seriousness of this issue. The author of the thesis was informed that her thesis would be a "revolution" in the company, as the company does not and has never used lean tools. For this reason, the author of the thesis starts with the 5S method, which will bring a clean and organized work environment to the company, increasing safety, productivity, and the quality of the work done.

Through the analysis conducted, it was found that employees in the case of the analyzed department very often look for work tools during working hours. Workers do not mind at all that there are unnecessary things in the workplace that they do not need for their work, nor do they address the situation when they do not find work aids at their places.

Based on the seriousness mentioned above, the company decided to set strategic plans. In the area of reducing operating costs, they talk about implementing 5S analysis, which is one of the first necessary tools of lean manufacturing, and with which a standardized working environment can be easily created.

To implement the 5S method, the author had a choice of two departments. The first department produces nougat spread, but upon closer observation of the workflow, the author assessed that this department was not a suitable candidate for implementing the 5S method. The thesis author immediately noticed more apparent and severe problems upon entering the second production department. The second department produces soybean bars (see department chapter 3.3), and from the interview with the foreman, the thesis author assessed that this department was in dire need of streamlining.

Then the author of this thesis discussed this situation with her consultant. Together, they evaluated this department in such a way that this department urgently needs to implement the 5S method and the SMED analysis to be implemented for the cleaning of the main machine.

The author was particularly interested in the soybean bars department:

- the organization in place and followed in the work process and workplace,
- whether the work area is tidy and clean,
- whether regular maintenance of the machines is carried out,
- whether the machines are cleaned regularly,
- all pathways are clear,
- whether there are unnecessary items or damaged items in the workplace,
- that employees have all necessary work equipment within reach of the work process,
- that the most used tools are near the employee, and not used tools are tidy in cupboards and outside the department.

The company's objectives for implementing the 5S method are:

- financial savings;
- efficient use of working time;
- improving health and safety at work;
- creating a cleaner working environment for employees.

4.2 Introducing employees to the 5S method

Before starting any work, all employees needed to be acquainted with the situation. This procedure was chosen so that employees would not be concerned about the situation of an author moving around the workplace during working hours. Also, employees were made aware that the author may question employees during her work shift.

Prior to implementing the 5S method, the author was introduced to the employees in the workplace. Three female employees work as packers, and one employee operates the machine (SC in the layout). The female employees rotate every 10 minutes during production at the workplace.

The process of processing soybean bars to final packaging is as follows. The cooked dough, which cools in metal trolleys, must first fall below a specific temperature. The machine operator, or operator, takes care of and checks the mainline throughout the shift. His job is to synchronize the cubes of soybean dough into the hopper so that the packers always have something to pack. He also checks the grammage of the soybean bars and adds flour to the flour hopper.

Employee number 1 straightens the soybean bars in a row on a rubber belt. Employee number 2 then takes over the packed soya bean bars and straightens them into pre-prepared boxes according to a predetermined number. Employee number 3 then assists employee number 2, straightens the boxes on the pre-prepared pallet, puts the cartons together, and prepares them for the packing table for employee number 2.

4.3 Current status of department of soybean bars before the introduction of the 5S method

In order to map and evaluate the current state of the soybean bars production department, the author was part of the production process. The first observation of the work process took place on the morning shift on March 29, 2022. The shift starts at 6:00 a.m. and ends at 2:00 p.m. There is a mandatory 30-minute break during the morning shift, which is set for 10:00 a.m. to 10:30 a.m. Employees use this break to rest or eat lunch. During this break, a cleaner comes to the ward to mop the floor with a wet rag, take out the rubbish bins and clean the toilets. After the rest or lunch break, the production process is resumed.

Due to the training of one of the female employees on the packaging machine, five employees were present on-site on this day. One employee operated the machine, and four female employees took turns at the wrapping machine. A laboratory assistant visited the department twice during the day to check the grammage of the soybean bars and check the metal detector. The metal detector is used to find any broken metal parts of the machine. The lab assistant inserts an object into the dough that is ready for metal detection, and the machine detects the foreign object and blows the soybean bars off the production belt.

During the analysis of the current situation, the author of the diploma thesis found the advantages of the soybean department. These benefits are described below.

Advantages:

All electrical outlets and devices have a warning label or are marked with safety tape. The company also has employees' drinking habits in mind, so employees have a vending machine where they can choose between chilled soft sparkling water and chilled sparkling water. Drinking bottle holders are located under the packing tables in the workplace. This is a very beneficial improvement whereby employees have drinking bottles immediately to hand in case of emergency. In addition, all entrances are marked with safety tape due to the increased risk of injury. Escape exits are marked on the ward. During one of the shifts, the author was pleasantly surprised by the coordination of the staff in packing the soya beans. The workers always rotate among themselves after about 20 minutes. The agreement is that one of the employees always stretches and rests when folding the boxes. Last but not least, the washbasin shows how to wash the hands properly.

Table 1 below lists the thirteen questions that guided the author in mapping the current situation. Their primary objective is to identify the main problems or deficiencies in the department. The author must point out that the questions below are not the subject of the survey; they are only meant to serve as supporting material in assessing the department's current state. Consequently, the author of the thesis has established the below evaluation scale:

- YES;
- PARTLY;
- NO.

Table 1 below represents the different views of one of the employees and the authors' views on the whole department.

Table 1: Questions by the author's work for evaluation of current status

QUESTIONS BY THE AUTHOR 'S WORK	Employee	OWN EVALUATION
Are work aids and tools in place?	NO	NO
Are work aids and tools in place after use?	NO	NO

Is the work area tidy and clean?	YES	PARTLY
Is regular machine maintenance performed?	YES	YES
Is regular workplace cleaning observed?	YES	YES
Are all roads passable?	YES	PARTLY
Are there unnecessary aids or tools in the department?	PARTLY	YES
Is the workplace handed over tidy?	YES	PARTLY
Are the most used items within reach of the employee?	PARTLY	NO
Are there enough work aids and tools in the workplace?	PARTLY	PARTLY
Are the defined zones on the desktop observed?	NO	NO
Is visualization in place at the workplace (signs for tidy work aids, areas)?	YES	YES
Is the workplace safe?	YES	PARTLY

Sources: own processing

Based on the thirteen questions above, which were carried out at the soybean bars production site, it was found that regular cleaning is carried out. The workers are always given 2 hours for cleaning. Cleaning consists of cleaning machines, sweeping the floor, mopping with a wet rag, and organizing documentation. No cleaning is carried out in the cupboards located in the work area. Employees place everything in the cabinets. There are work tools, empty PET bottles, rubber gloves, empty plastic bags, unorganized office supplies, or a layer of flour at the bottom of the cupboard.

It also depends on which shift is doing the cleaning. Some staff underestimate the cleaning of the department and do not carry it out consistently. There is a departmental standard in the workplace in hanging boards, according to which employees should clean the production department. Employees always do cleaning after the end of a given shift. Around 2:00 pm each day, a cleaner comes in to mop the floors, empty all the bins, and clean the toilets. She then moves on to another department to clean.

In addition, internal questions indicate that the precise placement of items so that each item has its own place is only partially in place in the soybean bars workplace. There are signs in some places in the workplace describing the location of work equipment. In Figure 11, the previous descriptions for the placement of work aids can be seen.

Figure 11: Description of the location of working aids

Sources: Own photo

As these are places that are not easily accessible, employees ignore them entirely and leave their work equipment lying loose on pallets, cabinets, or the floor, see Figure 12. Therefore, during production, employees often search for these items and in most cases find them only at the end of the shift.

Figure 12: Unreturned working aids

Sources: Own photo

There are also places in the workplace where workers are already used to returning tools to their original location. For instance, the magnet is attached to the center of the columns, and the knives are attached to the magnet. These concrete columns are located in an excellent strategic location in the middle of the production. So, the employees have learned to return the knives to the magnet without losing any time. An essential and best practice would be for the employees to agree among themselves and then determine the most efficient place to put the items. Concerning this, it should be mentioned that if the operator wants to measure the weight of the finished product, the digital scale is located very far from the primary department. The operator always has to go around the entire production machine, weigh it, and return the same way. This trivial task alone takes about 20 seconds.

An analysis of the soybean bars department revealed a massive waste of raw materials. Much dough falls outside the machine during production, creating an unclean, dangerous environment that is cleaned up after the shift is over. The author of the thesis noticed that when a worker drives a cart with dough to the hopper, the worker always stops very far from the filling hopper. The machine operator who processes the dough and puts it into the trolley often misses; the dough falls to the ground and is immediately thrown into the garbage bag. In addition, it would be advisable to clean some of the working aids regularly after each shift, for example, in a double-shift operation.

The author of the thesis also found that the passageways in the soybean department are accessible. Even with more orders required, the routes are accessible as the raw materials are moved on trolleys. These carts are placed in a free, large area where the dough waits for the correct production temperature on a large order. While observing the work process one day, the author noticed that there were many large, unfolded bags of flour, and they were interfering with the main path.

From pre-prepared questions, it was found that unnecessary objects appear in the workplace. Workers claim that these items are used, especially during the summer days. There are four fans, where two are hidden under a blue bag in the corner of the compartment, and two fans are located in the packaging machine. Figure 13 shows an example of unnecessary fans.

Figure 13: Unnecessary fans in winter

Sources: Own photo

Then, during the production process, the author of the thesis found that the employees did not have their work tools at hand. The most used tool is the spatula, which is found in several different places during the production process. In Figure 14, it can be seen that the spatula is hidden behind a sack and is located away from the employee. Occasionally, an item is borrowed by another worker and then not returned. If an employee borrows an item from another employee, they should be 100% responsible for returning it. Work aids used to clean the department are usually out of place, or many are missing.

Subsequently, it has been observed that there are redundant items, empty PET bottles, uncleaned handling boxes, and many others in the production department. The workers in the department already come in white clothes, with a water bottle ready and a small plastic bag containing only the essentials. Other personal belongings are kept in staff lockers in the changing room.

Table 1 shows that the department is handed over tidy between shifts. However, this may not always be true. The main department in which the employees are present is always properly tidy, but when the shift is handed over, the workplace is not organized; for example, things are not tidy in their places.

Figure 14: Working aid – spatula

Sources: Own photo

Generally, if a piece of equipment is lost or even missing from the workplace, it is immediately purchased or replenished from another department where it is currently unnecessary.

