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Enhancing continuous improvement in the production unit

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ABSTRACT:

Continuous improvement comprehensively develops the processes of an organization in small steps, thus maintaining the competitiveness of the company. Effective continuous improvement requires high-quality and systematic process management, which guides development activities to achieve the organization's goals. Lean and Six Sigma are popular strategies for implementing continuous improvement to ensure high-quality work and efficient performance. This thesis combines the principles and practices of continuous improvement and Lean Six Sigma to ensure systematic development.

The visibility of continuous improvement and the participation of assemblers in its daily implementation have been questioned in the production unit. The aim of this thesis is to map the current state of continuous improvement in the production unit, to find ways to make it more efficient, and to evaluate the related financial benefits. The inefficiency of the production unit and the resulting development potential are assessed through the average waiting time. The current state analysis is based on interviews with key personnel in the production unit, a survey of production assemblers, and process data.

The research results show that the unit does not have its own development responsibility, and the processing of production development proposals is entirely up to the parties receiving them. Continuous improvement is implemented in a project-based manner, without a systematic and goal-oriented development entity. The production unit has significant development potential, which can be realized by implementing the systematic continuous improvement model presented in this thesis. As an alternative solution, the thesis also offers individual development ideas to enhance continuous improvement, which offers the possibility of partial implementation if necessary.

The improvement proposals presented in this thesis support and complement existing continuous improvement practices. They enable effective employee involvement, transparency of the development process, and monitoring of results against objectives. Thus, ensuring systematic continuous improvement of operations and the achievement of financial benefits.

KEYWORDS: Continuous improvement, management, efficiency, systematic development, Lean Six Sigma

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Tiivistelmä:

Jatkuvalla parantamisella kehitetään kokonaisvaltaisesti organisaation prosesseja jatkuvasti pienin askelin, mahdollistaen yrityksen kilpailukyvyn ylläpitämisen. Tehokas jatkuva parantaminen edellyttää laadukasta ja systemaattista prosessijohtamista, jonka avulla ohjataan kehitystoimintaa organisaation tavoitteiden saavuttamiseksi. Lean ja Six Sigma ovat suosittuja strategioita jatkuvan parantamisen käyttöönotossa laadukkaan työn ja tehokkaan suorituskyvyn varmistamiseksi. Tämä tutkielma yhdistää jatkuvan parantamisen ja Lean Six Sigman periaatteita ja käytäntöjä systemaattisen kehittämisen varmistamiseksi.

Jatkuvan parantamisen näkyvyyttä ja asentajien osallistumista sen päivittäisessä toteutuksessa on kyseenalaistettu tuotantoyksikössä. Tämän tutkielman tavoitteena on kartoittaa tuotantoyksikön jatkuvan parantamisen nykytila, selvittää keinoja sen tehostamiseksi ja arvioida siihen liittyviä taloudellisia hyötyjä. Tuotantoyksikön tehottomuutta ja siitä koituvaa kehityspotentiaalia arvioidaan keskimääräisen odottamiseen kulutetun ajan kautta. Nykytila-analyysi perustuu tuotantoyksikön avainhenkilöiden haastatteluihin, tuotannon asentajille suunnattuun kyselyyn ja prosessidataan.

Tutkimustulokset osoittavat, että yksiköllä ei ole omaa kehitysvastuuta ja tuotannon kehitysehdotusten käsittely on kokonaan niitä vastaanottavien tahojen varassa. Jatkuvaa parantamista toteutetaan projektiluonteisesti, ilman systemaattista ja tavoitteellista kehityskokonaisuutta. Tuotantoyksikkö omaa merkittävän kehityspotentiaalin, jota voidaan realisoida ottamalla käyttöön tämän tutkielman esittämä systemaattisen jatkuvan parantamisen malli. Vaihtoehtoisena ratkaisuna tutkielma tarjoaa myös yksittäisiä kehitysideoita jatkuvan parantamisen tehostamiseksi, mikä tarjoaa tarvittaessa mahdollisuuden myös osittaiseen käyttöönottoon.

Tässä tutkielmassa esitetyt parannusehdotukset tukevat ja täydentävät jo valmiiksi käytössä olevia jatkuvan parantamisen käytäntöjä. Niillä mahdollistetaan työntekijöiden tehokas osallistaminen, kehitysprosessin läpinäkyvyys ja tulosten seuranta suhteessa tavoitteisiin. Näin varmistetaan toiminnan systemaattinen jatkuva parantaminen ja taloudellisten hyötyjen saavuttaminen.

Avainsanat: Jatkuva parantaminen, johtaminen, tehokkuus, systemaattinen kehittämien, Lean Six Sigma

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1 Introduction

Continuous improvement (CI) is a central theme in many organizations, both academically and in practice (Sunder & Prashar, 2020). According to Rother (2010, p. 10), Toyota describes CI as a daily activity that takes place at all levels of the company and by everyone, in collaboration. Previous studies show that implementing systematic tools and techniques of CI can improve process efficiency and productivity (Khan et al., 2019, p. 543). Modern organizations are constantly looking to improve their operations due to consumer requirements, globalization, and increasing competition (McLean et al., 2023, p. 2223). These improvements are often sought through CI initiatives, and for this reason, CI is often considered a cornerstone for staying competitive (McLean et al., 2023, p. 2223).

The purpose of this thesis is to investigate continuous improvement and process efficiency in a production unit and to find out whether the implementation of CI could be improved. In a literature review, the study first presents the key topics and methods that support both the reader's understanding and the data collection and analysis when conducting the research, providing a theoretical framework to be used in the research. The research methodology section discusses the research approach and data collection and analysis methods, as well as their reliability. The results are presented as an analysis of the current state of the process, including performance, management model, and improvement capability. Piloting development ideas based on the results is not part of this study, so the discussion section will consider possible improvements and their benefits. The conclusion section answers the research questions and highlights key findings and the business cases.

The work progresses according to the DMAIC structure, the most common and widely used Lean Six Sigma method (Munro, 2022, p. 8). The DMAIC phase-based model consists of the words "*define*," "*measure*," "*analyze*," "*improve,*" and "*control*" and is used to systematically identify improvement opportunities (see Figure 3, p. 32) (Munro, 2022, p. 22). In this thesis, the define phase consists of an introduction and literature review section, which describes the research problem and the theoretical framework of the study. The measure phase is implemented by performing the research methods described in the research methodology section. The results section of the study covers the analyze phase, which presents the current state analysis based on the research results. The improve and control phases are combined, and the implementation is applied in the discussion and conclusion sections of the study, which present the improvement opportunities and the results of the study. That is, in contrast to the normal DMAIC process's practical testing practices, where the improve and control phases usually require practical testing and setting a control plan (Munro, 2022, pp. 8, 428), these phases are treated at a hypothetical level in the results and discussion sections.

1.1 Background and research context

Competition in the market is constantly increasing, which in turn requires companies to make continuous efforts to remain competitive (Khan et al., 2019, p. 543). According to Parente and Rocha (2025, p. 1773), systematic development is an important factor in maintaining competitiveness. Systematicity ensures that root causes are identified and that process variability is under control (Parente & Rocha, 2025, p. 1773). Continuous improvement methods have become increasingly important factors in surviving in the market (Khan et al., 2019, p. 543).

Systematic development is an important part of continuous improvement, as Zighan and Ruel (2023, p. 238) and de Jager et al. (2004, p. 315) emphasize, and it enables the organization to achieve its expected performance (Zighan & Ruel, 2023, p. 244). In recent years business environments and processes have become increasingly complex and uncertain (Zighan & Ruel 2023, p. 236; Metz et al., 2025, p. 2). Actual conditions and process development must be systematically integrated to ensure high-quality products and stable processes. Thus, process management requires systematic process control (Metz et al., 2025, pp. 2, 24). Companies need to be able to respond quickly and adequately to opportunities and threats (Zighan & Ruel, 2023, p. 234). Responding effectively to market demands requires rapid and systematic development (Metz et al., 2025, p. 2). Without a systematic approach, identifying and analyzing errors is challenging (Aljedaani et al., 2025, p. 4), and the lack of systematic identification of problems has a direct impact on operational efficiency (Grenzfurtner et al., 2022, p. 240).

The production unit under study is responsible for one key subassembly as part of a larger production system. The unit consists of approximately 40 people in total. The assembly team works in two shifts, in one location, divided into different workstations. These workstations are product-specific, and assemblers are assigned to them based on the type of product they specialize in. Depending on the product, their assembly takes from two days to two weeks. The team coordinator assembler acts as a link between assemblers and management, working among assemblers to ensure and communicate production progress, and executes corrective actions for production-related issues. The modules are manufactured in this location from start to finish, from where they are transferred to the next stage of the production process. The operation of this production unit is significant for the entity, and the efficiency of its operation contributes to the completion of the entire process. Figure 1 shows a chart of the case unit and the organization that is the focus of this study.

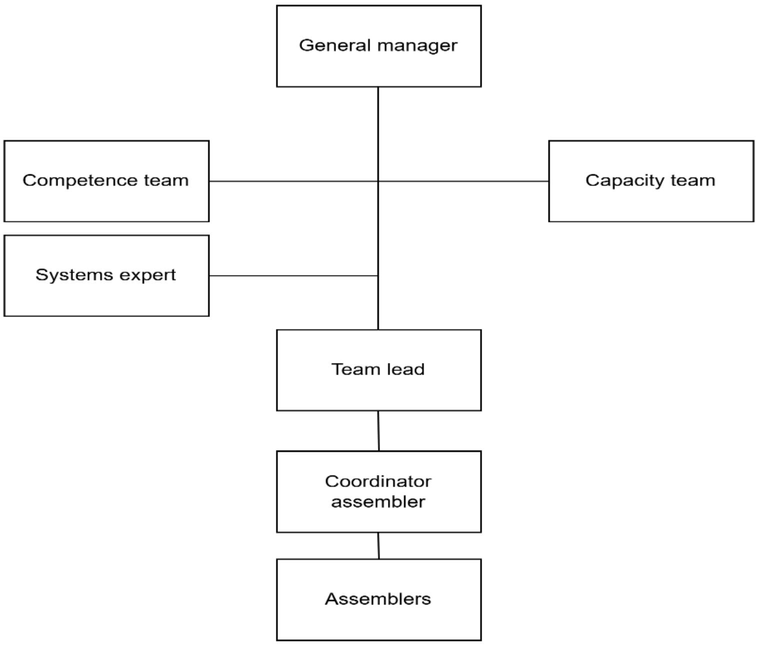

Figure 1. Production unit organization chart.

Team leaders and their immediate management and support functions guide the production team's daily operations. Management is strongly present in the implementation of operations in the production environment, holding daily meetings and monitoring and directing operations to achieve operational goals, maintaining high quality and efficiency. Table 1 presents the unit's management structure meeting practices in more detail. Leaders are also responsible for the well-being, safety, and maintenance of competence of assemblers, as well as for setting personal and team-specific goals to secure and monitor employee development.

Table 1. Production unit meeting practices.

Name of the meeting	Target group	Purpose / topic	Repetiveness
Morning meeting	Assembly team	Status review, Division of tasks	Daily
Morning meeting	Team lead	Status review, General matters	Daily
Production status review	Office workers, All relevant stakeholders	Status review	Daily
Weekly goals meeting	Team lead, project	Mapping and resourcing of weekly goals	Weekly
Weekly production meeting	Team lead, Coordinator assemblers, Quality department	Status review, Quality matters, Safety matters, General matters	Weekly
Production breefing	Office workers, Coordinator assemblers	Current matters in production	Weekly
Quality meeting	Team lead, Coordinator assemblers, Quality department	Examination of quality issues	Weekly
Factory information event	Everyone	Important news	Occasionally
Performance review	Assembly team	Team-specific goals	Annual

The capacity team is responsible for the production schedule and ensures that the necessary resources are available to implement it. The systems expert assists employees in solving problems related to systems and acts as part of the continuous development of production systems. The competence team ensures that employees have completed the training assigned to them and communicates and organizes new training.

1.2 Research problem and gap

Continuous improvement has been widely studied, and related data is already available in the existing literature. However, information on the topic is relatively fragmented, and scientific studies on the topic mostly cover the subject areas in a very limited and precise manner, related to the context of the articles in question. In other words, comprehensive and holistic sources related to continuous improvement and process efficiency are limited among modern studies. This claim is supported by the fact that the construction of the theoretical framework for this thesis requires the review of hundreds of reliable scientific sources. This constitutes the research gap of this thesis, and the purpose is to unify and compile existing knowledge into one comprehensive framework.

From the perspective of the production unit under study, the key challenge in implementing continuous improvement is its visibility in production facilities, in the daily work of assemblers, and in management in the form of measurable results. There is a lot of talk about it within the company. Training is held on the subject, but its visibility in daily work remains questionable. The challenge for the production unit, from the perspective of daily CI, is the involvement of assemblers and management, as well as the lack of guidance, systematic operating models, and personal and team-level goals. The research gap in this study lies in the fact that CI is being carried out, but without clear goal setting, measurement, and a consistent structure.

1.3 Purpose, objectives and research questions

The main purpose of the study is to evaluate and develop a systematic continuous improvement approach in the production unit. More specifically, come up with development ideas enhancing the CI. Inefficiency, waste, and development potential are assessed from the current state analysis of the case unit. The study is examined as a business case, and rough financial benefit estimates are given for potential improvements to justify its significance. This study will also serve as a process development model and toolkit that supports and emphasizes CI.

This study aims to answer the following questions:

- What is the current state of continuous improvement in a production unit, and how could it be improved?
- What is the potential for improving the efficiency of the assembly process, and how much time and resources are wasted due to inefficiencies?
- What kind of financial improvement potential can be identified to support a business case for systematic CI with clear goals defined?

1.4 Scope and limitations

This research focuses on one production unit and the assembly process it is responsible for. The continuous improvement practices and process efficiency occurring in the case unit are mapped, with a particular focus on waste. The case unit includes the assemblers and their immediate management. In other words, the research focuses on things that can be done within and by this production unit, focusing on development management and problem-solving.

The research does not focus on external processes, support functions, and actors related to the production unit. Other units of the organization and the examination of broader entities are also excluded from the work.

The available data is limited, and most of the results and conclusions will be based on information collected through interviews and a survey conducted during the research. This also limits the creation of accurate financial calculations, and therefore it is based on rough estimates, only to support the business case. The research is also conducted from the perspective of only one production unit, without considering other possible external influencing factors. The part of the organization being studied only contains a small portion of the organization's actual number of people, which has a limiting effect on the sample size of the data collected.