The author of the thesis noticed that only a tiny part of the visualization system is in place in the workplace. The labels of the work aids are already posted along with the labels of the raw material store, distributed production, or mixing of nougat spread.

By the author's discretion and observation, the author of this thesis noticed that there were three hangers behind one of the machines not in use. These hangers were not used during the work process and are completely useless and unhelpful in the workplace. In the case of these unused hangers, the author suggests moving them closer to where the employees are. In Figure 15, empty hooks can be seen where work aids are missing. These tools are currently uncleared.

Figure 15: Unused hangers

Sources: Own photo

Furthermore, the author of the thesis noticed a large number of essential documents lying fallow under the packing table, as shown in Figure 16.

Related to this problem is that employees have a just tiny stool on which to place their items such as glasses or arm braces. Employees lack a locker in which to store these things.

Figure 16: Documents under the packing table

Sources: Own photo

4.4 Assessment of the current situation before the implementation of the 5S method

From the research carried out, it is possible to see what problems occur in the workplace. According to the interview with one of the employees, it is also possible to observe the different views of the author of this thesis and the interviewed employee on the department's current state.

The author believes that each employee has a different idea about cleaning, and this is how the quality of the cleaning differs from the correctly cleaning done. In order to make cleaning more effective, it is necessary to unify the employees so that cleaning in the workplace is performed by each employee diligently, and there is no situation where one employee performs cleaning correctly, and the other one does not. Then there is a situation where a worker who regularly cleans the department after a worker who does not clean up then tends not to do the cleaning because the worker who does not clean it bears no responsibility for it, and the situation goes through it.

Following the cleaning, the location of work equipment should be significantly reassessed. During the observation period, the thesis author heard countless times that employees were constantly looking for something during working hours. This implies that the word "search" should be eliminated during the shift.

The author and management believe that when the 5S method is implemented, the mindset of the employees should change. Furthermore, employees need to realize that there could be rewards for a job well done. From this research, the author evaluated that the company culture, which was significantly damaged by the previous management, should also improve.

4.5 Introduction of the 5S method to the soybean bars production department

The 5S method was implemented at only one site. If the method were implemented company-wide, essential details could be overlooked, it would be time-consuming, and the implementation might not be done correctly. The following are the steps used when implementing the 5S method.

Procedure for implementing the 5S method:

1. Separation of items in the department, decision to remove, place or move them.
2. Cleaning and tidying the department.
3. Making a department standard.
4. Compliance with the department standard.
5. Random inspection of the department.
6. Introduction of a workshop when the 5S method is not followed.
7. Motivation of employees.

The individual steps are detailed in the following subsections.

4.6 Procedure for the introduction of the 5S method for the department of soybean bars

There are six machines in the department, and these machines are connected to each other as a production line. The description of the entire department has already been described in chapter 3.3 above.

On Friday, 15/04/2022, a workshop was held with the employees of soybean bar production. The author of the thesis was given this task; first, the author had to prepare a meeting to introduce all employees affected by the future change to the basic principles of 5S. Afterward, it was urgent to convince them of this method's usefulness and thus get the employees to cooperate positively. If necessary, the employees must also be involved in the process.

The workshop took place in the afternoon when all employees from the morning shift were invited to the CEO's office. Here the author had prepared a PowerPoint presentation for the employees. The author of the thesis first asked them if they had ever encountered the 5S method or if they knew how it worked. No one answered the author's questions, so the author of the thesis first played a short funny video to lighten the situation. In the video, there was a situation where an employee was told that the 5S method was going to be implemented. However, the employee had no idea how the method worked. This video was meant to show the employees that they were not just sitting in training to listen to the author’s presentation, they have to be a part of this process. The video was mainly meant to show that this method was meant to make the department more efficient and pleasant so that the employees would be happy with, for example, the new placement of work equipment.

Afterward, the general characteristics of the 5S method, how the method works, and the benefits for the company and especially employees were explained to the employees. After that, the employees were taken through the soybean bars department. In the department, the employees pointed out places where they thought it would be good to implement the 5S method. In the future, it was agreed that for the employees to remember the principle of the method and follow it correctly, a re-training session will be held once a month for two months.

The author of this thesis has agreed with the director that the workplace inspection will be carried out once a week, and an internal 5S audit will be introduced.

4.6.1 Implementation of separation

In this implementation, objects that are in the workplace must be sorted. Items not needed in the workplace should be removed and moved to another department only if the department will use them. If another department does not use the items either, they should be removed from the company entirely.

On the other hand, items that remain in the workplace should be located so that the most frequently used items are kept close at hand. In addition, tools or items that employees use once a week should be put away in a closet. Tools or items used once a month should be close to where they are used, and items or tools used seasonally should be placed in a nearby storage area.

Before implementing the 5S method, the cupboard, metal table, and pallet were cluttered. Therefore, a sorting of items was done at the workplace. Since the author was not and will not be part of this department in the future, the author evaluated that she would not make her own decisions about which items employees would and would not need. Therefore, the author chose a more efficient route whereby the author would take one of the staff members and carry out the first phase together.

The author of the thesis chose an experienced employee who has been with the company since she was 16 years old. Together they removed all unused items, removed redundant work aids and items, and left only used and necessary work aids and items in the workplace. Many of the work aids were damaged, and these were discarded. Furthermore, during the sorting process, many new work aids were found that the employees had no idea were in the department see Figure 17.

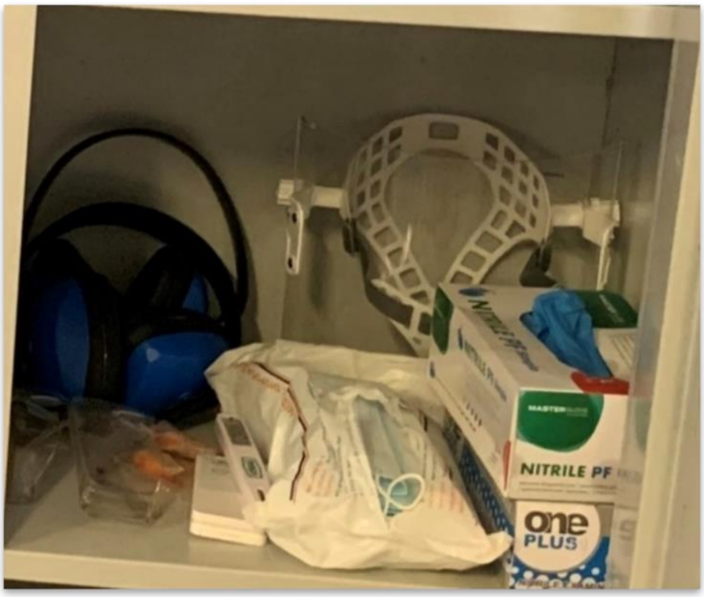

Figure 17: Newly discovered work equipment (shield, earplugs, safety glasses etc.)
Sources: Own photo

The next goal was to find a place for sorted work aids, items, or spare items so that employees would be aware of these tools.

For this part of the 5S method, a precise plan was created describing what the location of all dismantled technical components should look like on a plastic pallet. This plan is illustrated below, and the location labels are not in English due to the staff's lack of English language skills. This plan is proposed in Figure 19.

The three hangers that were located behind the parked machine have been moved closer to a more utilized location. These three hangers were newly hung next to the cabinet located next to the packaging machine.

Figure 18: Newly position of hangers for working aids

Sources: Own photo

Employees can store brooms and shovels used for cleaning the floor or machines or pallets during the cleaning process. The new hanging can be seen in Figure 18 above.

Figure 19: Placement of technical components on the pallet

Sources: Own photo

The author created this plan to avoid the employees' uncertainty after dismantling, to see precisely where part of the dismantled machine belongs. Another reason for creating this plan was that an employee forgot to put some technical components on the pallet during one measurement, thus creating a waste of time. This error had to be eliminated immediately.

4.6.2 Implementation of systematisation

At this stage, employees should determine where the work aids are placed. In this implementation, the staff must work together and know very well which is the best place for the aids. They should give their opinion on how they would like the department to be arranged. They are the ones who are in the workplace every day and know best what will suit them best. If a design is created without staff input, there could be disinterest from staff, and they may not adhere to the departmental layout.

After removing unnecessary items, only used and needed items were left in the workplace. The main objective was to find a suitable and strategic location for each work tool or item.

Figure 20: Before implementation

Sources: Own photo

Figure 21: After the implementation

Sources: Own photo

As previously mentioned, in Figure 20, these three hangers are located behind an old unused machine. One hanger was removed. From the picture, we can also tell that the employees do not return their work equipment to the site and do not use these hangers. They are located very far away from the production line. Therefore, the graduate student and the employee mentioned above concluded that it would be better to place these aids closer to the production line.

Figure 21 shows the new location for the work aids proposed by the graduate. The thesis author has placed the tools so that they are immediately next to the production line. Will be also add a new sweeping kit for back relief. The column is a perfect strategic point, and the aids that the employees most use will be hung on safety hooks in this way.

While observing the production process, the author noticed that many documents were loose under the packing table. Furthermore, the author observed that the employees' personal belongings were placed on the edge of a small wooden stool, and pens and markers were lying fallow in plastic containers, see in Figure 22.

Figure 22: Before implementation

Sources: Own photo

Figure 23: After implementation

Sources: Own photo

For this reason, the author suggested purchasing a four-drawer metal container and wall file tray for documents will be purchased. In Figure 23, the new location can be seen, which will primarily be used for employees to put away personal belongings. There are always four employees working in the workplace, so each drawer will be for an employee's use. At shift change, the employee will clean out this drawer and hand it over clean. There will be a new wall-mounted file cabinet above the locker for essential documents, which will hold documents from behind the packing table.

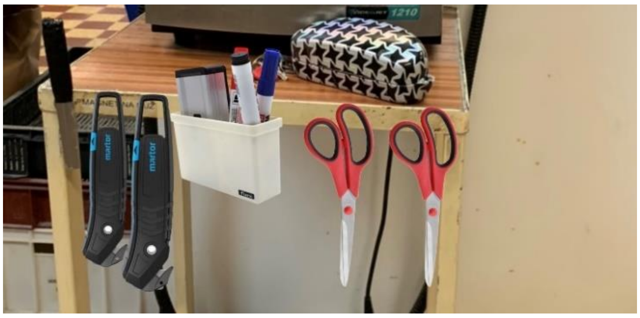

Figure 24: New placement of items

Source: Own processing

Figure 24 shows the new location design for the work aids that the employees at the wrapping machine need during the wrapping process. These items were always in plastic crates and were not often found by the female employees as, in many cases, the items fell through the loopholes and could not be retrieved. After consulting with one of the female employees, the author of the thesis evaluated the situation and proposed a new solution, which can be seen in the picture above.

4.6.3 Implementation of cleaning

A thorough cleaning was carried out in the soya bean production department. The author and a staff member cleaned all cabinets, eliminating several fans from a corner of the work area. The rubber belt on the packaging line was replaced, and the shelf in the raw material area was organized. Management did not wish to release pictures of these activities. The graduate removed an empty PET bottle from the table and performed a thorough deep cleaning of the cabinet. This cabinet can be seen prior to cleaning in Figure 25.

This closet contained unnecessary items. Many items have been completely removed. There was a high layer of flour in the cupboard, boxes dirty with oil, old unused items, or employee work equipment that the employees themselves had no idea about.

Figure 25: Before cleaning

Sources: Own photo

Figure 26: Deep cleaning of the cabinet

Sources: Own photo

The author did a thorough cleaning, sorting the shelves according to the use of things. This cleaning can be seen in Figure 26.

There are still items in the closet's left part that do not belong in the department. These items will soon be moved to another department with practical use. The author has made arrangements with a staff member in the maintenance department to keep these items in the closet for the time being. The top shelf contains a floor wiping bucket, documentation, and two barrels of cleaning supplies. A cardboard box with plastic bags is stored behind the cleaning supplies. On the right side of the cabinet in the first shelf are spare brooms and dustpans, a paper towel, and a metal detector box. The plastic compartment holds work gloves and tools. The second shelf contains work equipment for employees. There are earplugs, two earmuffs, safety glasses, a shield, and two boxes of rubber gloves. The third shelf contains duct tape, stickers, extension cord, strings, and a cardboard box containing spare parts. The bottom shelf holds three cardboard boxes of unwanted items waiting for permission to be removed.

4.6.4 Implementation of standardisation

After the three phases of the 5S method were implemented, the cabinets were photographed. Standards were created for this phase, and photographs were inserted. These photographs allow staff to see exactly how the cupboards are to be tidied and hand them over to the next shift in that condition at the end of the shift. The following activities are included in the proposed standards:

- Arrangement of cabinets and shelves,
- tidy packing lines
- tidy compartments
- sorting documents into the document tray.

Č.	Předmět	Umístění	Pozice
1	Lepící páska	1	Vlevo
2	Náhrada do lepící pásky	1	Uprostřed
3	Dokumentace	1	Vpravo
4	Kancelářské potřeby	2	Vlevo
5	Gumové rukavice a síťky na vlasy	2	Uprostřed vlevo
6	Náhrada do videojet	2	Uprostřed vpravo
7	Náhradní díly do vysavače	2	Vpravo
8	Lepící samolepky	2	Vpravo
9	Nový hadr na stroje	3	Vlevo
10	Náhradní díl do balící linky	3	Uprostřed
11	Lihový čistič	3	Vpravo
12	Kýbl na stroje	4	Vpravo
13	Kýbl na podlahu	4	Uprostřed
14	Čistící prostředky	4	Vlevo

Figure 27: Standard tidy cupboards

Sources: Own photo

For this phase, only one standard will be introduced according to the wishes of the company management. For this thesis, permission was granted to use a photograph of one of the two tidy cupboards. This cabinet can be seen in Figure 27 above and is located in the work area by the packing line. The location of labels is not in English due to the staff's lack of English language skills.

4.6.5 Implementation of self-discipline

This final implementation is also the most important phase of the whole method. However, the implementation of self-discipline is already a question of the discipline of the employees, i.e., mainly a question of their attitude. It is a challenging task to create a positive attitude in the employees so that they are not immediately discouraged by the method at the beginning. Reluctance and fear to change the current working pattern, even if negative, will create insecurity in employees, and it is not easy to convince them to cooperate positively.

For example, an 'idea box' could be set up to improve relations between employees and management. In this box, employees would be able to put their ideas for improving the department or the production process. Management would read and discuss these suggestions for improvement with employees weekly or monthly.

To comply with the 5S method, employees should use a control card to pass the department between shifts and regular random inspections. The employee should sign this control card. He would confirm that he is taking over the department in a completely standardized order with his signature. If the department took over the untidy and signed the control card, he would take full responsibility at that moment.

If the employees do not follow the 5S method, a workshop should be arranged for the employees. On the other hand, if the employees follow the 5S method, they should be rewarded appropriately.

Employee motivation also plays a significant role at this stage. If employees follow the 5S and are not rewarded for it, the 5S method will disappear from the department entirely after a short time. In motivation, their master also plays a vital role. He should motivate them by rewarding them for following the 5S and penalizing them for not following the 5S.

4.7 Costs associated with the introduction of the 5S method for department of soybean bars

For the separation of soybean bars, ten pcs of hook and screw will be purchased for attaching work tools to the concrete column. In addition, a drawer container, wall file tray for documents, and a broom kit will be purchased for faster and more efficient cleaning.

All items purchased soon are listed in Table 2 below and are calculated at the current quote for the Soybean Bunch department at 7 175 CZK.

Table 2: Future costs after the introduction of the 5S method

Items	Number of units	CZK/Units	Total
Hook with srew	10	5 CZK	50 CZK
Drawer container (4 drawers)	1	4 742 CZK	4 742 CZK
Wall file tray for documents	1	1 745 CZK	1 745 CZK
Broom set	2	319 CZK	638 CZK
Total costs			**7 175 CZK**

Sources: Own processing

Due to the company's modernization, these items were not immediately purchased. The company currently has a defined main objective of modernization. For this reason, the 5S method was not fully completed. Therefore, utilizing photo editing, the author proposed how the author would imagine the new implementation of the 5S. The management approved this proposal. The company plans to purchase these items as soon as possible.

5 Own proposal for the application of SMED analysis

Another task that was solved by the author of the diploma thesis in Chocoland company was the introduction of the SMED method on the production machines VEMAG HP30E, VEMAG SCR360, and VEMAG MMP223. By introducing the SMED method, the author of the diploma thesis aims to reduce the lost time caused by the lengthy cleaning process of these machines. The management has defined a target to reduce the lost time incurred during the cleaning process by at least 30 %.

The video footage taken by the graduate revealed the wastage during cleaning and was very helpful in finding ways to eliminate it. At the time of the measurements, it was found that a significant problem with VEMAG machines was the long cleaning time of the machine. To reduce cleaning times, the author of the thesis will use the principles of the SMED method. No team has been formed for applying the SMED method, nor has any competent person been assigned. This analysis was left to the diploma student by the CEO, who had a consultant in the form of the CEO in case of utmost necessity.

Video footage was taken by the graduate from the soya bean department using a mobile phone and a tablet. A stopwatch was used during the cleaning process to determine the exact duration of each activity, and a data collection form called a schedule was used to record the sub-activities. In this form, the author recorded the individual actions of the worker and the duration of the sub-activities.

Subsequently, the author analyzed the individual activities of the maintenance worker and the operator to reduce the time required for this work. First, the thesis author divided the activities into internal and external. Subsequently, the author tried to convert some of the activities that the operator and the maintainer performed after the machine had stopped. In this way, the author tried to convert internal activities, performed when the machine is stopped, into external activities, i.e., activities that can be performed while the machine is switched on.

The analysis of the video footage revealed an enormous waste of time during the process of cleaning the hopper and maintaining the production line. The video footage was taken for the maintenance and machine operators. These two employees are involved in this activity and must-see exactly where the time wastage occurs. Based on the improvement of the cleaning process, a brainstorming session was held between the graduate and the employees. The employees provided the thesis writer with their insights, improvements, and suggestions for making the activities more efficient.

Filming of the cleaning process was done a total of three times. The first measurement was based on manual cleaning. A newly purchased steam cleaner was prepared and used for the second measurement. In the third and final measurement, the new design was presented to the employees by the author of the thesis. From the second measurement, the steam cleaner proved its worth, and the diploma holder here took into account both the first and second measurements and thus created a new proposal for the cleaning process.

In the last part of this analysis, the diploma student will try to reduce the time of these activities.

5.1 Reasons for introducing SMED analysis

The main goal is to clean the machine quickly, well, and above all, use the time during the process. Furthermore, the main objective is to reduce the time by at least 60 minutes of cleaning time. Other benefits of the SMED method have cost reduction, smoothness of the cleaning process, increased worker safety, and increased productivity. The outcome of the introduction of the SMED method is the creation of a standard for machine cleaning, thus avoiding individual approaches and errors in the cleaning process. The defined reasons for the introduction are given below.

Reasons for introducing SMED analysis:

- Elimination of a long cleaning process.
- Increasing the efficiency of the cleaning process.

5.2 Problem description

The problem arises at the soybean bars workplace where the VEMAG HP30E, VEMAG SCR360, and VEMAG MMP223 are. The procedure for cleaning the machines is not adequately organized, and the rules are not clearly defined. There is also a complete lack of a standard of work for cleaning these machines. In the author's opinion, it is necessary to draw up a standard of work since each employee cleans and dismantles the machines differently, leading to unnecessary mistakes and further losses. It was also found during the measurements that the employees were not sufficiently trained and did not have the necessary tools for cleaning and dismantling the machines, and some tools were even missing. The main problems identified are summarized in Table 3 below. The table also presents the individual measures for eliminating the sub-problems.

Table 3: Problems and their measures

The Problem	Measures
Lack of rare working aids	Purchase of new tools
Enormous waste of time	Use of SMED analysis
Failure to follow the same workflow	Compliance with the proposed new design

Sources: own processing

5.3 Current status

All cleaning processes were first videotaped, and based on this, and so-called cleaning process schedules were subsequently developed. First, the CEO arranged with the foreman to videotape the working hours. A date was then arranged for the first measurement so that the employees knew that the graduate would be on site. At the same time, the employees were not informed about this method; thus, there is no Hawthorne effect[1].