Due to scheduling reasons, the development ideas based on this research are not piloted and tested in practice, which also leads to the application of the DMAIC structure. In other words, the research deviates from the testing practices of the typical DMAIC process, and the development ideas and their effects are treated only hypothetically. They are presented as suggestions to the department management.

2 Literature review

2.1 Continuous improvement

Toyota, one of the originators of continuous improvement, has adhered to its principles since its founding, thus creating a reliable reputation worldwide (Toyota Auto Finland Oy, n.d.). Their success is based on customer-oriented thinking, which means that quality comes first and operations are continuously improved (Toyota Auto Finland Oy, n.d.). CI ensures daily improvement of every process at all levels of the organization, which means involving everyone, from management to employees (Rother, 2010, p. 10). Involving all parties can potentially enable development without major investments (Singh & Singh, 2015, p. 77). These daily improvements, whether large or small, are made even if the set goals have already been achieved (Rother, 2010, p. 10). There is always room for improvement regardless of the system; areas that can be improved just need to be identified (Khan et al., 2019, p. 543).

Continuous improvement is a process that aims for improvement, rather than a series of discrete improvement actions (Meiling et al., 2012, p. 141). This process is continuous and carried out daily, making it a normal way of working (Rother, 2010, p. 16). The process remains constant, predetermined, and independent of the content, i.e., the development target, which makes it easily applicable regardless of the case (Rother, 2010, p. 16). This means that an effective development process is systematic, not random (Parente & Rocha, 2025, p. 1773), which in turn means utilizing structured, planned, and organized approaches (Khan et al., 2019, p. 543). In addition to fixing the problem, it is also necessary to find its root cause so that it can be avoided in the future (Parente & Rocha, 2025, p. 1773).

An important part of process development is to focus on customer needs and eliminate non-value-added activities, i.e., waste, as Khan et al. (2019, p. 543) emphasize. A culture of continuous improvement helps an organization reduce waste in all its systems and processes (Lizarelli et al., 2021, p. 983). Identifying wasteful processes is one of the prerequisites for remaining competitive (Khan et al., 2019, p. 543). In practice, workers often identify waste, as Singh and Singh (2015, p. 80) state, highlighting the importance of everyone's involvement. According to Singh and Singh (2015, p. 82), standardization of work is also an important factor in reducing waste and increasing process productivity. It means properly structuring the activities and standardizing the process in question so that the variation in it is reduced (Singh & Singh, 2015, p. 82). CI helps to improve and maintain these standardized processes (Singh & Singh, 2015, p. 96). Studies show that CI is specifically focused on existing standards and reducing the variation in them (Neag et al., 2021, p. 4; van Kleeff et al., 2023, pp. 1, 4), which suggests that only a standardized process can be developed systematically.

The word "Gemba" refers to the work environment where work is done, such as a production hall (Suárez-Barraza et al., 2012, p. 29). This word refers to an approach that is one of the fundamental principles of continuous improvement and the original Japanese management system (Suárez-Barraza et al., 2012, p. 29). Problem solving is most effective where the problems occur (Bateman et al., 2016, p. 7350), and in addition to everyone doing their part in identifying them, it is important for management to also move from their workstations to see the process with their own eyes (Suárez-Barraza et al., 2012, p. 29). On-site observation and understanding of the production process allow the identification of inefficiencies, real-time monitoring, and promotion of problem-solving (Díaz-Reza et al., 2024, p. 2). This gives management the opportunity to interact directly with workers and thus learn and develop operations based on their experiences (Díaz-Reza et al., 2024, p. 2).

2.1.1 Continuous improvement in production environment

Previous research has shown that successful implementation of continuous improvement begins on the shop floor, and it is the responsibility of management to support it (Ma et al., 2018, p. 1942). Production level teams play a key role in improving daily operations and practices, thereby increasing process efficiency (Lodgaard & Powell, 2021,

p. 596). This task mainly includes reducing waste and variation, identifying and resolving problems, and standardizing production processes (Lodgaard & Powell, 2021, p. 597; Ma et al., 2018, p. 1944). Standardization of processes and practices is important because it creates a foundation for development (Torres et al., 2020, p. 827). CI is implemented in practice utilizing many different methods and practices (Khan et al., 2019, p. 543).

According to Zarbo (2022, p. 166), daily management (DM) is a continuously operating structure for problem-solving and one of the significant enablers of continuous improvement on the shop floor. The team itself is responsible for day-to-day management. This brings structure, consistency, focus, and accountability to the work, continuously improving the group's work output (Zarbo, 2022, p. 166). DM is a structured and visible way to develop team activities collaboratively, as noted by Zarbo (2022, p. 167). It enables immediate resolution of issues to ensure work continues and issues are documented for later root cause investigation (Zarbo, 2022, p. 166). DM is also described by Zarbo (2022, p. 166) as a comprehensive approach that provides identification of recent process failures and their clear and visual depiction. These DM dashboards can be utilized during Gemba walks, activating Lean thinking among employees, and promoting CI by asking questions about the data (Zarbo, 2022, p. 166).

Regular team meetings are an important part of implementing and maintaining continuous improvement, as Carvalho (2022, p. 216) notes. The frequency of meetings varies, but the most common models include daily short meetings (Daily Kaizen) (Carvalho, 2022, p. 216). Team meetings aim to improve team cohesion and motivation, show performance status, track improvement activities, plan future work, and provide an opportunity to report on events (Carvalho, 2022, p. 216).

The use of visual tools in operations management has become more common in recent years (Bateman et al., 2016, p. 7345). These visual management (VM) solutions are used as part of Lean implementation for, among other things, planning, communication, and performance monitoring (Ma et al., 2018, p. 1944; Bateman et al., 2016, p. 7346).

Describing processes visually enable understanding the situation and locating problems quickly and is therefore considered a platform for development and continuous improvement (Bateman et al., 2016, p. 7346). VM methods are widely used in daily management to promote CI (Zarbo, 2022, p. 166). Visual indicators in DM help employees identify problems and thus motivate them to participate in problem-solving (Zarbo, 2022, p. 167).

There will always be problems due to continuous errors by people or equipment. Carvalho (2022, p. 153) emphasizes that it is important for organizational development to share the awareness that there is always something that can be done better. People recognize problems differently, and therefore Carvalho (2022, p. 153) highlights the importance of pushing employees to examine their environment and locate shortcomings. The most important thing in problem solving is to recognize the problem and accept that it exists. All methods and tools intended for problem solving are secondary (Carvalho, 2022, p. 154). Continuous improvement often applies to tools such as a four-step Plan-Do-Check-Act cycle to identify problems, develop and implement solutions, and standardize results (Ma et al., 2018, p. 1943). There are numerous tools to support problem solving and root cause analysis, such as DMAIC, 5-Whys, A3 reports, and the Ishikawa diagram (Carvalho, 2022, p. 154).

Involving all members of the organization is seen as an enabler of continuous improvement. Everyone should monitor their progress against goals and resolve any related issues (Zarbo, 2022, p. 166). Employee involvement also enables small, daily improvements that may not have a measurable impact on their own but together can have a large impact on efficiency (Ma et al., 2018, p. 1943). This philosophy is also supported by the fact that it is natural for employees to identify problems and to tell others about them on their own initiative, and most often also to describe how things should be done (Carvalho, 2022, p. 155). Employees' ability to identify defects continuously improves when performing the same tasks repeatedly (Sanders Jones & Linderman, 2014). Many organizations try to receive and then implement these ideas by utilizing various suggestion systems (Carvalho, 2022, p. 155).

Leadership plays an important role in implementing a culture of continuous improvement (Zighan & Ruel, 2023, p. 245). Daily CI practices in collaboration with employees are not possible until leaders themselves have embraced cultural change and new ways of working (Zarbo, 2022, p. 166). Only then can leaders motivate employees to accept the CI culture and get them to support it (Ma et al., 2018, p. 1944). The role of leaders is to support daily operations in all aspects, without taking over (Zarbo, 2022, p. 166). The leader listens to employees, improves their well-being, and guides them and empowers them to improve processes and solve problems (Zarbo, 2022, p. 166; Ma et al., 2018, p. 1944).

2.1.2 Typical challenges and barriers to improvement

Implementing Lean practices in organizations involves several challenges and barriers to success (Kurpjuweit et al., 2019, p. 5575). These problems are most often manifested in management and employee involvement, lack of resources, and employee resistance (Kurpjuweit et al., 2019, p. 5575), as well as monitoring and evaluating results (McLean et al., 2017, p. 230).

The implementation of improvements should always be based on the needs of the organization, not on trends, as McLean et al. (2017, p. 224) emphasize, because the wrong motive affects the quality of implementation. Some organizations make the mistake of being aggressive in their pursuit of results, thinking of continuous improvement techniques as immediate and only partial solutions (McLean et al., 2017, p. 224). According to McLean et al. (2017, p. 227), partial implementation of CI is detrimental to the operation because it does not achieve its full potential and can only hinder daily operations. A weak implementation structure and only partial involvement complicate implementation. This is often due to the lack of a roadmap for the implementation process (McLean et al., 2017, p. 227). Setting realistic goals is essential to avoid unnecessary disappointment. Failure to meet goals can lead to significant losses (McLean et al., 2017, p. 224).

Also, it is necessary to understand that successful process development requires standardized processes, as without process standardization there is no systematic improvement (Backlund & Sundqvist, 2018, p. 1310). In addition, hierarchical management structures can also hinder the implementation of changes, as can employee turnover and poor communication between departments (McLean et al., 2017, p. 225).

McLean et al. (2017, p. 226) emphasize that organizational changes require strong leadership. The lack of commitment from management makes the implementation process difficult (Kurpjuweit et al., 2019, p. 5580). Lack of commitment can also distract from improvement efforts (Backlund & Sundqvist, 2018, p. 1310), which can manifest as shifting priorities, inadequate support, and poor involvement or delegation (McLean et al., 2017, p. 226). As McLean et al. (2017, p. 226) note, the implementation of continuous improvement can be initially difficult and slow, and this can frustrate management and cause them to abandon initiatives and focus on other tasks. The additional tasks resulting from improvement can also burden lower-level managers, which can also lead to indifference (McLean et al., 2017, p. 226).

The strategic goals of the organization are based on its vision. These can be described as the goals of the top management (Lesníková et al., 2022). The strategy is translated into operational goals, i.e., the organization is aligned with the strategy (Lucianetti et al., 2019, p. 341). This means that the strategy is implemented in the daily activities of all employees, divided between different departments, clarifying the connection between short-term and long-term goals (Lucianetti et al., 2019, p. 341). It is the responsibility of leaders to align the goals set for employees with the goals of the organization (Alnadi & McLaughlin, 2021, p. 1077). If actions are not tied to goals, they are focused incorrectly, and this can in turn lead to organizational failure (McLean et al., 2017, p. 228).

Employees may resist changes because they are accustomed to certain ways of doing things. The resulting hesitation can reduce the effectiveness of improvements ("More than just reduction…", 2025). Negative perceptions of change are usually due to lack of information and understanding, which in turn creates sense of uncertainty (McLean et al., 2017, p. 224). In other words, everything new may seem too complicated and vague. When changes are perceived as a threat, McLean et al. (2017, p. 224) explains that it arouses cynicism, which can easily spread to other employees. Employees may also avoid the mindset of continuous improvement until they see some benefit in it for themselves (Zighan & Ruel, 2023, p. 245).

There may be differences in opinion between management and employees, which can be problematic. McLean et al. (2017, p. 224–225) emphasize that managers must be able to motivate employees to participate and solve problems. Various incentives have been used to address this problem, but rewards run the risk of making employees put profit before learning (McLean et al., 2017, p. 224). Sometimes employees just want to focus on what they specialize in and would rather not get involved in anything else (Backlund & Sundqvist, 2018, p. 1314). Reporting failure can be challenging for some, and some may be afraid of making mistakes, however, this can be addressed by creating a forgiving culture where mistakes are allowed (Backlund & Sundqvist, 2018, p. 1314). On the other hand, it may just be a matter of time pressures and a feeling that there is simply no time to participate in improvement (McLean et al., 2017, p. 229). The lack of vision and the big picture can also make it difficult to identify and address problems for people who are new to the concepts of continuous improvement (McLean et al., 2017, p. 229). Some employer-provided training programs are not comprehensive enough for employees to understand everything they need to know about the required techniques and how to apply them (McLean et al., 2017, p. 227). Addressing the challenges of engaging in improvement initiatives can be challenging, as simply forcing an employee can also lead to failure (McLean et al., 2017, p. 229).

Lack of resources is often problem for implementing Lean methods, as Kurpjuweit et al. (2019, p. 5580) point out. This can mean insufficient budget, weak systems or poor support from supporting departments (McLean et al., 2017, p. 225). However, McLean et al. (2017, p. 230) emphasize that the most important resource is employees. Utilizing their full potential requires investing in employees and training them. Furthermore, time, as a resource, is often a problem (Kurpjuweit et al., 2019, p. 5580), which can manifest itself as conflicting situations between different tasks (McLean et al., 2017, p. 229).

Poor monitoring of changes, and evaluation and reporting of results can be detrimental to implementation, according to McLean et al. (2017, p. 230). Organizations may face challenges in monitoring and analyzing long-term performance (McLean et al., 2017, p. 230–231), and this is due to the lack of comprehensive indicators (Lewicki et al., 2025, p. 4). Effective indicators allow for the collection of reliable and unambiguous process data (Lewicki et al., 2025, p. 4). Challenges with verifying achievements can lead to inaccurate results (McLean et al., 2017, p. 230–231). For example, annual savings estimated based on short-term observations may be inaccurate, which can lead to unnecessary or premature profit announcements (McLean et al., 2017, pp. 230–231). On the other hand, the interdependence of complex production processes and key performance indicators (KPIs) can make visualization difficult, and large companies often have many KPIs in use simultaneously, but only a few are used for monitoring and optimizing daily operations (Kurpjuweit et al., 2019, p. 5581).

2.2 Process efficiency, maturity and management

2.2.1 Process efficiency in production

Process efficiency is one of the key factors in surviving in the market and remaining competitive (Lewicki et al., 2025, p. 2). Efficiency relates to the performance of a system, describing the use of resources in relation to results and whether the results justify the resources used (Ravelomanantsoa et al., 2019, p. 5028). Efficiency is an indicator for evaluating the production process, and its importance in maintaining competitiveness and profitability has been emphasized in the literature (Lewicki et al., 2025, p. 3-4).