The schedule describes all the different activities that took place during the cleaning process. Each step of the activity takes a different amount of time, and these times are shown in the

[1] A concept that relies on psychological regularity in that provided people receive some attention, they are able to improve their behavior. It is expected to be caused by increased morality and self-respect in particular, which people experience greatly when others take notice of them (Kalina, 2008).

operation time column. The total time represents the accumulation of the operation times. These accumulated times are added up until the machine is cleaned.

5.3.1 Description of the current state – first measurement

In the first measurement, two employees, a maintenance worker and a machine operator were involved in the cleaning process. The maintainer was tasked with dismantling all three machines and the machine operator with cleaning the machines. The main task for the operator is to clean the hopper. Both workers were informed that the entire cleaning process would be recorded and monitored. Production was stopped just after the author arrived at the department.

In the case of the first measurement, the work started with the preparation of the work tools, the preparation of an empty table, the moving of the table, and the moving of a pallet to the machine on which the technical components are to be washed would be deposited. All these activities were carried out while the machine was already switched off and was carried out by the machine operator. The essential cleaning process began with the arrival of the maintenance man in the department, where he first released the hopper. He then dismantled the mass formers, which kept the dough in shape during production. He then loosened the dough dispenser and removed the dough residue from the machine's bowels. Next, the maintenance worker poured water into the hopper and switched on the machine. The machine removed the dough from the inside of the machine.

During this process, the maintenance man moves to the second machine and disassembles the first two pieces of the cone to maintain the shape. He dismantles two pieces of rubber bands and smaller technical components and takes these parts to the pallet. Meanwhile, the first machine has finished cleaning out the machine's insides, and the maintenance man shuts down the machine. He rereleases the hopper and dismantles the wiper blades from the hopper. He then moves from the hopper to dismantle the outer nut in the through-hole, then releases the inner nut and opens the machine's interior. Using a short metal corkscrew, which he screws onto two rollers, he pulls out the augers, which are used to thoroughly grind the dough to form the dough for the soybean bars. Then, he removes the core from behind the machine using a long metal corkscrew, which he screws in again. After taking these two components to the pallet, the maintenance man dismantles the mixing propeller and removes the two pieces of the rubber seal.

Next, he moves to the third machine and first removes the outside of the cover, then removes the inside and dismantles one piece of rubber belt. At the end of the dismantling of all three machines, the maintenance man takes a spatula and removes the dough from the machine. The maintenance man leaves and changes with the machine operator. Meanwhile, the machine operator scrapes the dough off the hopper with the spatula during the dismantling process. The machine operator takes the pallet truck to the wash bay on the same floor as the soybean bars production. He runs hot water and slowly puts all the technical components into the container. After washing all the components, the operator returns to his department. He hangs rubber bands on the hangers to dry them by the next shift.

In the next section, the operator takes a squeegee in hand and removes the dough from the hopper and surrounding area. Since the dough can sometimes be dry and stuck to the hopper very quickly, it is complicated to remove. Therefore, the operator goes to the cabinet to get a cleaner to take off the dough more easily. Since there is water under the machine during cleaning, the operator solved this problem by moving the crate. During the cleaning of the hopper, very often, the operator changes the various aids to clean the hopper. Since there was dirty water in the bucket almost immediately after manual cleaning, the operator had to go frequently to get new water. At the end of a complete cleaning of the machine, the operator washes the aids and returns them to the metal table.

5.3.2 Timetable for the manual cleaning process

Table 4 below shows that the cleaning of the machines takes 2 hours, 18 minutes, and 52 seconds (138:52 minutes). If the total cleaning time could be reduced, the process would be more efficient. The first measurement was made during the morning shift, which started at 06:00 a.m. and ended at 2:00 p.m. The cleaning process started at 11:17 a.m., and the machine was wholly cleaned at 1:35 p.m. Table 5 further shows that there are inefficient operations in the schedule and do not add any value. The inefficient operations occur in Table 5 below. These operations must be removed and prevented from occurring again. To achieve this situation, the author of the thesis will communicate the schedule results to the employees and management.

Table 4: Timetable for the manual cleaning process

Step number	Operation time	Total time	Activity description – MANUAL CLEANING	Internal/ External/ LOSS
1	0:15	0:15	Preparation of aids	Internal
2	0:18	0:33	Preparing an empty table	Internal
3	0:28	1:01	Moving the table	Internal
4	0:20	1:21	Moving the pallet	Internal
5	0:03	1:24	Hopper release	Internal
6	0:12	1:36	Disassembly of mass dough	Internal
7	0:11	1:47	Dough release	Internal
8	0:45	2:32	Removing excess dough	LOSS
9	0:25	2:57	Walking for water	LOSS
10	0:08	3:05	Pouring water into the hopper	Internal
11	0:07	3:12	Returning the hopper to operating condition	Internal
12	0:07	3:19	Switching on the machine -> removing the dough from the rest of the machine	External
13	0:14	3:33	During this process, disassemble the 2x cones for shaping	Internal
14	0:09	3:42	Transport 2x cones per pallet	LOSS
15	0:23	4:05	Disassembly of 2x rubber girdle	Internal
16	0:09	4:14	Technical components	LOSS
17	0:13	4:27	Transport of 2 rubber girdle per pallet	LOSS
18	0:10	4:37	Switching off the machine -> removing the dough from the sides of the hopper	External
19	0:07	4:44	Hopper release	Internal
20	0:24	5:08	Disassembly of the wiper slat	Internal
21	0:27	5:35	Remove the dough from the holes	LOSS
22	0:06	5:41	Loosening the outer nut in the through-hole	Internal
23	0:07	5:48	Nut transfer per pallet	LOSS
24	0:01	5:49	Loosening the inner nut in the through-hole	Internal
25	0:08	5:57	Nut transfer per pallet	LOSS
26	0:30	6:27	Using a short corkscrew to remove the snails	Internal
27	0:10	6:37	Transport of snails on a pallet	LOSS
28	0:22	6:59	Using a long corkscrew to remove the core	Internal
29	0:12	7:11	Core transport per pallet	LOSS
30	0:06	7:17	Removing the mixing propeller	Internal
31	0:11	7:28	Transfer of the mixing propeller to the pallet	LOSS
32	0:14	7:42	Removal of 2 rubber seals	Internal
33	0:09	7:51	Transfer of 2 pcs rubber seal	LOSS
34	0:13	8:04	Removing the outside of the machine	Internal
35	0:07	8:11	Empty table transfer	LOSS
36	0:01	8:12	Disassembly of the first part of the metal surface	Internal
37	0:07	8:19	Transfer of the first part of the metal surface to the table	LOSS
38	0:06	8:25	Disassembly of part II of the metal surface	Internal
39	0:06	8:31	Part II of the metal surface on the table	LOSS
40	0:12	8:43	Removing one piece of rubber belt	Internal
41	0:11	8:54	Transfer of one piece of rubber	LOSS
42	0:46	9:40	Using a spatula, take off the dough	Internal
43	0:11	9:51	**Disassembly of the machine Done**	
44	0:59	10:50	The external worker is leaving	LOSS
45	1:12	12:02	The arrival of an internal worker to the machine (machine operator)	LOSS
46	0:24	12:26	Pallet removal, technical components for cleaning	Internal
47	0:08	12:34	Opening the door	Internal
48	0:09	12:43	Driving a pallet truck	Internal
49	0:07	12:50	Closing the door	Internal
50	0:23	13:13	The pallet truck is transported to the washing tank	Internal

51	0:06	13:19	Switch on water to soak up technical components	Internal
52	1:55	15:14	Inserting technical components into the washing container	Internal
53	2:00	17:14	Waiting for water to fill the wash tank	LOSS
54	0:17	17:31	Insert three pcs of rubber belts into the washing container	Internal
55	2:15	19:46	Washing rubber belts	Internal
56	0:05	19:51	Transfer back of 3 rubber belts on a pallet	Internal
57	1:02	20:53	Waiting for more water to enter the washing tank	LOSS
58	8:55	29:48	Cleaning and washing of all technical components + storage back on the pallet	LOSS
59	0:20	30:08	Washing working aids	Internal
60	1:36	31:44	Transport of a pallet truck back to the workplace	Internal
61	1:43	33:27	Hanging rubber belts on a rope for drying	Internal
62	0:22	33:49	Take the pallet to its original place	Internal
63	0:09	33:58	Take away and tidy the pallet truck back to its original place	Internal
64	0:10	34:08	Arrival at the machine – hopper	Internal
65	13:00	47:08	Using a spatula, remove the dough from and around the hopper	LOSS
66	2:20	49:28	Back for the bucket to the cabinet, pour "JAR" back for water + arrival at the machine	LOSS
67	1:10	50:38	Cleaning the hopper with water and a broom	Internal
68	1:00	51:38	Go for crate due to overflowing water from the machine	LOSS
69	14:10	65:48	The internist cleans the hopper with various aids	LOSS
70	0:45	66:33	An internist changes the water in a bucket	LOSS
71	16:07	82:40	Entry of 1 employee (further 1e) into the process -> washing the surface of machines	Internal
72	5:35	88:15	1e -> washing the grease drawer and removing grease from the work surface	Internal
73	1:06	89:21	An internist changes the water in a bucket	LOSS
74	12:33	101:54	The internist cleans the hopper with various aids	LOSS
75	0:30	102:24	The internist is looking for the right tools to remove the dough from the hopper	LOSS
76	15:27	117:51	The hopper cleaning process continues	Internal
77	4:02	121:53	Replacement of hopper cleaning aids	LOSS
78	14:16	136:09	The hopper cleaning process continues	Internal
79	1:04	137:13	The internist washing working aids	Internal
80	1:39	138:52	Return of aids	Internal
Machine cleaned				

Sources: Own processing

5.3.3 Verification of waste and elimination of inefficient activities in the first measurement

Table 5 shows the inefficient and unproductive operations performed during the machine's first cleaning process.

The total time of the first measurement of inefficient operations is 96:44 minutes. As a result of the timetable analysis, it was found that there was a high wastage of time during the cleaning process. The enormous wastage here is the manual cleaning of the hopper, trying different aids to clean the hopper, the unnecessary pause, and the repeatedly waiting for the water to be filled into the washing vessel. There are also inefficient changing of aids to clean the hopper and the repeated leaving of the machine to get a bucket, aids, or to change clean water into a bucket.