According to Lewicki et al. (2025, p. 2), the efficiency of the production process can be influenced by assigning appropriate roles to employees and factors affecting efficiency can be determined by analyzing various quality tools. Identifying problem areas enables process optimization and increased production efficiency (Lewicki et al., 2025, p. 3). Certain types of organizational changes can also increase efficiency, and by analyzing the resulting effects and utilizing Kaizen methods, operations can be made even more efficient (Lewicki et al., 2025, p. 4).

Effectiveness is related to value creation and describes how well the set goals are achieved (Ravelomanantsoa et al., 2019, p. 5028). Effectiveness and efficiency are therefore compared to each other in such a way that effectiveness is a measure of how well customer requirements are met (quality), while efficiency measures the use of resources to achieve a certain level of customer satisfaction (productivity) (Ravelomanantsoa et al., 2019, p. 5029; Schmitt et al., 2025, p. 82129).

2.2.2 The process maturity

According to Van Looy et al. (2011, p. 1120), assessing maturity aims to improve processes systematically and, over time, to improve the performance of the entire organization. Yang (2013, p. 112) points out that elements of maturity and project performance are proven to be related. Maturity ensures the ability of business processes to improve performance over time, by developing the capabilities of both individual processes and the entire organization (Van Looy et al., 2011, p. 1126). In practice, maturity is a measure used to assess current capabilities in certain areas (Van Looy et al., 2011, p. 1126). These capabilities to be assessed include definition, management, measurement, and continuous improvement of the process (Yang, 2013, p. 112; Charlampowicz et al., 2024). In the literature, maturity is defined as the extent to which the processes in use are explicit and consistent (Van Looy et al., 2011, p. 1126; Yang, 2013, p. 112), which in turn emphasizes the previously noted importance of systematicity.

Process maturity is used to determine the level of progress and trajectory for progression of an organization, and this usually utilizes a conceptual framework that includes maturity levels (Charlampowicz et al., 2024). These maturity levels define the envisioned, desired, and typical trajectory for the progression of an organization, according to Charlampowicz et al. (2024). Van Looy et al. (2011, p. 1129) emphasize that maturity should not be viewed as an isolated assessment but rather should always be viewed in relation to objectives and key performance indicators to achieve operational excellence.

Van Looy et al. (2011, p. 1127) also state that there is a consensus on the importance of maturity level in demonstrating organizational growth. The five-level maturity assessment originally originated from the Capability Maturity Model Integration (CMMI) model (Charlampowicz et al., 2024). Furthermore, based on this model, these five levels have been selected for the Business Process Maturity (BPM) model to assess process maturity (Szelagowski & Sliz, 2025, p. 2296):

- Level 1: Processes are not defined, and individuals' experiences guide actions.
- Level 2: Processes are repetitive, but without consistency and standards.
- Level 3: Processes are defined and standardized, combining training and documentation.
- Level 4: Processes are measured, and process management is data-driven, tracking metrics, KPIs, and goals.
- Level 5: The highest level of maturity, combining continuous improvement and consideration of customer requirements.

Process maturity assessment has become an important part of modern management, and leadership is a key factor in its implementation (Charlampowicz et al., 2024). Activities that deviate from a systematic approach often turn out to be a waste of time and resources (Szelągowski & Śliz, 2025, p. 2294), which highlights the need for leadership commitment. Above all, leadership ensures the strategic alignment of processes, the unity of goals, and the development of competence (Szelągowski & Śliz, 2025, p. 2297).

In conclusion, process maturity is a significant factor in improving manufacturing performance (Yang, 2013, p. 112). In a changing business environment, process maturity helps to consider increased demand and optimize operations (Charlampowicz et al., 2024). The maturity path can guide the continuous improvement of the organization and transform processes into standardized operating methods (Van Looy et al., 2011, p. 1130). The capability of the organization increases as the maturity increases, according to Van Looy et al. (2011, p. 1130).

2.2.3 Maturity of the continuous improvement

Carvalho (2022, pp. 165–166) presents a four-level maturity model in his book “*Continuous Improvement in Organizations”* to assess the maturity of an organization's continuous improvement. According to Carvalho, this model usually starts with the application of lean methods in the production area, after which it includes administrative and support activities. Carvalho also notes that defining maturity levels is not easy, as the boundaries between levels are unclear and open to interpretation. However, Carvalho distinguishes four main levels: Level I—Occasional improvements; Level II—Routine improvements; Level III—Structured continuous improvement; and Level IV—Total continuous improvement. These levels are illustrated in Figure 2, which describes the levels of the model and their main characteristics (Carvalho, 2022, pp. 165–166).

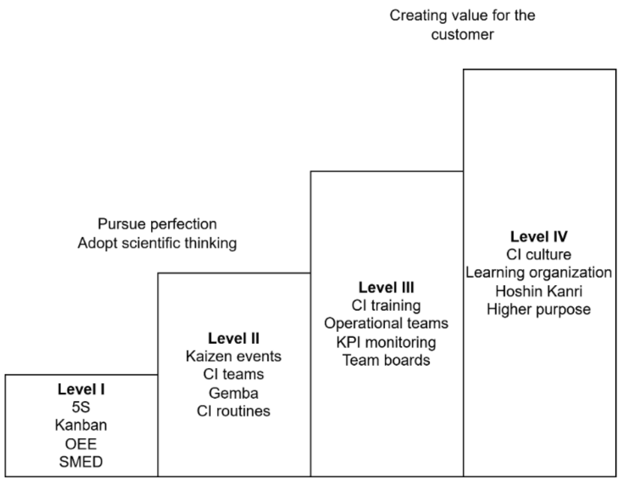

Figure 2. Continuous improvement maturity levels (Adapted from Carvalho, 2022, pp. 165-166).

At level one, Carvalho (2022, pp. 166–169) explains that improvements are occasional and often implemented on a project basis, utilizing methods in production facilities such as 5S, VSM, OEE, SMED, and layout changes. Therefore, Carvalho states that there is no routine for continuous improvement yet at this level of maturity.

At level two, Carvalho (2022, pp. 169–170) notes that there are resources for improvement activities and routines have been formed. At least one person or team has also been designated for continuous improvement (Carvalho, 2022, pp. 169–170), which also indicates some degree of management commitment. This level can be concretely identified, among other things, by the implementation of Kaizen events, Gemba observations, and competence development (Carvalho, 2022, pp. 169–170).

At level three, Carvalho (2022, pp. 172–173) explains that the organizational structure has been shaped to support continuous improvement. The organization has formed natural or operational teams with goals, CI routines, such as 5S and problem identification, and key performance indicator monitoring (Carvalho, 2022, pp. 172–173). At this level, a dedicated team has been assigned to direct and develop continuous improvement activities (Carvalho, 2022, pp. 172–173). However, Carvalho (2022, pp. 172–173) notes that there is still a clear distinction between CI tasks and operational work.

At level four, Carvalho (2022, pp. 173–176) states that every employee in the organization participates in the daily implementation of continuous improvement through their own activities, and CI is fully integrated into operations, quality, and management. At this level, culture and leadership are emphasized, meaning respect for people, humility, and a higher purpose for action (Carvalho, 2022, pp. 173–176). Changes in culture and behavior also emphasize the invisible side of action, and the practical implementation of goals is done using Hoshin Kanri techniques, according to Carvalho (2022, pp. 173–176). In addition, people development has created a positive feedback loop, meaning that as people grow, the organization grows, which in turn increases investment in people (Carvalho, 2022, pp. 173–176).

2.2.4 Process management and its impact on efficiency

According to Hernaus et al. (2012, p. 377), processes and their interactions directly affect the strategic implementation of an organization. As noted in the literature, planning, controlling and improving processes are an essential part of process management (Sanders Jones & Linderman, 2014). Process management utilizes continuous improvement and quality improvement to ensure that the organization maintains its competitive advantage (Yangailo, 2025, p. 98). More specifically, this is done by converting inputs into outputs, i.e., by ensuring production flows. In line with this, process management involves stabilizing organizational processes and creating an environment that enables effective identification of improvement targets (Sanders Jones & Linderman, 2014, p. 336).

Business processes become more efficient when everyone participates and shares their actions and interests (Gošnik et al., 2023, p. 2). Furthermore, previous research shows that process management is a prerequisite for achieving significant improvements in processes, such as improving cycle time (Hernaus et al., 2012, p. 380). Process control is an important part of process management and focuses on existing processes, monitoring them and ensuring consistent performance (Sanders Jones & Linderman, 2014, p. 337). In practice, this is done by identifying and eliminating defects and reducing process variation (Sanders Jones & Linderman, 2014, p. 337). By improving existing processes and producing consistent products, process efficiency can be ensured (Sanders Jones & Linderman, 2014, p. 340).

Aligning business processes with external dynamics is essential, which highlights the importance of process management in managing processes to achieve strategic goals (Badakhshan et al., 2020). Gošnik et al. (2023, p. 2) state that collaboration between all parties involved in the process, both internal and external, is paramount for competitiveness, as it enables rapid response. Business process management must be based on the knowledge of all employees, and its proper implementation is of paramount importance, considering the relationships between employees, management, suppliers and customers (Gošnik et al., 2023, p. 3). Moreover, empirical findings indicate that employee involvement has been shown to have a positive relationship with leadership as a process management function (Gošnik et al., 2023, p. 1).

2.3 Lean

Originally, the main purpose of the Lean Management System was to eliminate waste from production processes to save resources and maintain competitiveness (Sohal et al., 2025, p. 2593). "More than just reduction..." (2025) states that Lean, despite its other aspects, is above all about seeking improvement by identifying and correcting inefficiencies in existing systems and processes. It also emphasizes that successful implementation requires a strategy related to Lean Management. The whole of Lean combines tools, methods, leadership, employee commitment and behavioral changes, which makes it the foundation of a cultural phenomenon and not just a set of tools (Sohal et al., 2025, p. 2594). Implementing Lean tools is easy and may initially appear successful as such, but long-term success requires a deeper, cultural implementation (Toledo, 2019, p. 1184).

Adopting a culture of continuous improvement is essential, as it enables systematic development, learning, and growth from change and thus effective adaptation to new situations ("More than just reduction…", 2025). Maintaining Lean principles requires a certain mindset, and adopting that mindset requires a cultural change, which, in turn, enables the principles to be adopted by every part of the organization ("More than just reduction…", 2025). According to Toledo et al. (2019, p. 1185), leadership plays an important role in implementing and sustaining lean changes, as leaders can influence employee values and attitudes to achieve goals. Effective Lean organizations, like Toyota, train employees to solve problems systematically, following specific methods (Toledo et al., 2019, p. 1188). By following a Kata coaching model like this, leaders can spread a culture where problems are constantly solved by employees while also enabling their personal development (Toledo et al., 2019, p. 1188). Learning and inclusive development require trust between leaders and employees, meaning openness and sharing of responsibility, without fear of failure (Toledo et al., 2019, p. 1185). In Lean companies, the role of leaders includes interaction with employees, which requires open communication, trust, and the development of collaboration (Toledo et al., 2019, p. 1185).

Lean in a manufacturing environment is generally associated with waste reduction and refers to eight different types of waste (Tashin et al., 2025, p. 2370; Douglas et al., 2015, p. 974):

- Overproduction—production exceeds demand
- Overprocessing—non-value-added work
- Waiting—waiting time between process steps
- Transportation—movement of material that is not essential to the process
- Inventory—all parts and products not in processing
- Motion—extra movement that does not contribute to the process
- Defects – work related to identifying and repairing defects
- Underutilization – not utilizing the full potential of the employees

2.3.1 Lean tools and practices

Lean utilizes several different tools and methods to eliminate waste in processes. Value Stream Mapping (VSM) is a popular technique for describing material and information flows and analyzing processes and value chains (Tashin et al., 2025, p. 2370). Creating VSMs allows for identifying waste and optimizing the process by eliminating it (Tashin et al., 2025, p. 2370). It also helps to understand how different factors affect process performance (Tashin et al., 2025, p. 2370).

The purpose of Gemba walks is to go on-site to observe and learn to understand how employees work (Gesinger, 2016, p. 33). It is also a way of showing respect to the employee and that their work is not beneath management (Gesinger, 2016, p. 34). When interacting with employees, the employees' feelings must be considered, i.e., they must not be criticized or judged, and they must not be made to feel inferior (Gesinger, 2016, p. 35). The goal is also to identify problems and strengthen problem-solving by asking employees "why," and it is therefore an effective tool for solving problems (Małysa et al., 2024, pp. 7-8). Regular interaction with workers promotes the relationship between management and employees, creating long-lasting respect, and allows for direct feedback (Gesinger, 2016, pp. 34-35). Spending time with employees also lowers their threshold for communication, increases trust and makes the employee more receptive to important topics such as safety (Gesinger, 2016, p. 34).

5S is a widely used method for maintaining a high-quality work environment and eliminating waste (Ma et al., 2018, p. 1944). The acronym 5S comes from the words "sort," "set," "shine," "sustain," and "standardize," which refer to cleanliness and order (Jaca et al., 2014, p. 4575). The purpose of this method is to instill good practices in the employees, which often leads to changes in employee attitudes and the initiation of development activities in the workplace (Jaca et al., 2014, p. 4575). Due to its significance, 5S is considered a strong foundation for implementing Lean methods and promoting a culture of continuous improvement (Mrabti et al., 2023, p. 1). However, effective implementation requires changes in the culture of the organization and the mindset of employees so that operating methods become standardized and routine (Jaca et al., 2014, p. 4575).

5-Whys is a common problem-solving method that works particularly well in the field, due to its ease of use, for solving small problems (Carvalho, 2022, p. 239). The purpose is to ask the problem "why" five times in a row to identify its root cause (Carvalho, 2022, p. 239) by analyzing the symptoms of the problem one by one (Benjamin et al., 2015, p. 421). Symptoms have been found to mask the causes of problems, which highlights the importance of identifying them (Benjamin et al., 2015, p. 421). Utilizing the 5-Whys can lead to the development of long-term corrective and preventive measures (Benjamin et al., 2015, p. 421). Previous studies have shown that this method works especially well in mapping the causes of waste and accidents (Benjamin et al., 2015, p. 419).

“Kanban” comes from Japanese and has many translations but most commonly refers to a card or a sign, and the Kanban method is based on a pull system (Ahmad et al., 2018, p. 96). In Kanban, the workflow is visualized in stages, for example, planned, in progress, and finished, and the cards move from one stage to another depending on their status (Ahmad et al., 2018, p. 98). Kanban can be implemented with a physical or virtual board, and it allows tasks to be described visually. It is easy for team members to select tasks from the board and visualize the whole (Ahmad et al., 2018, p. 98). Kanban can be used to limit the amount of work in progress (WIP), monitor and control production processes, schedule, improve flow, respond to changes, facilitate high production, avoid overproduction, improve capacity utilization, and shorten production time (Ahmad et al., 2018, pp. 97-98).

Kaizen events (KE) are small, independent activities carried out by employees, with the aim of achieving continuous improvement goals (Kharub et al., 2023, p. 2337) within a short period of time (Garza-Reyes et al., 2022, p. 427). KEs improve processes while promoting employee autonomy (Kharub et al., 2023, p. 2337). These projects are structured and apply lean tools, focusing on improving a specific area at a time (Cannas et al., 2018, p. 3915). They are based on teamwork, employee development, management commitment, waste reduction, employee suggestions, and process implementation and standardization, while combining management concepts, methods and techniques (Kharub et al., 2023, p. 2339).

2.4 Lean Six Sigma

As previously stated, Lean is a systematic approach to waste reduction (Drohomeretski et al., 2014, p. 806) and focuses entirely on speed and efficiency, thus ensuring that resources are directed to the right activities (Laureani & Antony, 2019, p. 54). Six Sigma, on the other hand, focuses on precision and accuracy, and ensures that actions are carried out right the first time (Laureani & Antony, 2019, p. 54). Originally, Motorola developed the Six Sigma concept in 1987 (Drohomeretski et al., 2014, p. 808). It is a strategy for improving business operations by identifying process failures and errors, emphasizing meaningful activities from the customer's perspective (Laureani & Antony, 2019, p. 54; Drohomeretski et al., 2014, p. 808). This data-driven method enables process stabilization and makes results more predictable, reducing process errors and variability (Laureani & Antony, 2019, p. 54). Successful implementation of Six Sigma requires management commitment, supporting infrastructure, employee training, and utilization of statistical tools (Drohomeretski et al., 2014, p. 808).

Lean Six Sigma (LSS) integration, which combines the tools and principles of Lean and Six Sigma, was first introduced in 2000 (Laureani & Antony, 2019, p. 53). The initiative to combine these two philosophies arose when it was realized that even the most popular improvement tools could not, on their own, solve all the problems companies faced (Drohomeretski et al., 2014, p. 804). When implemented well, LSS has been shown to improve performance faster than Lean and Six Sigma implemented separately (Drohomeretski et al., 2014, pp. 804-805). Lean and Six Sigma have grown into the most popular strategies for implementing continuous improvement to improve quality and performance, and the benefits of their combination have been widely highlighted in the literature (Laureani & Antony, 2019, pp. 54-55). In practice, LSS helps meet customer needs, remove non-value-added steps from processes, improve quality, reduce defects in both transactions and products, reduce lead times, deliver the right products to the right place at the right time (Laureani & Antony, 2019, p. 54) and bring added value to all stakeholders in every sector of the organization (Drohomeretski et al., 2014, p. 805).

2.4.1 DMAIC

DMAIC is the most recognized and widely used method in the Six Sigma implementation phase (Drohomeretski et al., 2014, 808). DMAIC is a framework for applying the Six Sigma model and a process for continuous improvement, and it consists of the steps Define, Measure, Analyze, Improve, and Control (Drohomeretski et al., 2014, p. 808; Ihalainen & Hölttä, 2001, p. 8). DMAIC is based on systematicity, science, and facts, eliminating unknown steps of the process, focusing on measurements, and identifying new areas for improvement (Ihalainen & Hölttä, 2001, pp. 8-9). It can also be described as a systematic problem-solving technique (Ihalainen & Hölttä, 2001, p. 58). The steps of the DMAIC process are illustrated in Figure 3 (Ihalainen & Hölttä, 2001, p. 58).

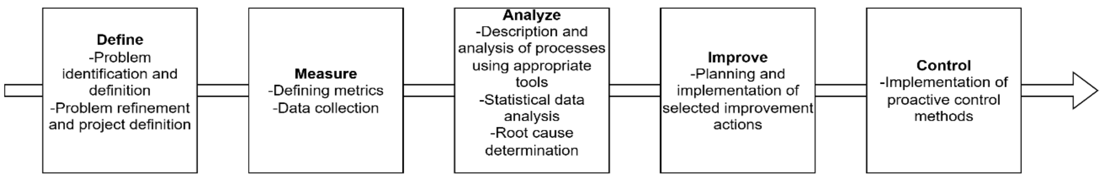

Figure 3. DMAIC Process.

2.4.2 The role of measurement

A key feature of Lean Six Sigma implementation is the focus on data and metrics, which are used to determine process performance and enable improvement (Kumar et al., 2024, p. 1997). By analyzing process data, such as cycle times, defect rates, and customer satisfaction, areas for improvement can be identified and improvement actions can be targeted (Kumar et al., 2024, p. 1997). A good measurement system ensures that the right data is collected. The right data is crucial in terms of decision-making (Liebermann, 2011). It is important to ensure the adequacy of the measurement system and validation of existing measurement systems, including routine systems, if necessary (Liebermann, 2011).

Measurement System Analysis (MSA) is one of the key concepts of Lean Six Sigma, as it refers to the assessment of the quality of measurement data using statistical methods (Pongboonchai-Emplp et al., 2025, p. 4-5). It is used to evaluate the variability in the measurement system and compare it to process variability and specifications (Liebermann, 2011). Gage Repeatability and Reproducibility (GRR) is the most important MSA tool for assessing how repeatable and reproducible a measurement is in relation to process variation (Pongboonchai-Emplp et al., 2025, p. 4-5; Liebermann, 2011). Repeatability means that the same user gets similar results when measuring the same sample and reproducibility refers to how well different users get similar results from measuring the same sample (Liebermann, 2011). The variation due to the measurement system is generally considered ideal if the standard deviation of the variation is less than 10% (Pongboonchai-Emplp et al., 2025, p. 4-5; Liebermann, 2011). Variation can be influenced by many different factors, such as the indicators, the evaluators of the measurement, the environment, and the methods used (Pongboonchai-Emplp et al., 2025, p. 4-5).

2.5 Measuring and reporting process efficiency

A Performance Measurement System (PMS) consists of a set of indicators that measure the efficiency and effectiveness of the production process (Bumba et al., 2023, p. 176). Ahmed (2023, p. 490) points out that these indicators monitor performance and enable communication and behavior in accordance with strategy. The indicators can also be used to form strategies, communicate goals, and set strategic priorities (Ahmed, 2023, p. 491). Goals should always be based on the needs of the company, and an appropriate set of indicators is set for the set goals to achieve strategic goals (Bumba et al., 2023, p. 176).

Performance indicators (PIs) measure actual performance qualitatively or quantitatively in relation to goals (Buchanan et al., 2023, p. 30). Indicators that are essential and critical to strategic goals are called key performance indicators (Bumba et al., 2023, p. 176). KPIs measure the achievement of goals (results) in relation to strategy, while PIs are indicators defined to achieve KPI goals (progress) that can be monitored, controlled, and led in real time (Juran & Godfrey, 1999, pp. 13.15-13.16). For this reason, choosing correct KPIs requires understanding of the organization's vision and goals (Gupta et al., 2024, p. 147). These indicators typically measure the achievement of periodic, operational goals or progress towards the organization's strategic goals (Gupta et al., 2024, p. 147). According to Ahmed (2023, p. 490), metrics that are inconsistent with strategy steer operations in the wrong direction. In terms of achieving strategy and goals, it is important that managers know how to select, prioritize and weight metrics from different perspectives, for example, from the perspective of lean operations (Susilawati, 2021, p. 345). Monitoring PIs and KPIs is relevant to operational management at every level of the organization (Buchanan et al., 2023, p. 34), as measuring and identifying processes is a prerequisite for continuous improvement (Bumba et al., 2023, p. 177).

Visual tools are important in reviewing the results of organizational performance measures and indicators (Sadowski et al., 2024, p. 1494). Sadowski et al. (2024, p. 1508) state that visual management is an important concept in presenting information and results to employees, especially the presentation of key performance indicators on visual boards. Sadowski et al. (2024, p. 1506) describe this as a clear way to present data, which helps employees better understand the results obtained. Measuring and monitoring performance is important for employees to see the results of their own improvement efforts (Carvalho, 2022, p. 215). VM tools have become an important part of organizations' management and decision-making processes, as well as valuable information acquisition (Sadowski et al., 2024, p. 1495). They also serve as an enabler of process transparency (Simons et al., 2016, p. 538).

2.5.1 Metrics of process efficiency

According to Lopes et al. (2016, p. 1348), measurement is always subject to imperfections and variation due to random effects. Therefore, repeating the same measurement process can produce different results (Lopes et al., 2016, p. 1348). They also point out that accurate and complete process data is not always available when measuring performance in real life. There are certain factors involved in the measurement process that may increase the differences between the measured and the actual value (Lopes et al., 2016, p. 1347). For this reason, it is important to understand that measuring itself is not enough but also requires the right metrics and comprehensive analysis, thus creating a big picture to support decision-making (Lopes et al., 2016, p. 1348).

The quality of the measurement system has a direct impact on the data, as Juran and Godfrey (1999, p. 9.11) state that data is never better than the measurement system that produces it. Therefore, verifying the measurement system is important for drawing reliable conclusions (Juran & Godfrey, 1999, p. 9.11). This highlights the importance of the previously mentioned measurement system analysis in data processing. On the other hand, the measurement accuracy should also be appropriate for the purpose and not always too detailed; this avoids unnecessary work and waste of resources (Asset Management Council, n.d.). There are many different metrics for measuring process performance, and comparing their results with objectives describes their effectiveness (Goal/QPC, 2002, p. 131). Table 2 presents some of the most used performance metrics.

Table 2. Typical process efficiency metrics (adapted from Carvalho, 2022, pp. 70–124; Goal/QPC, 2002, pp. 133–165).

Metric	Purpose / what it indicates
Lead time	The time it takes to complete an activity from start to finish, including delays.
Cycle time	The time spent on successfully completing a work process.
Flow efficiency (%)	Value-adding time as a percentage of total lead time.
Throughput	The time it takes to produce a product, from raw materials to finished products.
WIP	Number of products in process or awaiting processing.
Overall Equipment Effectiveness (OEE)	Equipment availability, performance efficiency and quality.
Productivity	Input-output ratio, efficiency of core processes.
Waste / non-value-adding time	Any time-consuming activity that does not add value.
First Time Through (FTT)	Percentage of units that go straight through the production process, without defects.

2.6 Summary and theoretical framework

Based on the literature review of this thesis, it can be stated that continuous improvement, process management, and process efficiency together form a comprehensive and mutually supportive whole for developing performance in a production environment. CI emphasizes systematic and long-term development work, in which processes are developed step by step by eliminating waste and reducing variation. This is enabled by an organizational culture where everyone participates in improvement through their own actions and through data-based decision-making. CI can be thought of as an engine for guiding process optimization.

Process management provides a structure for the systematic planning, control, measurement, and development of processes. Strategic goals come from the top down in the organization, and it is the responsibility of management to set up the roles and objectives of employees in line with the goals. Then, based on the measured and monitored results, operations are improved. Standardization is also an important part of process management, as it is a prerequisite for systematic development. Process management therefore acts as a link between strategic goals and operational functions.

Process efficiency describes an organization's ability to convert resources into value-generating outcomes. Key goals of efficiency include maximizing customer value, minimizing waste, and reducing variation. The impact of improving process efficiency is visible in process lead times, product and operational quality, and productivity, which highlights the importance of a comprehensive process measurement system.

Lean and Six Sigma are widely studied and recognized for their ability to provide structured approaches to process improvement. Lean focuses specifically on eliminating waste and improving flow efficiency, and when integrated with Six Sigma, it also provides statistical quality control and variation reduction. The methods of these process improvement philosophies can be supported by measurement and reporting practices, ensuring reliable assessment of the impact of improvement efforts.

Therefore, CI, process management, Lean Six Sigma, and process efficiency form the theoretical framework of this thesis. CI acts as a driver of organizational development. Process management provides a structure that supports process planning, control and monitoring, and leads development activities. By utilizing Lean Six Sigma methods, process development takes place in practice. Together, these enhance the efficiency of processes and thereby improve organizational performance.

3 Research methodology

3.1 Research approach and case study design

According to Woodside (2016, Chapter 1), mixing multiple methods, both qualitative and quantitative, can often significantly improve case study reports. This research is based on a mixed-methods approach, as it can make the research more precise and comprehensive (Woodside, 2016, Chapter 2). Most of the data is qualitative and consists of interview results, open-ended survey responses, and observations, complemented by quantitative material, which in turn consists of survey and process data. The choice of this approach is based on research questions that require a deep understanding of the current state of continuous improvement and a quantitative assessment of process inefficiencies in production. The research strategy is a case study because, according to Woodside (2016, Chapter 1), a case study aims to understand, predict, describe or control a specific unit. This research is limited to the operations of a specific production unit, which is examined in its own context.

The research is descriptive and exploratory in nature, and the goal is to determine the current state of CI practices, including management and goal setting, process efficiency in terms of waste, and to identify development potential, as well as possible development solutions. The overall logic of the research is based on a deep understanding of the production unit management and process perspectives generated by interviews; identification of everyday problem areas and assemblers' experiences based on a survey; objective perspective of efficiency and waste provided by process data; and observation that complements and validates other data.

3.2 Data collection methods

The target group of the study consists of a total of 45 people. This includes six interviewees and 39 potential respondents to the survey. The main subjects of the study are the general manager, who is responsible for the operations and development of the production unit; the team lead, who is responsible for the daily management and organization of the work of the assemblers; the coordinator assembler, who is the link between the management and the assemblers; and the assemblers, who carry out the assembly processes of the products in practice. These individuals cover all roles that are key to the research, as their daily work has a direct impact on the unit's continuous improvement, management, and inefficiencies. The sample for the study consists of certain key individuals and all assemblers. The sample for interviews is chosen at discretion, including only a few key individuals, while the survey is directed at all assemblers. The study is limited to this one production unit and the examination of the assembly process it performs, excluding all external processes and support functions.