Table 5: Ineffective operation from the first measurement

Operations	Time of activity
Removal of dough	0:45
Walking for water	0:25
Transfer 2x cones	0:09
Transfer of technical components	0:09
Transfer of 2 rubber bands	0:13
Removal of dough	0:27
Transfer of outer nuts	0:07
Transfer of inner nuts	0:08
Transfer of screws on pallet	0:10
Transfer of core on pallet	0:12
Transfer of mixing propeller	0:11
Transfer of 2 rubber seals	0:09
Transfer of empty table	0:07
Transfer of the first part to the table	0:07
Transfer of the second part to the table	0:06
Transfer of rubber belt	0:11
Transfer of workers	0:59
Big pause when the intern arrives	1:12
Waiting for the washing container to fill	2:00
Waiting for more water to fill the wash container	1:02
Cleaning and washing all technical components, returning them to the pallet	8:55
Use of spatula to remove dough	13:00
Going for the bucket, pouring the cleaning agent and coming to the machine	2:20
Exit for crate due to overflow of water from machine	1:00
Manual cleaning of the hopper	14:10
Changing the water in the bucket	0:45
Changing the water in the bucket again	1:06
Cleaning the hopper	12:33
Intern looking for the right tool to remove the dough	0:30
Trying out different tools for cleaning the hopper	15:27
Changing the hopper cleaning aid	4:02
Hopper cleaning continues	14:16
Total	**96:44**

Sources: own processing

5.3.4 Breakdown of internal, external and first measurement loss activities

From the timetable, it can be seen that steps (No. 12) and (No. 18) are external activities; that is, they are carried out while the machine is running, and the dough is being removed from the cleaning vessel. During this process, the maintenance worker dismantles the second machine to avoid wasting time and make the dismantling faster. Since all three machines are dismantled, these two external activities are the only ones in the whole cleaning process. The following Figure 28 shows the ratio of internal, external, and loss activities during the first measurement.

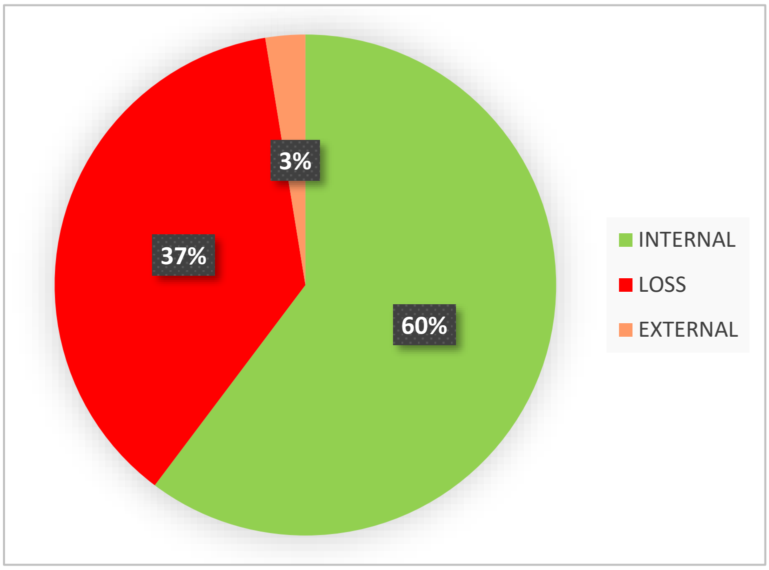

Figure 28: Division of internal, external and loss-making activities

Sources: Own processing

From Figure 28, it is evident that during the cleaning of the machine, the activities that take place at the time when the machine does not produce prevail, i.e., the internal activities prevail over the external ones. Only 3% of activities are performed by the operator/maintainer while the machine is switched on. Furthermore, it can be read that there is a high percentage of time lost in the cleaning process, up to 37%.

5.3.5 Conversion of internal activities to external in the first measurement

From the measurement of the first cleaning process, the author of the diploma thesis chose four activities that could be performed to external activities within the cleaning process before stopping the machine. These activities are preparation of aids, preparation of the table, preparation of the metal table, and preparation of the pallet. These activities are shown in Table 6.

Table 6: Conversion of internal activities to external

Step number	Operation time	Total time	Activity description
1	0:15	0:15	Preparation of aids
2	0:18	0:33	Preparing an empty table
3	0:28	1:01	Moving the table
4	0:20	1:21	Moving the pallet

Sources: Own processing

The graduate suggests that these activities should be carried out before the machine stops all production. This would avoid unnecessary delays for the operator during the cleaning process. In the case of the first proposed externalization, the operator moved away from the machine many times during the first measurement, looking for the right tools. As for the other three activities, these can be carried out without any problem before stopping production. The operator throws the last cube of soy dough into the hopper and can perform all these four proposed activities without losing time during the cleaning process.

5.4 Second measurement – cleaning with the steam machine

The first measurement showed a massive waste of time, and the machine operator always needed strength to manage the cleaning of the hopper and the maintenance of the machine within two hours. This lengthy process author will try to be eliminated by using a steam machine. It is more specifically the cleaning of the hopper where the dough is always very stuck and very difficult to remove. The second measurement took place immediately two weeks after the first measurement.

5.4.1 Description of the second cleaning process

In the case of the second measurement, starting with preparing the working tools, the machine operator prepared an empty table and brought in a pallet to put away the removed technical components from the machine. All these operations are carried out with the machine switched off and are performed by the machine operator.

The dismantling of the machine starts with the maintenance worker coming to the machine, where he first releases the hopper tray. The operator then removes the large pieces of dough left in the hopper. The maintainer releases the dough dispenser and removes the dough from the machine's bowels. Meanwhile, the machine operator reaches for the water and pours it into the hopper. After switching on the machine, the maintenance worker takes the container and waits for the dough to be removed from the machine. After removing the dough and cleaning the interior, the machine is switched off, and the dough residue is removed again. Using a long corkscrew, the maintenance worker removes the augers and core from behind the machine. He then dismantles the technical components and removes the rubber belts. Next, he releases the hopper, and the operator starts cleaning the hopper with a spatula. The operator has been on hand to assist the maintenance worker in taking away all the technical components up to this point.

From the activity of loosening the outer and inner nuts from the through-hole, the maintenance worker himself takes the dismantled components to the pallet. He then removes the rubber seals, dismantles the mixing propeller, and transfers these last components to the pallet. The machine operator takes a pallet truck and takes the pallet with the components to the wash bay. During this process, the maintenance worker dismantles the first and second parts of the metal cover. As part of this process, the maintenance worker forgot to remove the long and short rubber belts, which he had to take to the wash bay. These mistakes must be avoided as they add much time and are fruitless.

The maintenance man carried out a thorough maintenance of the machine. The machine operator helped with removing grease from the machine during the process. The machine operator was trained to handle the steam machine. Due to arriving late for the training, the machine operator did not remember exactly how to prepare the steam machine. Therefore, there was a loss of time. The actual cleaning of the hopper using the steam machine was done in very good amount of time.

5.4.2 Timetable for steam cleaning

The second measurement took place during the afternoon shift, which started at 2:00 p.m. and ended at 10:00 p.m. The cleaning process began at 7:02 p.m., and the machine was cleaned at 9:12 p.m. From Table 7 below it can be read that the cleaning of the machine takes 2 hours 10 minutes (130:00 minutes). If the total cleaning time could be reduced, this process would be much more efficient again. At first glance, it is clear that there are no significant differences between the first and second measurements. Table 8 further shows that there are inefficient loss-making operations in the timetable or operations that do not add any value. Inefficient operations are listed in Table 8 below.

Table 7:Timetable – steam cleaning

Step number	Operation time	Total time	Activity description – Cleaning with steam machine	Internal/External/ LOSS
1	0:13	0:13	Preparation of aids	Internal
2	0:20	0:33	Preparing an empty table	Internal
3	0:29	1:02	Preparing the table	Internal
4	0:20	1:22	Shifting the pallet	Internal
5	0:03	1:25	Release the tray	Internal
6	0:45	2:10	Removing dough	Internal
7	0:12	2:22	Removing dough from the machine bowels	Internal
8	0:11	2:33	Release dough dispenser	Internal
9	0:45	3:18	Removing excess dough	LOSS
10	0:25	3:43	Walking for water	LOSS
11	0:08	3:51	Pouring water into the hopper	Internal
12	0:07	3:58	Returning the hopper to the operating state	Internal
13	0:07	4:05	Switching on the machine -> removing the dough from the rest of the machine	External
14	1:40	5:45	Waiting for the dough to be removed from the machine	Internal
15	0:10	9:53	Switching off the machine -> removing the dough from the sides of the hopper	External
16	1:27	7:12	Dismantling the augers	LOSS
17	2:07	9:19	Disassembling the core	LOSS
18	0:09	9:28	Disassembly of technical components	Internal
19	0:15	9:43	Disassembly of rubber belts	Internal
20	0:07	10:00	Release the hopper	Internal
21	2:06	12:06	Cleaning the hopper with a plastic spatula	Internal
22	0:27	12:33	Removing the dough from the holes	Internal
23	0:06	12:39	Loosening the outer nut in the through hole	Internal
24	0:08	12:47	Transferring the nuts to the pallet	LOSS
25	0:05	12:52	Loosening the inner nut in the through hole	Internal
26	0:08	13:00	Transfer nuts to pallet	LOSS
27	0:30	13:30	Removing the rubber seal	Internal
28	0:10	13:40	Removing the mixing propeller	Internal
29	0:22	14:02	Transferring the mixing propeller to the pallet	LOSS
30	21:02	11:04	During cleaning, the intern washes all technical components	LOSS
31	2:22	13:26	Carrying the forgotten long rubber belt to the washing box	LOSS
32	1:08	14:34	Disassembly of the metal cover parts I and II	Internal
33	2:02	16:36	Disassembly of the short rubber belt	LOSS
34	0:35	41:11	Carrying the forgotten short rubber belt to the wash bay	LOSS
35	18:45	59:56	Maintenance of the machine	LOSS
DISASSEMBLY COMPLETE				
36	2:13	62:09	Fat removal	Internal
37	12:25	74:34	Preparing the steam machine	LOSS

38	55:26	130:00	Cleaning the hopper	Internal
Machine cleaned				

Sources: own processing

5.4.3 Verification of waste and elimination of inefficient operations in the second measurement

In Table 8, the total time of inefficient, operations in the second measurement are 64:54 minutes, performed in the second cleaning process. As a result of the analysis of the second measurement schedule, it is also found that excessive time wastage occurs during the process. The most wasteful activities in the second measurement are washing technical components and taking forgotten items from the compartment to the wash bay. Furthermore, it can be read that some activities performed by the maintenance staff can be done faster, see the removal of the augers, the removal of the core, or the removal of the rubber belt.

Table 8: Ineffective operation from the second measurement

Operations	Time of activity
Removal of excess dough	0:45
Walking for water	0:25
Dismantling the augers	1:27
Disassembling the core	2:07
Removing the dough	0:27
Transferring the outer nuts	0:08
Transferring the inner nut	0:08
Transfer of mixing propeller	0:22
During cleaning, the intern washes all technical components	21:02
Carrying the forgotten rubber belt to the washing box	2:22
Removing the rubber belt	2:02
Carrying away the forgotten rubber belt	0:35
Maintenance of the machine	18:45
Grease removal	2:05
Preparing the steam machine	12:25
Total	**64:54**

Sources: Own processing

These deficiencies from the first and second measurements will have to be eliminated or completely removed from the cleaning process.

5.4.4 Division of internal, external, and loss second measurement activities

The following Figure 29 shows the incidence of the second measurement and the distribution of the ratio of internal, external, and loss-making activities.

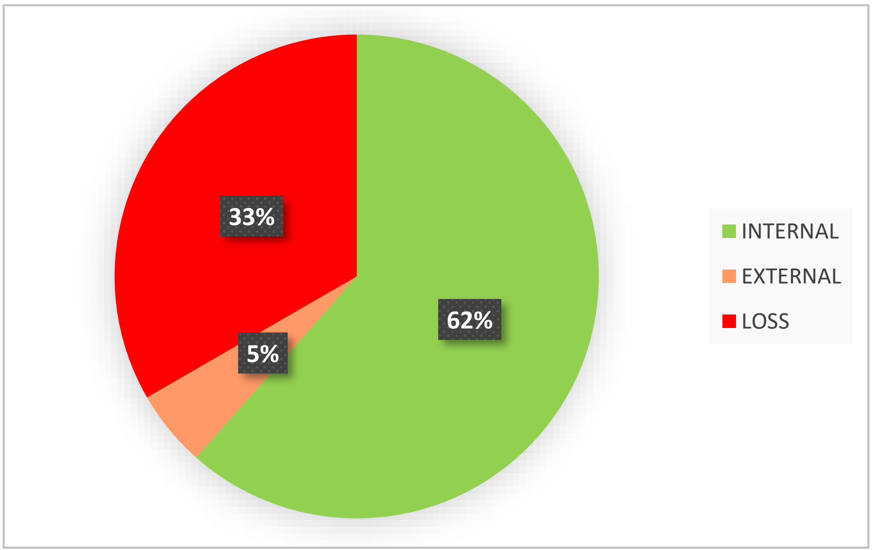

Figure 29: Division of internal, external, and loss second measurement activities

Sources: Own processing

From Figure 29, it is evident that during the cleaning of the machine, the activities that occur when the machine is not running, i.e., internal activities, prevail over external ones. The operator/maintenance staff carries out only 5% of the activities while the machine is on. It can also be read that there is a high percentage of time lost in the cleaning process, up to 33 %.

5.4.5 Conversion of internal to external activities in the second measurement

During the second measurement of the cleaning process, four activities were again selected that could be prepared in the cleaning process before the machine was stopped. The internal activities to be converted to external are preparing tools, moving the pallet, preparing the empty table, and moving the table. The above activities are listed in Table 9.

Table 9: Conversion of internal to external activities in the second measurement

Step number	Operation time	Total time	Activity description
1	0:13	0:13	Preparation of aids
2	0:20	0:33	Preparing an empty table
3	0:29	1:02	Moving the table
4	0:20	1:22	Shifting the pallet

Sources: Own processing

The author of the thesis proposes that these activities should be carried out before the machine is stopped.

5.5 Evaluation of the results

The results of the two measurements clearly show that the operator and the maintainer do not follow the SMED method during the cleaning process of the machine. There are substantial time delays, the cleaning time takes too long, and there are unnecessary, wasteful activities that are of no benefit to the company.

Most of the activities were carried out during the cleaning process when the machine was switch off. This needs to be eliminated as it significantly increases the cleaning time. For this reason, the author suggested that the first four activities be performed while the machine was processing the last pieces of dough. As this is a process where the machines have to be switched off, many more internal activities dominate over the external ones. Subsequent evidence of inadequate staff training was the lengthy preparation of the steam cleaner. An employee lose confidence when he did not know the correct liquid to pour into the cleaner. This activity took the operator almost thirteen minutes.

Further evidence of the enormous waste of time was the lengthy washing of the technical components in the wash box. A subsequent major problem was an employee's misconduct who failed to check the number of technical components placed on an empty pallet. This activity resulted in two completely unnecessary mistakes. The machine operator had to return to the workplace twice, take the components from the maintenance worker and return to the wash box.

These activity times, which take up most of the measurement and waste time, need to be reduced or eliminated and thereby cleaning time significantly reduced. An important step to properly designing a new cleaning process is to immediately flag activities that appear wasteful during the shoot.

The following Figure 30 compares the first measurement of total cleaning time with the second measurement of total cleaning time. The difference between these bars is not that visible; however, in the second measurement, one of the workers was injured at the beginning of the machine disassembly. For this reason, another maintenance worker was brought in for this cleaning process, but he was not thoroughly trained, which made the cleaning process very long.

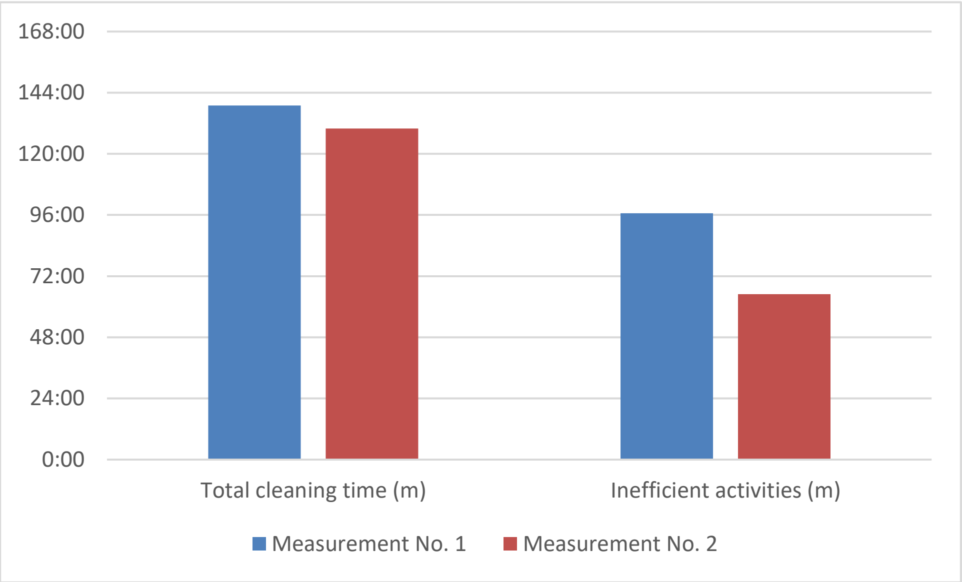

Figure 30: Total comparison of cleaning times

Source: Own processing

Next, the comparison of the inefficient activities of the two measurements can be seen in Figure 30. The difference between these bars is more visible than the difference in total cleaning time. For the second measurement, it can be seen that employees have learned from the previous measurement and eliminated some inefficient activities.

The author of the thesis must point out that the cleaning process was performed well, yet each time differently and with different durations of the total cleaning time.

6 New SMED method timetable for department of soybean bars

In this chapter, the author of this thesis will discuss the application of the SMED method in the department of soybean bars to shorten the cleaning process of the machines. As a result, a new schedule will be designed, and annual time savings will be calculated.

As in previous measurements, video footage was again taken here to document the process. The video recording will verify the correctness of the proposed procedure and should reveal any wasteful activities. Prior to measuring the new cleaning process, the employees were informed in advance. In contrast to the first measurement, employee productivity may be affected, and there will be maybe a Hawton effect.

6.1 Description of the new proposal of the cleaning process

The author first suggested that the machine operator would turn the water into the washing box while processing the final dough. Subsequently, he prepares all the aids used in the cleaning process, prepares a table for storing disassembled parts of the machine, and uses a pallet truck to move a plastic pallet to the machine. This pallet already describes the location of all disassembled parts of the machine from the 5S method to avoid the forgotten disassembled parts of the machine. Furthermore, the machine operator comes to the measuring cup in advance, turns the water into it, and leaves it ready for the maintenance employee. All the above activities will become external.

At this point, a maintenance worker enters the cleaning process and switches off the machine and pours water into the hopper. Then the machine switches on again and pushes the plastic crate under the open hole so that the dough falls into the crate and does not cause unnecessary pollution of the surroundings. During this process, the handyman disassembles the cone twice, which is used to shape the dough. During this disassembly, the machine operator goes to switch off the water in the washing box. The operator returns to the handyman and is available throughout the disassembly to always take the disassembled item onto the pallet. There is no need for a maintenance person to take the components to the pallet. The maintenance worker then switches off the machine and removes the remaining dough from behind the machine, releases the hopper, and removes the excess dough from the hopper. He then disassembles the wiper blade, loosens and disassembles the outer and inner nuts in the through-hole of the machine, and removes the screws using a short corkscrew immediately afterward using a short corkscrew. In the mixing propeller's next step, two pieces of rubber seal are removed. The outer part of the machine is then exposed, the first part of the metal cover is disassembled, and then the second part of the metal cover is disassembled. Rubber belts are removed from all machines.