The survey is structured and consists of multiple-choice, Likert scale, and open questions. According to Woodside (2016, Chapter 3), structured data complements open, qualitative data. The survey maps the assemblers' experiences and views on the smoothness of the process, continuous improvement and opportunities for influence, as well as process inefficiencies. The survey is important for the reliability of the research because it highlights the perspective of the assemblers and increases the sample size, producing quantitative information to support qualitative observations. The survey was conducted electronically, and there was a one-week response period. Team leads were utilized to encourage responses. The responses are anonymous, which lowers the threshold for participants to answer honestly, and the survey is presented as a good way to improve the quality of work, which can increase the number of participants. After the survey response window closed, 19 assemblers responded to the survey, covering 48.7% of the assembly team members.

The interviews were conducted in a semi-structured manner, combining systematicity and flexibility. In practice, this means that the questions remain the same but are open-ended (Woodside, 2016, Chapter 13). The interviewees included the general manager; three team leaders, one of whom is the team lead of the assembly team under review and two of whom are typical replacements; a trainee to the main team lead to bring a fresh perspective; and the coordinator assembler. The interviews discussed the goals of both the company and the team and their impact on daily work; the current implementation of continuous improvement; and production problems and problem-solving. Interviews were recorded and transcribed to enable deeper analysis, and each one took about 30 minutes. Interviews allow for deeper understanding and context creation, and they also help with the interpretation of survey responses and potential process data.

The available process data describes all production waste, which can be filtered for different time periods and teams, and is also broken down into different waste types. By examining process data, production efficiency can also be investigated by examining how the amount of waste has changed over time. It can also potentially confirm or cancel claims made in interviews as concrete evidence. The study only deals with process data related to the case unit and not those related to processes and activities outside the study. Process data provides an objective perspective for the study and supports data collected by other means.

Observation is based on getting to know the production environment, and the goal is to visualize the research target unit and its operating methods and practices and possibly sources of waste. This enables confirmation or questioning of interview and survey results and provides an overview of the case unit's operating environment. In addition, understanding the target unit in practice strengthens the reliability of data analysis.

3.3 Data analysis methods

The results of the survey interviews and open-ended questions are systematically analyzed by first presenting the collected raw data on employee views, divided into the themes of process management, continuous improvement, and efficiency in the results section. The results are then summarized analytically at the end of the results section, linked to theory in the discussion section, and to the research questions in the conclusions. The qualitative data and its analysis help to answer the research questions "What is the current state of continuous improvement in a production unit, and how could it be improved?" and "What is the potential for improving the efficiency of the assembly process?"

The quantitative data of the survey is analyzed using descriptive statistics, averages, distributions, and cross-tabulations. Quantitative and process data are used to support qualitative data and identify sources of inefficiency and their approximate frequency of occurrence. This is then used to break down the duration of a single event, assess the overall impact on the team, and estimate how many man-hours are spent on these annually. Finally, this is converted into a monetary estimate. The analysis is performed using Excel. The quantitative data analysis helps answer the research question, "How much time, resources, and money are wasted due to inefficiencies?"

The current state of the research includes process management, CI and inefficiencies assessment, and later in the discussion section, an assessment according to the process maturity model in accordance with the characteristics presented earlier in the theory section. The maturity levels are defined based on all the data of the research, combining the perspectives of management and assemblers, which are supplemented with process data and documents. However, the limitations of the research must be considered, which may distort the final determination of the maturity levels. The maturity assessment confirms the answer to the research question "What is the current state of continuous improvement in a production unit?"

3.4 Reliability, validity and ethical considerations

Methodological and data triangulation strengthen the validity of research results. Triangulation refers to the use of different perspectives when studying the same subject to strengthen and deepen understanding (Woodside, 2016, Chapter 1). The questions of the surveys and interviews are derived directly from the research questions, which are also supported by a comprehensive theoretical framework. Process data is an independent source that confirms the validity of qualitative observations. The interviews use the same structure and theme, which strengthens their repeatability. The survey questions are formulated clearly and unambiguously. The documentation of the analysis processes is carried out step by step, systematically. In addition, the data is collected and analyzed transparently, which enhances the credibility of the research.

Interviews present a risk of bias, as reactions between the interviewer and the interviewees can shape responses. There are also potential social impacts associated with the entire sample, as respondents may seek to present a more positive picture of the organization and their own actions than is realistic. However, these risks are mitigated by formulating and presenting the questions neutrally, ensuring the anonymity of the survey, and presenting the research as an attempt to improve and facilitate employees' work, without blaming. The results may also be biased by the limitations of the confirmed process data. Limiting the study to the perspective of one unit may also limit the generalizability of the research results.

Informed consent is requested from participants in connection with surveys and interviews. The data is treated confidentially, following the company's instructions, and before the data is analyzed, it is anonymized, ensuring that the respondents are not identifiable from the results presented. When conducting the research and processing the data, the researcher behaves completely impartially so that the content of the research results is not distorted.

4 Results

4.1 Process management

The interviewees have a consistent understanding of the company's goal, and almost all describe it in the same way as one interviewee described it: *"the goal to manufacture products with the highest possible quality, on schedule, and safely."* Thus, they emphasize not only the manufacture of products but also how they manufacture them, in this case, timeliness, quality and safety in achieving this main goal. One interviewee added efficiency to this description. These are related to the fact that the company also aims to stay at the forefront of development. The comment related to goals, *"Currently, our goals are in line with what we are able to do,"* also suggests that the goals set are perceived as realistic and in line with production performance. The goals come from the top, and the immediate management implements them to the assembly teams. In other words, the prerequisites for success are created for the assemblers, and then they implement them to the best of their abilities.

One of the interviewees described the vision of the goals in practice as *"Coordinating activities with support actors to make everything run as seamlessly as possible,"* which in the case of this unit are, for example, suppliers, project teams, and the development team. This was strongly linked to the problem-solving aspect of achieving goals, where challenges are overcome through collaboration. The importance of communication was emphasized in the interviews, as the communication between the assembly teams and support actors provides information on whether production will remain on schedule. On the other hand, it also became apparent that there is room for improvement in communication between certain parties, as sometimes Teams messages are used exclusively, which is problematically slow in the face of production challenges.

Daily management was described in interviews as *"a morning meeting where we go over production, what the priorities are, how we're progressing, whether we have any repairs coming up, and whether we have any updates coming up for the products."* In addition, this includes the division of labor and, depending on the situation, considerations related to occupational safety. Development issues were not mentioned in the interviews in connection with the daily meetings of the target unit, and Figure 4 also shows that development issues are not discussed, at least not jointly, in the presence of everyone. Daily production activities are always coordinated according to the production program. This also requires continuous change and situation-specific management from managers, and one interviewee described this as *"eternal change is our field of work; hopefully at some point we will be able to standardize the way we do our work."* One interviewee also emphasized the importance of production control, and the consequences of inadequate control are immediately visible. The operations could be more controlled, but this is also partly difficult because control is in practice carried out through many different actors. The open-ended responses to the survey also revealed that there is room for improvement in production control and communication between management and employees. In addition, the interview sparked a discussion about the interaction between the closest management and the assemblers. It was noted that it is important to talk to the assemblers about other things than work, as it increases trust and lowers the threshold for coming to talk.

The production metrics are extensive, and it was described as *"We have so many metrics that we do not even know what metrics we have."* The interviewee also stated that these should be strengthened and brought to the fore more, even to assemblers, so that they can better understand the overall picture of the unit's operations. One key performance indicator that is tracked in relation to the company's main goal is describing the progress of production products. It consists of phase confirmations of production systems. In practice, this happens so that the assembler confirms the system when a phase has been completed. If confirmations are not made, the measurement results are distorted. This has been talked about a lot and is part of the work, but some assemblers are against working on computers or simply forget to do it. This should become a standardized part of the work routines. In addition, another important indicator is related to occupational safety. It monitors near-miss and accident reports in production in relation to the goal of zero accidents. Production deviations are also monitored by deviation type and production area; for example, the data in Tables 3 and 4 (p. 52) have been collected from this measurement data. Based on interviews, this is an example of a metric that not everyone is aware of.

4.2 Continuous improvement

Production unit development activities mainly focus on improving occupational safety, quality, and operating methods. Occupational safety in production requires particularly careful monitoring, verification, and development. This requires development in responding to problem situations, as adapting the right tools and operating methods to risky situations prevents risk factors. The goal is also to produce products of the highest possible quality, and the regularity of related deviations has become problematic. Also, developing punctuality between production stakeholders is important for staying on schedule. For example, suppliers and their actions have a direct impact on product quality. Figure 4 shows that the company's general development targets have also been communicated to the assemblers, and the importance of continuous improvement has been understood and is generally perceived as a positive thing for operations.

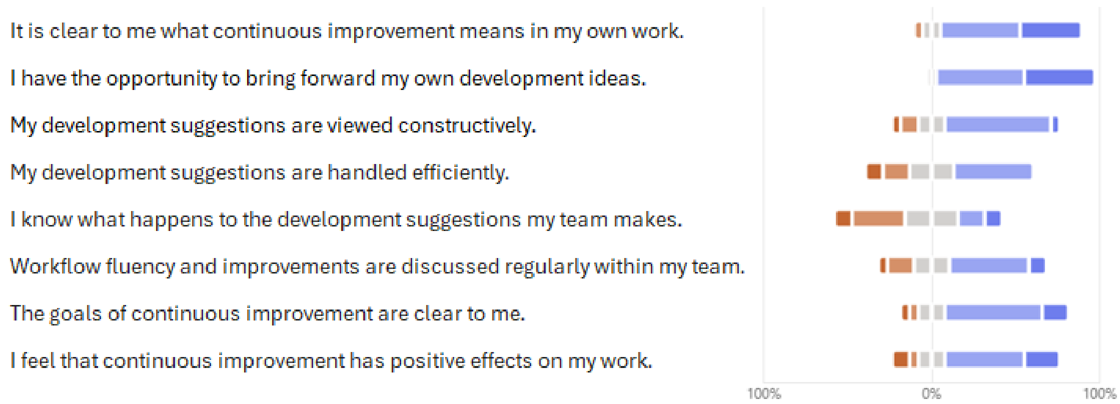

Figure 4. Continuous improvement – Likert scale results.

The interviews summarize the process of bringing forward development ideas: *"You can take things directly to the team lead, the assembly coordinator, the development team, but then we have these initiative systems as a tool."* And this claim is also confirmed by the data in Figure 4, where all survey respondents were aware of their opportunity to report development ideas. The organization also has a culture of learning from mistakes, meaning that it continuously strives to develop operating methods based on mistakes and problems. Figure 5 shows that problems occur in production, but all respondents confirmed that they know how to act at least on some level if a problem occurs. The system that emphasizes development the most was described as *"from an official perspective, it's our initiative system, where these development suggestions, improvement suggestions come directly from the employees,"* from which the ideas are directed to the parties that process them. If an initiative made by an employee is accepted, a financial reward is received. The team leader often must ensure the progress of these initiatives so that change is achieved, which may require separate contacts.

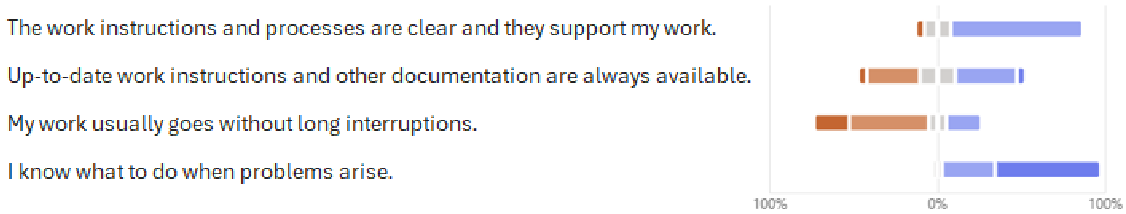

Figure 5. Process and workflow fluency – Likert scale results.

Safety-related improvements are usually made through a dedicated, separate system. All accidents and near-misses are reported to this system, which is handled daily, and are also reviewed separately on a weekly basis with key stakeholders to develop operations and avoid similar situations. Smaller safety-related improvements and any corrective actions are carried out immediately after the situation is resolved. At the organizational level, accidents and near-misses are measured and reported quarterly and annually, with the aim of minimizing personal injuries, as one interviewee describes it: *"We strive to ensure that everyone gets home healthy."*

The practical implementation of production is guided by a system that contains the instructions and work stages required for the manufacture of products. Deviations in production related to working methods, products, and tools are always reported through this system. Depending on the type, these deviations are directed at the responsible parties who solve the problems. The operations are often developed based on identified solutions.

According to the interviewees, the most common low-threshold way to raise improvement suggestions is to contact the team leader directly, who either logs the issue in the system or directly forwards the issue to the people responsible for it. At the same time, the team lead checks whether there are any obstacles to the improvement. If it is an idea with high potential, they urge the assembler to make it an official initiative to receive a reward. Team leaders receive such improvement suggestions, roughly assessed on a weekly basis. Ultimately, the development activities are primarily the responsibility of the department responsible for the tools or a separate development team within the organization. Many deviations are directed at people working in these departments, depending on the topic. Smaller and simple changes can be made directly by the assembly team and its immediate management.

Continuous improvement projects are carried out when an improvement target is identified. These involve and determine specific people from different departments, depending on the situation, and are implemented with the cooperation of all parties to implement and enable the matter. This allows individual improvements to be implemented from time to time. In addition, the cleanliness and orderliness of the work environment are continuously monitored and improved because of the strong implementation of 6S. Although 6S is strongly considered a part of daily production operations, a couple of open-ended responses to the survey stated that tools are not always returned to their correct places, even though they should be.

4.2.1 Recent developments and concrete results

The interviewees brought up many examples of ongoing and implemented development activities. These mainly consist of production unit CI projects, 6S, and other smaller improvements. CI projects have been implemented to clarify and speed up the assembly process, ensure quality, enhance problem-solving, and occupational safety. Examples of these include phasing of a specific component, modification of assembly racks, and increasing product testing. The responsibility of the coordinator of the target unit is now being shared with another person so that they have their own areas of responsibility. 6S is also constantly being worked on, which in practice means maintaining the cleanliness and order of the work environment and continuous improvement. For example, clear places have been set up and marked for work tools so that everything needed is always available.

As a result of these practical development measures, according to the interviewees, work has generally become faster, lead times have been shorter and occupational safety practices have been strengthened, which is reflected in the reduction in accidents. The entire safety culture has been formed and strengthened in recent years, partly because of continuous reviews. Questionable practices can be avoided more effectively in certain risk situations. Corrective measures have been reduced overall, which in turn also reduces working in unusual work environments further reducing the risk of occupational accidents. Danger areas have been isolated and marked, and the performance of different work tasks in the same place at the same time has decreased. 6S activities have improved the safety and meaningfulness of the work environment, and accidents occur less frequently.