The machine operator uses a pallet truck to take the technical components to the washing box, where he then places them in the washing container, and he returns to the machine back. There is a significant change in the cleaning process, as in the first and second measurements in the washing box, the operator stayed and washed these components. In the meantime, the maintenance employee maintains the machine and fastens a plastic bag around the hopper opening so that does not cause unnecessary pollution of the surroundings of the machines which occurs during steam engine cleaning. After this activity, the maintenance worker leaves the workplace, and the machine operator begins the process of cleaning the hopper. First, using a plastic spatula removes more extensive dough deposits from the hopper so that the hopper can be cleaned better when using a steam engine. At the end of this activity, the machine operator prepares the steam engine. The machine operator can begin the cleaning process when the machine is ready, and the green light is on. After cleaning the hopper using a steam engine, the operator goes to wash the technical components in the washing box, which have soaked him. He stores these components back on the pallet and takes the pallet back to the department. He hangs up the rubber belts so that they are dry the next shift and returns the pallet truck to its place. He then washes all work tools and returns them to their original location.

6.2 Timetable of the new proposal of the cleaning process

The new metering proposal was run during the afternoon shift, which started at 2:00 p.m. and ended at 10:00 p.m. The cleaning process started at 6:27 p.m, and the machine was cleaned at 7:43 p.m. From Table 10 below, it can be seen that the cleaning of the machine was reduced to 1 hour and 16 minutes (86:58 minutes). The difference between the original first cleaning measurement and the new design measurement is 52 minutes. In Table 10, the new design measurement can be seen.

Table 10: Timetable of the new proposal of the cleaning process

Step number	Operation time	Total time	Activity description - New cleaning method	Internal/External
1	0:25	0:25	Turn on the water in the washing machine	External
2	0:15	0:40	Preparing the tools	External
3	0:03	0:43	Preparing the table	External
4	0:09	0:52	Move the pallet	External
5	0:11	1:03	Walking for water	External
6	0:06	1:09	Pouring water into the hopper	Internal
7	0:01	1:10	Switching on the machine -> removing the dough from the rest of the machine	External
8	0:11	1:21	During this process, disassemble the 2x cone for shaping	Internal
9	0:24	1:45	Walking off to shut off water to wash box	Internal
10	0:20	2:05	Disassemble 2x rubber belts	Internal
11	0:09	2:14	Disassembly of technical components	Internal
12	0:10	2:24	Switching off the machine -> removing the dough from the sides of the hopper	External
13	0:08	2:32	Release the hopper	Internal
14	0:20	2:52	Removal of excess dough	Internal
15	0:06	2:58	Disassembly of the wiper blade	Internal
16	0:09	3:07	Loosening the outer nut in the through hole	Internal
17	0:12	3:19	Loosening the inner nut in the through hole	Internal
18	0:20	3:39	Remove the augers using a short corkscrew	Internal
19	0:12	3:51	Use a long corkscrew to remove the core	Internal
20	0:06	3:57	Disassembling the mixing propeller	Internal
21	0:13	4:10	Remove the 2 rubber seals	Internal
22	0:11	4:21	Removing the outer part of the machine	Internal
23	0:07	4:28	Disassembly of the first part of the metal surface	Internal
24	0:08	4:36	Disassembly of part II of the metal surface	Internal
25	0:15	4:51	Removal of one piece of rubber belt	Internal
26	0:28	5:19	Removal of the pallet, technical components for cleaning to the wash bay	Internal
27	0:19	5:38	The pallet truck is transported to the washing tank	Internal
28	0:55	6:33	Inserting the technical components into the washing container	Internal
29	6:46	13:19	Maintenance of the machine by an outsider	Internal
30	0:10	13:29	External worker leaves	Internal
31	0:02	13:31	Internal worker arrives at the machine (machine operator)	Internal
32	10:50	24:21	Using the spatula to take off a large amount of dough	Internal
33	15:27	39:48	Preparing the steam machine	Loss
34	38:16	78:04	Cleaning the hopper with the steam machine	Internal
35	0:24	78:28	Going to the washing box	Internal
36	5:55	84:23	Cleaning and washing all technical components + placing back on the pallet	Internal
37	0:25	84:48	Transporting the pallet truck back to the workplace	Internal
38	0:35	85:23	Hanging the rubber belts on the drying rope	Internal
39	0:01	85:24	Transport and clean the pallet truck back to its original location	Internal
40	0:52	86:16	Washing of work equipment	Internal
41	0:42	86:58	Returning the tools	Internal
MACHINE CLEANED				

Sources: Own processing

6.3 Verification of waste and elimination of inefficient activities in the new measurement design

In the Table 11, the total time of inefficient operations in the new measurement design is 15:27 minutes, which were performed to measure the new design for the cleaning process. As a result of the measurement schedule analysis, it is also found that there is excessive time wastage during the process of steam engine preparation. Again, this happened because the employee was not properly and adequately trained.

Table 11: Inefficient activities

Operations	Time of activity
Preparation of the steam machine	15:27

Source: Own processing

6.4 Division of internal, external, and loss activities of the new measurement design

From the timetable, it can be seen that steps numbered 1, 2, 3, 4, and 5 are external activities, meaning that they are performed while the machine is running, where these activities are performed while the last pieces of dough are being processed. In the following graph, Figure 31 the ratio of internal, external, and loss activities during the new measurement.

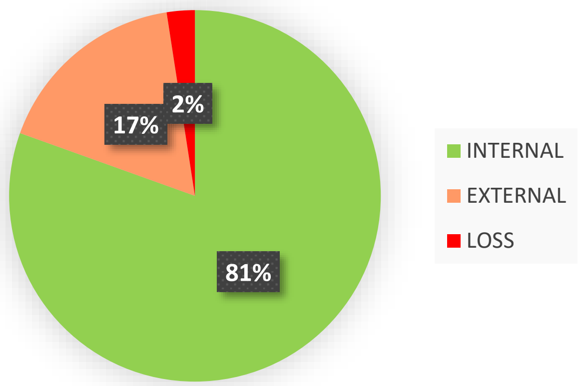

Figure 31: Division of internal, external, and loss activities of the new measurement design

Source: Own processing

From Figure 31, it is evident that during the cleaning of the machine, the activities that occur when the machine is not in production are still predominant, i.e., internal activities prevail over external ones. Internal activities account for 81 %. Compared to previous measurements, external activities have increased to 17 %. The operator/maintenance staff performs these activities while the machine is switched on. Furthermore, the cleaning process has been reduced from the original measurement of 80 steps to only 41 steps. From the original measurements, where the loss activities accounted for 39% in the first and 33% in the second measurements, the new design has eliminated these activities to only 2%.

7 Economic evaluation

In the following chapter, an economic evaluation of the two methods introduced is carried out. The aim is to evaluate the application of the 5S method, define the financial savings followed by the non-financial benefits, and calculate the time savings. Another objective is to evaluate the newly designed method of the machine cleaning process. This saved time will be used to produce soybean bars while increasing the company's profit. The evaluation of the two methods is calculated from the adjusted coefficient, and therefore, these calculations are only indicative.

7.1 Economic evaluation of the application of the 5S method

The 5S method has been successfully implemented in the soybean bars department. This method, once introduced, has made the workplace more organized, thoroughly removing things that do not need to be there and generally organizing the department. It has successfully had employees have their work tools close to their work area, eliminating the word "search" and thus saving production time that would have been lost searching for these items.

To implement the 5S, work aids will be purchased, and a standard were posted in the cabinets so that employees know exactly how the cabinets are to be properly cleaned. Order was introduced into the cupboards using Dymo tongs by naming the shelves and arranging them according to staff needs. The staff themselves said how the cupboards would be arranged. In one of the cabinets mentioned, deep cleaning and arrangement of the compartments were carried out. In addition, the staff appreciates the acquisition of a new drawer cabinet for storing their personal belongings.

Costs were incurred for implementing the 5S method in purchasing a hook, the purchase of work tools for cleaning, the purchase of a drawer container, and the purchase of a wall-mounted document holder. It can be said that the costs incurred have been returned to the business in the form of financial savings in total time, which the business estimates to be reduced by at least 30%.

Financial savings

In order to calculate the annual loss from unnecessary tasks prior to the introduction of the 5S method, it was necessary to know the values shown in Table 12. The per second earnings are calculated as the average monthly income of the employee divided by the number of hours worked per month. The resulting value is then converted into seconds. Then the product of the previous result with the time spent on unnecessary tasks and the number of unnecessary tasks per day is performed. The resulting value is multiplied by 20 working days. The monthly losses from unnecessary tasks are calculated. To find the annual losses, it is sufficient to multiply the resulting value by 12.

Table 12: Losses from unnecessary actions

Inserted values	**Values**
Average monthly employee income	20 000 CZK
Number of employees	8
Number of hours worked per month	160 hours
Time spent on unnecessary tasks (eg walking for the weight, switching off the machine)	20 sec
Number of unnecessary actions per day	20
Second earnings – per employee (CZK / seconds)	0,03 CZK
Daily losses from unnecessary actions/employees	12 CZK
Monthly losses from unnecessary actions/employees	240 CZK
Annual losses from unnecessary actions/employees	2880 CZK
Annual losses from unnecessary operations	**23 040 CZK**

Sources: Own processing

If we multiply this result by the number of employees, the annual loss from unnecessary actions of all employees is obtained.

Non-financial benefits

There are also non-financial benefits for the company after introducing the 5S method. The main benefit was the strategic location of work tools closer to the production process. In cooperation with the employees and taking into account their needs:

- sorting and comparing work aids,
- organizing and thoroughly cleaning the cupboards,
- creating a working standard,

- clear organization of important documents,
- easier orientation and overall standardization.

From the above, flexibility and increased safety in the workplace have also been ensured. The employees themselves are happy with the changes introduced and want to participate further in any future improvement plans actively.

7.2 Economic evaluation of the application of the SMED method

In this chapter, a timely evaluation of the application of the SMED method will be carried out, the costs will be quantified, and then the payback period of the investment will be calculated.

Quantification of time savings

The time saved (see chapter 6.2) represents the time that can be used to extend the operation of the machine. This introduction has ensured that the extra time saved is used to produce soybean bars. Consequently, the company will also make more profit. The time saving can be calculated as the difference between the duration of the original measurement time and the newly designed cleaning process. The calculations in Table 13 below are taken in minutes.

The original cleaning time was measured at 139 minutes. The steam machine's second measurement did not improve much and was measured at 130 minutes. Therefore, the author analyzed the whole process and suggested a new procedure for the cleaning process. After the new proposal, the cleaning time was reduced to 87 minutes. Firstly, the new cleaning condition has to be subtracted from the original cleaning time condition to get the time-saving. The time saved for the cleaning process has been reduced to 52 minutes, and the lost time has been reduced by 38%.