Improved cleanliness and order in the work environment have made work smoother, and its maintenance has also been strengthened and has become part of daily activities. As an example of this, one interviewee describes cleanliness as *"it has become automated so that we do not always have to clean those places when we have guests,"* meaning company visits and regarding preparation to them. The arrangement of work tools has been standardized, their designated places marked, and they are thus more easily accessible. Among other things, movable tool racks have been added for frequently needed tools, and the tools can be easily moved from one place to another if necessary. In addition, certain special tools have been tagged and can be located. Overall, all production development measures have reduced the need for overtime, which in turn saves costs.

4.2.2 Barriers for development

Monitoring the progress of the development process of an initiative and its implementation is practically non-existent, as they usually only become apparent when the improvement is put into use. What happens between the initiative and the result is not known to the assembly team. Asking is the only sure way to find out about progress. One interviewee describes improvement suggestions in general as, *"Well, sometimes they go unaddressed, and then we wait for years to see if anything happens, and rarely anything happens,"* emphasizing the slowness of official routes. However, the interviewee emphasizes that this is partly understandable, as there is a lot of data and work, and therefore not everything can be done. Figure 4 (p. 45) shows that opinions are divided among assemblers regarding the efficiency of handling development ideas, but the majority believe that ideas are handled constructively and efficiently. On the other hand, assemblers also believe that the transparency of the development idea progression process is relatively questionable. According to interviewees, the progress of a development idea can also depend on how busy the responding stakeholders are, and they always try to implement the ideas as quickly as possible. Of course, the development idea itself affects how easily and quickly it can be implemented. Differences in opinion and opinions about the impact of the ideas can also affect how they are implemented.

In some cases, the decision is made to make the changes themselves, which means they do not follow official guidelines and the resulting practices applied can, in the worst case, appear dangerous. Therefore, improvements would be welcome in the development processes. Assemblers may also have difficulty finding a link to the initiative system or may not know about its existence. The initiative system is described as *"a bit stiff in my opinion; the initiative system has a bit too long response time; it requires expert work."* The interview revealed that initiative channels should be emphasized and improved, as the ideas of the assemblers are good. In addition, the organization's development people are scattered into different teams, without unity, which hinders synergy and communication.

According to the interviewees, there is a lot of development potential in production, because compared to some other departments in the organization, the operations are somewhat primitive and poorly automated. As an example of this, the interviewee describes the journey of material from another department to their unit: *"We see everything, where it has been and how long it took for that particular stage, and then it comes here to the hall, and anything is possible after that."* Figure 6 shows that assemblers also confirm the high development potential of the production unit. The development activities of the target unit are more mechanical, without greater integration into systems. It has also been noticed that development ideas do not come so easily by asking directly but are best obtained when the employee reports the matter when it comes up during work.

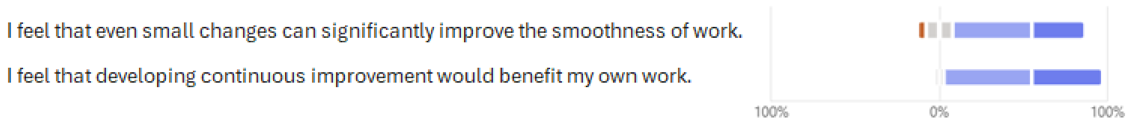

Figure 6. Development potential – Likert scale results.

4.3 Process efficiency and waste

The interviewees agreed that *"the flow of materials is probably the biggest obstacle."* Specifically, they meant the availability, quality and flow of materials. This claim is also confirmed by the survey results shown in Figure 7, and the answers to the open-ended question related to production problems in the survey were unanimously related to material shortages. Based on interviews, sometimes material also gets lost in production and it can generally take from ten minutes to two hours to react to this. Tools can also get damaged while working, and a report is also made about them, after which the department responsible for them reacts to them as soon as possible. High employee turnover affects the professionalism of production and thus also the quality of work. In addition, there are also space challenges in production.

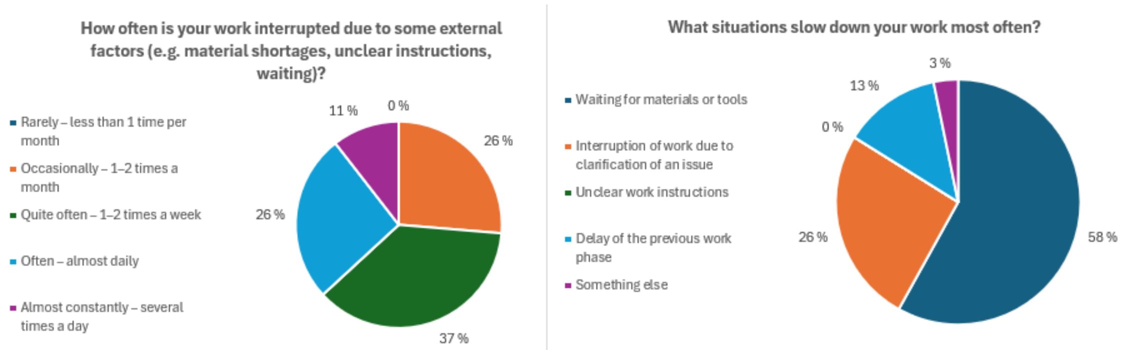

Figure 7. Frequency and most common problem types.

Tables 3 and 4 describe the production unit's recorded material deviations for 2025 and 2026. Table 4 shows that currently, material-related deviations account for 62.1% of the total deviation in the production unit from quantity. There are several different types of deviations in material availability, influenced by both internal and external actors, and these account for a total of 40.9% of all deviations in the production unit. Component quality-related deviations, in turn, account for 21.2% of all deviations in the production unit. According to survey results in Figure 7, the frequency of these deviations is regular, with some encountering problems monthly and some daily, depending on the workstation. As a result of these deviations, assemblers must wait an average of 30 minutes to 2.5 hours per day, with a median of 1-1.5 as shown in Figure 8.

Table 3. Material deviations in 2025.

2025	Material-related deviations in the production unit		
Material availability		**Material quality**	
Deviation types	Picking late Picking error Material lost in production Material ordered late Material shortage Purchasing shortage internal Purchasing shortage external Setting error Delivery late Delivery error Wrong delivery location Stage released late Receiving/shelving error	Deviation types	Quality deviation Supplier mistake
Relative share of all recorded deviations	41,3 %	Relative share of all recorded deviations	25,8 %
Median resolution time (h)	5.4	Median resolution time (h)	1
Typical range of resolution times (h)	0.3-20 (Majority) 20-80 (Minority)	Typical range of resolution times (h)	0.1-6 (Majority) 6-25 (Minority)

Table 4. Material deviations in 2026.

2026	Material-related deviations in the production unit		
Material availability		**Material quality**	
Deviation types	Picking late Picking error Material lost in production Material ordered late Material shortage Purchasing shortage internal Purchasing shortage external Setting error Delivery late Delivery error Wrong delivery location Stage released late Receiving/shelving error	Deviation types	Quality deviation Supplier mistake
Relative share of all recorded deviations	40,9 %	Relative share of all recorded deviations	21,2 %
Median resolution time (h)	19	Median resolution time (h)	0.7
Typical range of resolution times (h)	1-30	Typical range of resolution times (h)	0.1-2.5

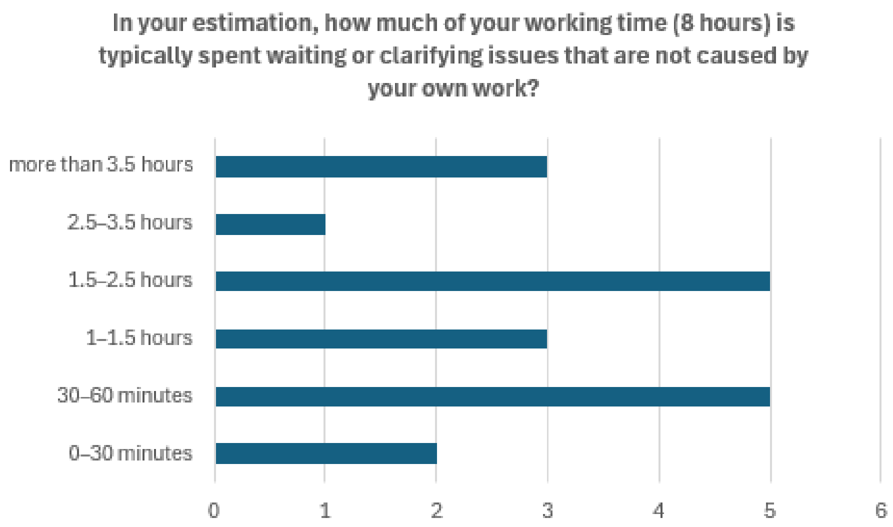

Figure 8. Average waiting time within the workday.

4.3.1 The deviation response practices and challenges

When a deviation occurs, the inspector usually reviews the situation and decides what to do. The inspector is called by recording the deviation in the system. The response to material shortages was described in the interview in relation to, for example, development proposals: *"Material shortages are, of course, the biggest; we always react to them very quickly, according to possibilities, but to development ideas a little slower, much slower."* The inspectors' response time varies on average from three minutes to three hours. Table 4 shows that it currently takes an average of 19 hours to resolve material availability-related deviations and less than an hour to resolve quality-related deviations. In particular, the range of resolutions for material availability-related deviations is high, while quality-related deviations are resolved relatively quickly. There are departments for each type of deviation that handle them, and the response time varies depending on the case. According to the interviews, no matter what the problem is, it is important to state exactly what the problem is so that it is not searched for in stock in vain, but a new one can be ordered immediately if necessary. The team lead can receive calls if things are not progressing, in which case they are in contact with the responding parties to speed up the process.

The interviews reveal that, in the worst case, poor quality from suppliers, both internal and external, can stop work for an entire shift. Volumes have increased, and not all suppliers always keep up, and the company's practice of making short contracts with suppliers prevents them from investing in their operations to improve operations. If faulty material is used, it can lead to later repair measures. The material may require modification or ordering a completely new part. The breakage of a tool will also stop working if a replacement cannot be found. It is difficult to describe the reaction to these problems precisely, as all departments react in their own way. On average, reaction times vary from minutes to hours, and a longer work stoppage can be reflected in the motivation of assemblers when they must wait. From the assemblers' perspective, there is a lot of room for improvement in reactions, and this was also confirmed in the survey responses. Employee turnover is also high, and a lot of new assemblers are coming to the company. They are trained and instructed, but in any case, it reduces the overall professionalism of production, which in turn affects the quality of work.

4.4 Analysis of the results

4.4.1 Process management

The main goals of the company and the production unit are clear to everyone, meaning the employees are aware of what they want to achieve to stay at the forefront of development. The goals are realistic and linked to current production performance. In addition, there is awareness of where the goals come from, who supports the implementation, and who implements them in practice. The production organizational structure is functional, and the activities of all parties are effectively coordinated, including communication. The production team is supervised daily, and the importance of effective production control is recognized. The interaction between assemblers and management is strong, and there is trust between them and the needs of assemblers are considered. In a normal production situation, the work process is standardized and functional.

However, the large increase in volumes causes the work to focus particularly on timeliness and efficiency, leaving the functions and aspects of development in the background. In other words, daily work focuses on what needs to be achieved and not on how existing operating methods could be improved. This is reflected, for example, in the fact that the focus of the target unit's review meetings with the team is not on development, but on daily work.

Due to the high frequency of challenges, working in change and unusual situations is everyday life for the unit. This leads to deviations from standardized working methods and adaptations according to the situation. Due to multiple actors, operational control is challenging in some situations. These challenges emerge especially in problem situations. In addition, in urgent situations, the effectiveness of communication may be insufficient. Production metrics are also unclear, and their meaning is not fully understood by the assemblers and their management, which leads to inadequate data maintenance and thus distorted process data.

Therefore, it can be summarized that the production unit, including assemblers, is clear about what is expected to achieve and how. The aspects emphasized in the work are in line with the improvement targets. The unit's operations are efficient, and it is effectively coordinated with other actors in the organization. Figure 5 (p. 46) shows that assemblers also find the processes and instructions clear, and they know how to act even when problems arise, meaning that the effects of the organization's cooperation are also concretely visible among the assembly teams. However, this functional structure is shaken when faced with problem situations. Operations are monitored in relation to the company's main goals, but the unstable operating methods of the assemblers negatively affect the measurement data collected.

4.4.2 Continuous improvement

The employees in the production unit know which areas the company aims to improve. Development is based on initiatives and deviations. The company recognizes implemented development ideas. There are separate deviation and initiative systems for different topics. The organization rewards good and feasible ideas.

The system for collecting safety observations works particularly well enabling measurement, review and effective response to resolve issues. Safety issues are resolved immediately with small corrective actions and are investigated later to avoid the problem in the future. Progress in safety is continuously monitored. The operations are driven towards the goal of zero accidents. Production errors and problems are addressed and used to continuously improve operations. Deviation reports are part of assemblers' daily work and operating methods. The unit does not judge assemblers or look for those responsible but learns from its mistakes.

The interaction between the team leader and the assemblers is uncomplicated, which lowers the threshold for communication and participation in development. Development ideas are brought up to the team leads continuously and regularly. Trust exists due to the fact that the team lead considers the employee's best interests when guiding them to take an official initiative to receive a reward, if it is an idea with particularly high potential. The team lead acts as an active information broker for the assemblers' issues and ideas.

Continuous improvement projects carried out in the unit involve other actors in the development than just the departments intended for development. Cooperation and communication between departments are maintained throughout the process. CI projects clearly focus on safety, quality, smoothness, and clarity, i.e., they are in line with the company's development targets. These projects and the corresponding individual improvements communicate active problem solving and everyday development.

The division of responsibilities within the team clarifies roles and reduces personal dependency. The work environment is also constantly improved. Cleanliness and order are maintained daily. This supports production efficiency and meaningful work, as everything is clearer. Also, the overall concrete results of the unit's development, such as the reduction of lead time, are clear and easily measurable. The effectiveness of the development is therefore easily proven. Especially, safety has improved and a clear development trend can be observed, and it is one of the most important indicators. In general, the development activities are seen as visible in the smoothness of daily work.

The production unit clearly knows what it wants to develop, but it does not know what it wants to achieve with the development. Reactions to deviations and initiatives vary depending on the type of problem, and seemingly minor issues may be forgotten or left unaddressed. Tracking ideas after they have been passed on to different departments has proven to be uncertain and invisible, which leads to the team lead having to investigate and ask different parties about the progress of the development process. Tracking ideas is therefore inadequate. Some employees find the systems unclear. This has led to an increase in the threshold for using systems and the preference for informal routes. The official development initiative system also rejects weaker ideas and rewards good ideas, which is against CI's practices, as several smaller ideas can also have a significant impact together.

The assembly team does not have its own development responsibility, but ideas are passed on. Whether something happens to them or not depends entirely on the receiving party. The team does not have its own CI structure. The responsibility lies entirely with management. The development practices in use focus mostly on 6S and safety-related activities, and these are the most advanced aspects of development. Development in the production unit is project-like, not goal-oriented. Meaning that individual improvements are made, but a clear development entity and target state are missing. CI projects are therefore not linked to any common development strategy.

Improvements are made in the production unit, but the effects of these improvements are not measured, which in turn weakens the systematicity. The improvement process lacks monitoring and transparency, as it is not linked to metrics. Development ideas are left unprocessed, and changes are waited for a long time when progress and goals are not visible. Slowness and ambiguity in the development process leads to problems being fixed by the employees themselves, resorting to questionable means, and thus causing a safety risk.

The current state of CI can be summarized based on the data. The development objectives are in line with the company's goals, i.e., how products are manufactured and what is intended to be improved are the same. Development focuses on safety, quality, timeliness, and efficiency. These are in line with the achieved development effects, meaning that the development is broad and diverse. It can be stated that when improvement actions are taken and committed to, changes and improvements can be achieved. However, no specific targets have been set for the development, except in improving occupational safety, which means that it is not completely systematic. Table 5 summarizes the unit's objectives based on the data obtained. Currently, the development activities contain rather systematic elements, as routines and methods are in place, but a systematic whole is missing. There is no clear monitoring of CI, and the results achieved are presented more as a list of good deeds.

Table 5. Development goals.

Theme	Objective	Metric	Target	Comments
Occupational Safety	Reduce accidents in the work environment	-Accident reports -Near-miss reports	-Zero accidents	Clear and actively managed target
Product Quality	-Reduce product deviations -Ensure high-quality output	Recorded product deviations	-	Improvement is desired, but no explicit target levels are set
Process Quality	-Reduce process deviations -Ensure stable output	-Process stage-specific "delivery accuracy" - Recorded process deviations -Lead times	-	-Aspirational objective -Target levels to be specified

If we look at Figure 4 (p. 45), it is generally clear to the assembly team what CI is and what effects it has on the operation. However, the bar gradually starts to shift in a negative direction when it comes to raising development ideas, reaching peak when discussing what happens to development ideas and how the assemblers see their progress. This observation, together with the interview results, confirms the need to improve the initiative systems and the handling of development ideas.

Safety issues and their development have clearly been taken to the forefront. This may be because the importance of safety is easier to justify to assemblers and can be demanded, while otherwise focusing on CI of work may seem pointless to some assemblers and they prefer to focus on their own work and making products. Also, the fact that the team lead's responsibility as a linker and supervisor of development activities has itself developed over time suggests that there are no clear, unified operating models and standard for development. And the reason why it has gone that way is due to the weakness of official development methods. Slowness in official initiative systems may indicate poor division of workload and accountability. CI is therefore very much dependent on the individuals.

Small improvements dominate in the production unit, but a larger development line is missing, meaning in this case, generally smaller operational organization and safety improvement, without systematic development and problem-solving based on root causes. CI is therefore not part of daily management, as improvements are made, but without a CI board, regular reviews, a standardized ideation process, or other similar production management methods. In other words, development is separate from the management of other activities.

4.4.3 Inefficiencies

The most significant deviations in production are related to materials. These deviations generally manifest themselves in two ways: either they are not delivered to the workstation on time and in the right quantity, or the material is of unusable quality. As Tables 3 and 4 (p. 52) show, material deviations consist of several different types of deviation. The data shows that currently, in 2026, material deviations occur in the production unit 5% less than in 2025, meaning that the operation has become more efficient. Although the frequency of deviations is decreasing, according to Figure 7 (p. 51), problems still occur regularly in the production unit. Although most responses, in this case 37%, indicate that problems occur mainly weekly, some also experience these situations daily. The production unit produces different products at different workstations, which would indicate that the frequency of problems also depends on the type of product. In any case, the recurrence of problems is regular in general in this production unit.

The average resolution time for material availability-related deviations in 2026 is 13.6 hours longer than in 2025, but on the other hand, the range of variation is smaller, as there were more individual, longer resolution times in 2025. In other words, the resolution of deviations is currently less variable. On the other hand, the average resolution times for material quality deviations are 0.3 hours shorter, and their resolution times currently vary significantly less compared to 2025. This means that the current situation regarding material deviations is less variable, and the occurrence of deviations is decreasing. Figure 8 (p. 53) shows that the average amount of time spent waiting is approximately 1 hour and 44 minutes of work time. This would suggest that although the occurrence of deviations stops work, the time spent waiting does not correlate with the time spent resolving the deviations. This is likely because when a deviation is encountered, the work is stopped, the problem is reported, and then the assembler moves to work on another product or work phase while waiting for the original problem to be resolved.

Earlier, based on the interview results, it was mentioned that efficiency has generally improved because of development activities. An example of this was the reduction in lead times. Process data related to material deviations supports this claim, as fewer deviations occur and the less time required to resolve them varies, the faster products can be manufactured, which also means shorter lead times. Based on the results, the development of the target unit is partly based on resolving deviations. This confirms the significance of these results for development, but it is not the only indicator of the development results achieved, but rather partial evidence for the statements made in the interviews.

5 Discussion: developing continuous improvement

5.1 Interpretation of the results in relation to previous literature

The coordination of activities with goals is emphasized in the literature (McLean et al., 2017, p. 228), which is also noticeable in the production unit, as the main goals of the company are clear according to the research results. Employees in the production unit are aware that through operations and their improvement, the company is intended to remain at the forefront of development and competitive, and continuous improvement plays an important role in achieving this (Khan et al., 2019, p. 543). The company has set realistic goals and aligned them with current performance, which in turn helps to avoid unnecessary failures (McLean et al., 2017, p. 224). Production employees know where the goals come from, who is responsible for their implementation, and who implements them in practice, and this indicates a functioning organizational structure, hierarchy, and successful implementation of goals (Lucianetti et al., 2019, p. 341). On the other hand, the set of indicators used by the production unit is unclear to employees, especially in development, and this weakens operations, as it is important for operations to choose the right indicators and monitor results in relation to goals (Susilawati, 2021, p. 345; Lopes et al., 2016, p. 1348). The research results show that the concrete development results of the production unit include some easily measurable results, like lead times, and these could be monitored easily by utilizing various efficiency indicators presented in the literature (Goal/QPC, 2002, p. 131).

The actors and departments of the organization are effectively coordinated, and cooperation and communication between departments are effective. This suggests that the conditions for effective CI exist in the organization, where everyone participates in development and collaboration (Zarbo, 2022, p. 166). There is trust and natural interaction between the assemblers and management of the production unit, which is one of the enablers of CI (Zarbo, 2022, p. 166; Ma et al., 2018, p. 1944). The literature highlights the importance of team meetings for cohesion, motivation, and communication between actors (Carvalho, 2022, p. 216), and this is already part of the daily work of the production unit. On the other hand, this is still lacking from a development perspective, as its aspects have not been integrated into the daily team meetings, which is essential for the effective implementation of the CI (Carvalho, 2022, p. 216).

The work processes of a production unit are standardized in normal production situations, but when production problems are encountered, the operation easily changes to perform non-standard work. This is detrimental to development, as standardized operating methods create the basis for development (Torres et al., 2020, p. 827). This means that the production unit has a partial foundation, but there is room for development. The employees of the production unit know what they try to develop, but they do not know what they want to achieve with the development. The development is therefore not systematic. The routines and methods in use do reveal partial systematic elements. The literature says that activities should be monitored in relation to the goals (Zarbo, 2022, p. 166). Development focuses partly on quality, and thereby on improving efficiency, which in turn is one of the most central development targets for CI in production environments (Toyota Auto Finland Oy, n.d.; Lodgaard & Powell, 2021, p. 596).

The development of the production unit's operations is based on the development ideas of assemblers and the production deviations they record. This is effective because employees naturally identify development targets while working (Carvalho, 2022, p. 155). Employee engagement utilizes a reward system, which is one of the well-known means of employee engagement (McLean et al., 2017, p. 224). Reporting deviations has become part of daily work, and the organization does not judge mistakes or look for culprits but focuses on improving practices. Enabling this practice to become standard indicates a forgiving organizational culture (Backlund & Sundqvist, 2018, p. 1314). Safety improvement has been taken to the next level, as it encompasses all the previously mentioned aspects of an effective development process. Incidents are reported, measured, reviewed, and most importantly, developed in relation to the goal, just as emphasized in the literature (McLean et al., 2017, p. 228).

Improvements are made in the production unit, but their effects and benefits are not measured, which weakens the systematic nature of development, and this in turn emphasizes the importance of measurement (McLean et al., 2017, p. 228). The transparency of the development idea progression process is questionable, and their progress is not shown to the employees. This leads to the preference for informal methods, which in turn makes monitoring and measurement even more challenging. Visual tools are therefore not utilized to describe the process and ensure transparency (Sadowski et al., 2024, p. 1495; Simons et al., 2016, p. 538).

The team has no responsibility for development, and development ideas are just mentioned in passing, given to someone else to handle, and then it is up to the receiving party whether to do anything about them. In the worst case, the receiving person can completely abandon the idea due to their busy schedule and move on to continue their own work (McLean et al., 2017, p. 226). The production unit does maintain and improve the working environment continuously, utilizing 5S practices. 5S is the foundation of a culture of CI (Mrabti et al., 2023, p. 1), and from the perspective of this production unit's operations, it increases the smoothness of operations, safety, efficiency, and comfort of the workplace. Also, the research results mentioned new divisions of labor in the production unit to improve efficiency, and this is important for efficiency also from a literature perspective (Lewicki et al., 2025, p. 2).

Short CI projects are carried out in the production unit as needed. These and the previously mentioned individual improvements signal active problem solving and everyday development. Such daily small development activities are part of the basic principles of CI (Rother, 2010, p. 10). On the other hand, development is largely project-based, rather than goal-oriented. Making individual improvements without a clear overall vision and set goal state indicates a partial implementation of CI, which weakens performance (McLean et al., 2017, pp. 224, 227). The production unit lacks a larger development line, and improvement activities do not delve deeper into root causes and systematic problem solving. CI is also not part of daily management, as standardized operating methods are not in use, and development is separate from other activities. Systematicity is a significant part of identifying root causes and managing process variation (Parente & Rocha, 2025, p. 1773).

5.2 The development potential in the production unit

Before calculating the development potential in more detail, it is important to describe the current level of the unit through maturity models, as they can be used to assess the unit's current capabilities and functions (Van Looy et al., 2011, p. 1126). This provides a clear starting point for development and a background framework for later analysis. Since this study focuses on improving the efficiency of a production unit through continuous improvement, it is justified to emphasize CI when determining the current maturity levels of the unit. Generally, CI is also one of the main capabilities assessed using maturity levels in the literature (Yang, 2013, p. 112; Charlampowicz et al., 2024). Utilizing maturity levels helps to visualize what kind of improvements are realistic to achieve in a production unit. By taking the unit's operations to the next maturity level, it can be confirmed that the operations have developed and therefore realize part of the development potential.

Table 6 first describes the maturity level of the unit's process, followed by a more detailed breakdown of the current maturity of the CI, utilizing the maturity models presented earlier in the theory section. The process practices are described at different levels, and the boxes are checked if the production unit meets the requirements of the level. The determination of maturity levels is based on data from the research interviews and the survey. The boundaries of some levels are vague, which means in practice that the unit can partially implement the requirements of a level. Partial implementations are mentioned in the notes section of the table.

Table 6. Maturity levels.

Production unit process maturity				
Maturity	**Description**	**Achieved (✓)**	**Not achieved (X)**	**Notes**
Level 1	Processes are undefined; work relies on individual experience.	✓		
Level 2	Processes are repeated but inconsistent and not standardized.	✓		
Level 3	Processes are defined, documented, and followed consistently.	✓		
Level 4	Processes are measured and managed using data and KPIs.	✓		
Level 5	Processes are continuously improved and aligned with customer needs.		X	CI visibility questionable

Production unit CI maturity				
Maturity	**Description**	**Achieved (✓)**	**Not achieved (X)**	**Notes**
Level 1	Basic CI tools are used (5S, Kanban, OEE, SMED), but practices are tool-focused rather than systematic.	✓		
Level 2	CI routines exist (Kaizen events, CI teams, Gemba), but improvement is still event-driven and not embedded in daily work.		X	Partial implementation through CI projects and initiatives, but no CI routines.
Level 3	CI is part of daily operations (training, team boards, KPI monitoring), and teams solve problems regularly.		X	Achieved in the development of occupational safety.
Level 4	CI is embedded in culture; improvement is continuous, scientific thinking is applied, and work aligns with purpose and customer value.		X	CI visibility questionable

Data triangulation and the maturity assessment derived from the results indicate that the production unit has development potential. Since this study focuses on investigating inefficiency through production waste, development potential can be measured using average daily waiting time. It was previously stated that an average of 1 hour and 44 minutes of assemblers' daily working hours are spent waiting. And this, in turn, is a result of production deviations and the regularity of their occurrence. Therefore, the development potential of a unit can be assessed by the ratio of waiting caused by inefficiencies to total working time. The total daily working time for the assemblers in this case is 7.5 hours, considering the lunch break, and of this time, the average ineffective time covers 23%. Figure 9 illustrates the development potential resulting from the unit's inefficiencies. It reflects the waste associated with this specific problem, but additional waste can be identified using in-depth process analysis tools such as Value Stream Map.