The cleaning process takes place every working day. The author of the thesis will calculate the time saved per year, and from that, the number of cleaning per year is to be calculated. The calculation of the number of cleaning per year can be seen below. The number of working days in the year 2022 is 252 days. To find the number of cleaning per year here, the thesis writer has to take the number of working days in 2022 and divide it by the number of cleaning per day. In this case, the thesis writer will calculate 252 cleaning days per year. The total savings per year can be calculated by multiplying the time saved by the number of cleanings. Thus, 52 minutes is multiplied by 252 days to calculate the annual time savings of 13,104 minutes, or 218.4 hours.

Table 13: Time savings per year

Time savings for cleaning	Number of cleanings per year	Time savings per year
52 min	252	13 104 min

Source: own processing

The company was losing profit with the original cleaning because the cleaning was not being done efficiently. The profit calculation is taken as gross only and does not deduct the costs associated with the overall production.

For the calculation, it is necessary to know the cycle time, i.e., when the soybean bar enters the working phase until the time when it is packed. Cooking and dough preparation are not included. The management wishes to rechange the following information to publish the work. The author has complied with the request and has adjusted all the following values by a coefficient. The author has averaged the selling price since the price varies from shop to shop.

Cycle time was calculated to be less than 0,7 seconds, so converting to minutes is 0,012 minutes per soybean juice. The average price of soybean meal is around 5 CZK/piece.

To calculate the units produced over and above per cleaning, the time saved per cleaning is divided by the cycle time (see relation 2).

$$Number\ of\ additional\ pieces\ per\ cleaning = \frac{cleaning\ time\ saving\ (min)}{cycle\ time\ (min)} \tag{1}$$

$$Number\ of\ additional\ pieces\ per\ cleaning = \frac{52}{0{,}012} \tag{2}$$

$$Number\ of\ additional\ pieces\ per\ cleaning = 4\ 333{,}33\ pcs \tag{3}$$

The calculation showed that 4 333 units (see relation 3) would be produced more than production. To calculate the lost profit in cleaning time, the product's price is multiplied by the number of units in excess the calculation results in a total lost profit for the cleaning time of CZK 21 667.

To calculate the units produced in excess per year, the annual time saved is divided by the cycle time (see relation 5).

$$Number\ of\ additional\ units\ per\ year\ = \frac{annual\ time\ saving\ (min)}{cycle\ time\ (min)} \tag{4}$$

$$Number\ of\ additional\ units\ per\ year = \frac{13\ 104}{0{,}012} \tag{5}$$

$$Number\ of\ additional\ units\ per\ year\ =\ 1\ 092\ 000\ pcs \tag{6}$$

The calculation found that 1 092 000 units (see relation 6) would be overproduced annually. In order to calculate the loss of profit during the cleaning time, the price of the product is multiplied by the number of units over and above. The company caused a loss of profit of CZK 5 460 000 through inefficient operations and a lengthy cleaning process.

Non-financial benefits

There were also non-financial benefits for the company in this area. The non-financial benefits of the SMED method mainly stem from the benefits after the introduction of the 5S method, which is mentioned in Chapter 7.1. The benefits to the company after the introduction of the new cleaning process include the increased motivation of employees to clean the line. Since, in the original measurement, the employee was depressed beforehand from the cleaning time process and the subsequent use of inefficient tools, there was a great reluctance to perform this activity. The employees who performed the cleaning process were always exhausted when they finished. After the newly introduced cleaning procedure, the employees welcome the change and are complying with it for the time being. The company management also promised to discuss with the employee possible rewards for handing over a clean work area to the next shift.

Quantification of costs

Included in the project costs was the purchase of a steam cleaner, work tools, and items that were proposed to be purchased for the soy bunch department after implementing the 5S method. The price quoted for the steam cleaner is an estimate only. Management did not wish to mention the actual price. The total cost of the project is CZK 207 175. The following table 14 provides specific figures.

Table 14: One-off investment

Items	Number of units	CZK/Units	Total
Hook with screw	10	5 CZK	50 CZK
Drawer container (4 drawers)	1	4 742 CZK	4 742 CZK
Wall file tray for documents	1	1 745 CZK	1 745 CZK
Broom set	2	319 CZK	638 CZK
Steam cleaner machine	1	200 000 CZK	200 000 CZK
Total costs			**207 175 CZK**

Sources: Own processing

A one-time investment in work tools, furniture, and a steam cleaner is required to implement the new cleaning procedure. The one-off investment assumes that these tools, items, and furniture will be functional for at least five years in the future. The total cost is negligible concerning the total value of the saving.

Total appreciation

The company was losing a very significant amount of money prior to introducing the new cleaning procedure. After introducing the new cleaning process, the author calculated that the production volume could be increased by 1 092 000 soybean bars per year by using the time saved. This would give the company a profit of 5 460 000 CZK per year. The author sees excellent potential to continue this method, as she believes that the cleaning process could be reduced in the future. Thus, she believes that employees are not trained correctly in most cases, and if this error is eliminated, the company will gain further time savings in the future by using this method.

In Figure 32 below, a comparison of all three measurements can be seen. At a glance, it can be seen that the original manual measurement was reduced from 139 minutes to only 130 minutes for the second measurement. After introducing the new method of cleaning process, the measurement was reduced to 87 minutes.

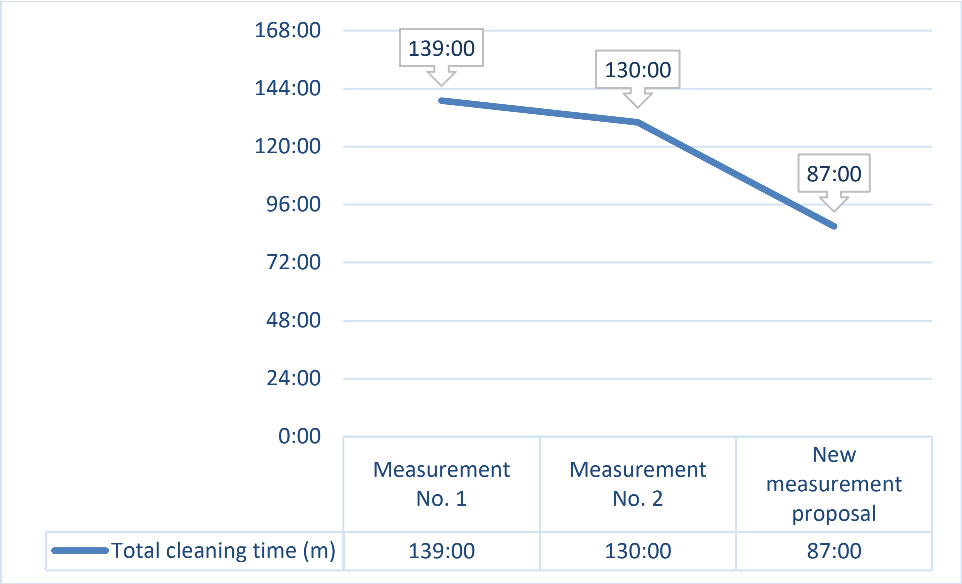

Figure 32: Total cleaning time of all measurements

Source: Own processing

The third measurement of cleaning showed that if the employees follow the standardized workplace and follow the procedure of the new design created for the cleaning process, the production of soybean bars can be extended.

Conclusions

This thesis dealt with the application of lean management implementation principles in a selected company, which was CHOCOLAND a.s. The graduate aimed to evaluate the current state of affairs, analyze the selected production process, and identify critical gaps. Subsequently, the author of this thesis proposed the most appropriate measures to eliminate the critical points with the help of selected lean management tools that will help the company streamline the selected production process and then economically evaluated the recommended changes.

The theoretical part of the thesis consisted of a literature search. In this part of the thesis, the basic theoretical definitions in the field of lean management and its outlined history were defined. Furthermore, the types of waste in business processes were described, specific lean management methods and tools were listed, and the general implementation of lean management and its success factors were defined.

After defining the theoretical part, the application part followed. In the introduction of the application part, the selected company was first introduced. For this thesis, the company analyzed was CHOCOLAND a.s., which is a leading producer and distributor of confectionery and semi-finished food products. Subsequently, its history, mission, vision, strategic goals, and plans were described. Afterward, an analysis of the current state of affairs in the soybean department was conducted.

The soybean department was selected for the application of selected lean management tools. To establish order in the department, the graduate proposed a 5S method to organize and clean the workplace. All redundant and unused work aids were removed from the workplace; for a precise arrangement of work aids, the author's newly proposed places for their more efficient use, the specific location was defined by the employees themselves. In addition, the cabinets in the workplace were thoroughly and deeply cleaned, and organization and proper placement were created using the Dymo label marker. Walking time was then eliminated for the digital scale, which was moved closer to the machine. The introduction of the 5S method helped to speed up production productivity, the goal of eliminating the word "search" was achieved, and production time was saved as a result. The level 1S target for 04/2022 was successfully achieved within the specified timeframe.

Another suggestion for improvement was to reduce lost time caused by tedious cleaning of a complete production line using the SMED method. First, an initial measurement of the current situation was carried out, which revealed a massive waste of time. In the second measurement, the staff avoided some of the errors from the first measurement. Nevertheless, many unexpected circumstances occurred in the second measurement, and the cleaning process was reduced by only 9 minutes. The author of this thesis considered both measurement times and made a suggestion for a new procedure for the cleaning process. Thanks to the implementation of the author's proposal, the SMED method was able to reduce the cleaning process time on the complete production line from the original 139 minutes to 87 minutes. The goal of reducing lost times due to the cleaning process by 38% has been successfully achieved.

In the final part of the thesis, an economic evaluation of the newly proposed procedures was carried out. It can be concluded that the implementation of the proposed changes was beneficial to the company.

The design of the two lean management methods and the preparation itself greatly benefited the diploma student. The graduate implemented these methods entirely on her own and only had her consultant in the form of the CEO available for consultation. Thanks to this work, the graduate gained experience, and thus the author's horizon in the field of business processes was broadened. The thesis author was pleased that the company chose her for cooperation. The graduate had the privilege of being part of the company and getting more insight into the production operations.

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