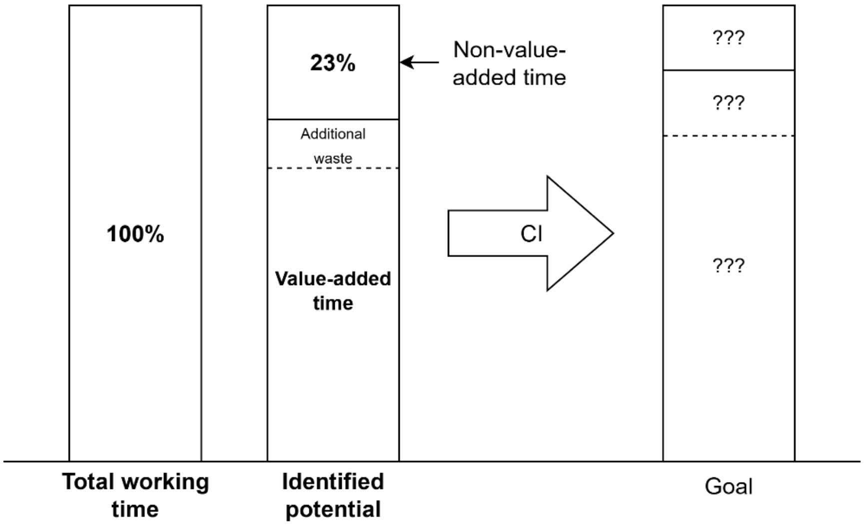

Figure 9. Development potential in relation to time spent waiting.

The unit's financial development potential *P* is calculated as the product of revenue *R* and the waste rate *w* identified in the process according to formula (1). The revenue is given per employee, and the total development potential is obtained by multiplying the result by the team size *n*. In 2025, the target company's revenue per employee was 340 000 €. The waste rate is previously determined to be 0.23, with a team size of 39 people.

$$P = n \cdot R \cdot w \qquad (1)$$

$$P = 39 \cdot 340\,000 \cdot 0.23 = 3\,049\,800\text{ €} \qquad (2)$$

Based on the result of calculation (2), it can be stated that the waste resulting from waiting is significant and thus constitutes a clear development potential. By enhancing CI practices in the production unit, part of the potential can be realized. Systematic CI has a positive impact on process flow, as research results show. Improving CI would potentially speed up decision-making and further reduce work interruptions. Reducing waiting time increases efficiency without additional resources, meaning the same work can be done with the current workforce. This means in practice that even if production volumes increase, as mentioned in the results for volumes, additional recruitment can be avoided. Improvements in efficiency are visible in shorter lead times, a more even workload, and lower costs. The potential value obtained in calculation (2) is a realistic estimate based on the waste observed in the survey results and is therefore a reliable indicative measure to support development efforts.

5.3 Improvement suggestions

The purpose of these continuous improvement enhancement ideas is to create a clear and transparent entity with goals for the assembly team. It also brings personal development responsibility to the team members that enhances cooperation and systematicity in the development activities of the entire team. The organization can also reward assemblers for successful initiatives in accordance with its own reward policies.

This section consists of two parts: First, a proposed systematic model for handling development proposals is presented. This model is an enhanced version of the occupational safety improvement model already in use in the production unit, applied to development. In addition, it is strongly influenced by the structure of the DMAIC problem solving and process development method (see Figure 3, p. 32). Second, individual development ideas are listed to enhance CI. These development ideas are connected to the proposed model but are fully applicable independently. The development model proposed in this section is comprehensive, and its implementation process can be laborious. Therefore, it is worth considering that even its partial integration can bring significant benefits to the unit's CI and results.

5.3.1 Systematic development model

This proposed continuous improvement model aims to make development ideas more visible, lower the threshold for presenting development ideas, avoid informal routes, and involve employees in development. This model also ensures that weaker development ideas are also addressed, as considering the combined effects of several smaller factors is part of effective CI. In this model, development ideas progress as shown in Figure 10, and it includes the following steps: goal setting, receiving, initial prioritization, processing and analyzing, implementing, control, and CI. The process also includes decision points regarding progress, as well as weekly reviews with key stakeholders. Ideas are therefore included in the weekly production meeting (see table 1, p. 10), where development is discussed as a separate topic in the same way that quality and safety are currently discussed.

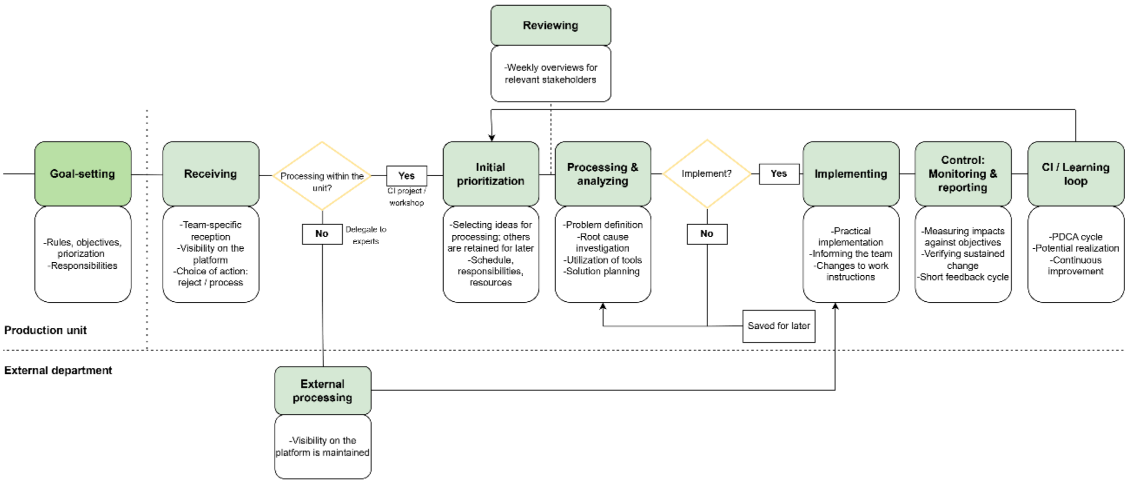

Figure 10. Systematic CI model.

In the goal-setting phase, rules, objectives, and prioritization principles are defined to enable the continuous implementation of the process. The rules and objectives of the process include the following: all development ideas go through this model process, thus avoiding the loss of ideas; a certain percentage of approved ideas are implemented within a certain time; a certain percentage of team assemblers submit at least certain amount of development ideas during the year, and this can be included in the team's annual performance review meeting (see Table 1, p. 10); and process efficiency targets are set, such as a certain number of fewer production deviations and a certain amount of faster lead times compared to the previous year, thus identifying the effects of the development and realizing the potential. The process is based on the idea that no development ideas are guaranteed to be implemented, but all ideas are considered equal. Regardless of the potential of the idea, they all go through the same handling process. Of these ideas, only those that are found to be useful are taken for processing. The ideas to be processed are then prioritized according to the idea's feasibility and potential impact.

In the receiving phase, all ideas appear on an electronic platform, which can be filtered into a team-specific idea view, just like in occupational safety observations. An example of a possible system view is shown in Figure 11, in a simplified form. This system shows the status of each idea, and by clicking on the idea boxes, more detailed information about the case can be opened. This is intended as a tool for operational management levels, and by maintaining cases through this system, data can be captured on a separate CI board presented to the production team in production facilities. Figure 12 shows a possible up-to-date CI board for display to assemblers in production facilities.

A CI board can include, for example, the workflow of development ideas in a Kanban style, product lead times, deviation efficiency, and CI completion rate. Such information provides a quick overview of the current state of CI. In the best case, an electronic board collects data directly from other systems, but a CI board is also feasible as a printed version. In the case of this model, the purpose is to make the progress of the development idea handling processes visible to assemblers, and the idea status is updated regularly from the beginning to the end of the process. The phase also includes a choice of whether to reject the idea directly or to proceed with processing it. Rejected ideas are also displayed on the platform, but their status is simply set to "rejected." This helps assemblers understand the situation and know what to expect and what not to expect.

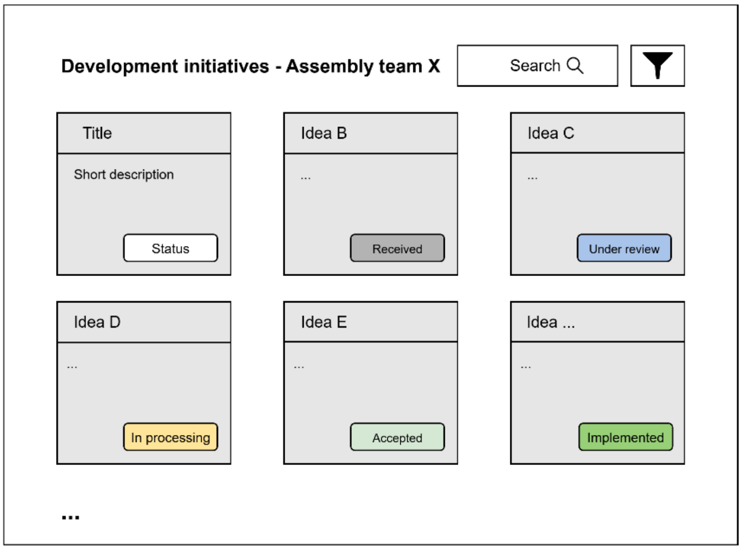

Figure 11. Simplified team-specific system view.

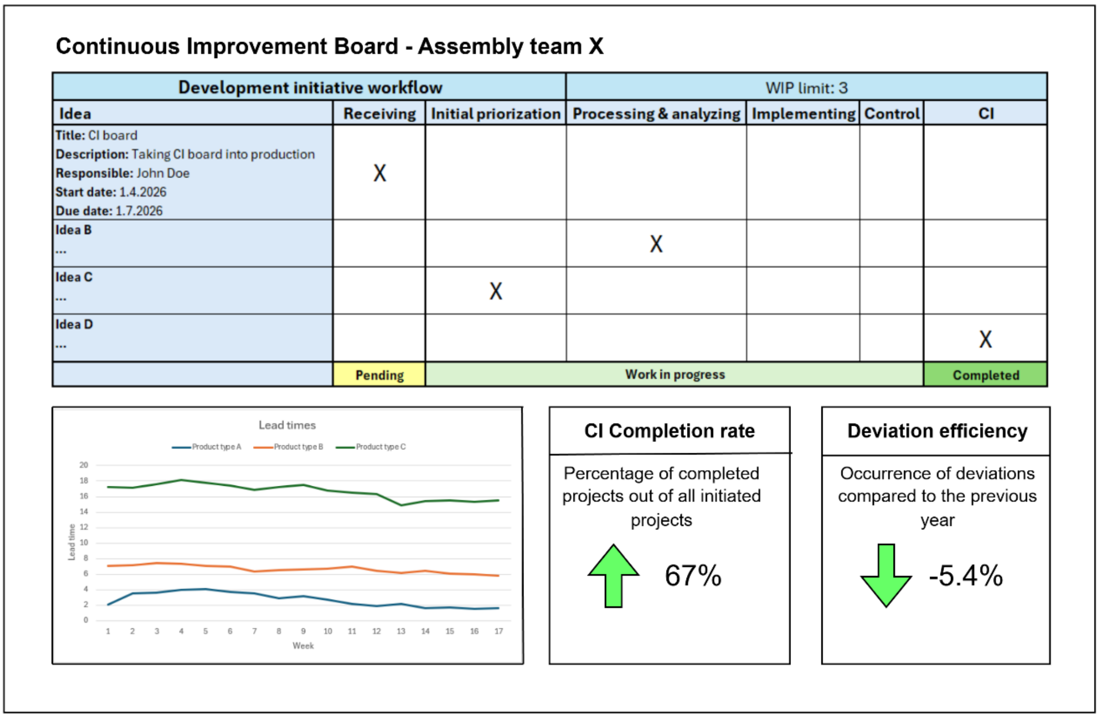

Figure 12. CI Performance dashboard.

After the idea has been received and a decision has been made whether to process the idea, the next step is to decide whether to process it within the production unit. If the answer is yes, the idea moves to the initial prioritization phase, and if the answer is no, the idea is transferred to another department for processing. The idea is transferred to another department if its processing requires professional expertise, such as product design or drawing. Even if the idea is processed by another department, its status remains visible on the platform from start to finish so that it is not forgotten.

In the initial prioritization phase, it is decided which ideas will be taken into consideration immediately and which will be saved for later. Most of the ideas are analyzed, but not all of them will be implemented if it is not profitable. Analysis can mean mapping the recurrence and impact of the problem, for example, looking at the data to see how many times something has happened and what its impact is. If the impact is small, it is worth saving it for later and focusing on more impactful ideas first. This phase also determines the schedule, processing method, and resourcing of the ideas to be processed. In this case, processing the idea within the production unit means creating a CI project around the topic or holding a workshop on the topic involving production employees. Additionally, key people from different departments can be involved if necessary.

In the processing and analyzing phase, the development idea is processed. It includes defining the problem, mapping the root causes, and finally designing solutions. Existing problem-solving tools can be utilized at this stage. Whether it is a CI project or a workshop, the structure remains the same, but the implementation team and schedule vary. The CI project is implemented in the same way as it is currently implemented in the unit. The only difference from the current CI project is that its progress is visible to assemblers. The workshop includes a couple of short processing sessions at minimum, where the first session focuses on drawing up the process, i.e., analyzing the situation and determining the problem and its root causes. The second session focuses on fixing the problem and processing improvement ideas. It is important to note that if solutions come to mind during the first session, they are written down immediately, but they are not discussed until the second session, when it is relevant.

As mentioned earlier, not all ideas are implemented, and now the decision is whether to implement the resulting improvement immediately or to save it for later. This depends entirely on the estimated impact and profitability of the idea at that time. If the improvement is implemented, it moves to the implementing phase, and if not, it is saved for later. Improvements saved for later can be re-evaluated later, and the decision to implement it again can be made at a better time.

The implementation phase can be initiated because of the unit's own idea processing process, or a development idea processed by another department can be received for implementation. In this phase, the improvement is put into practice. The team is informed about it and its possible effects. Possible changes to the process or work instructions are also highlighted. Once the idea has been integrated into daily activities, the transition to the control phase follows.

In the Control phase, the process impacts are measured against the objectives, and it is continuously monitored and controlled. The change is ensured to be permanent and evaluated in the form of a short feedback cycle. This ensures that the improvement works and has the intended effect.

Although at this point the development ideas have already been discussed and implemented, this does not mean that the processing is over. This is where CI and the realization of the process's potential begin. To ensure success, learning and development loops are carried out, which are of two levels. The smaller loop is the responsibility of the team and remains part of daily work. It includes short situation reviews and CI, for example, by utilizing the PDCA cycle. The larger loop is a broader enhancement of the improvement proposal, and it can be moved back in the process and, if necessary, involves external factors of the team. The purpose of this phase is to maintain CI of the improvement proposal to maintain and enhance the expected impact. This is followed by a transition back to the initial prioritization phase, where the viability of implementing new ideas and ideas previously saved for later use is assessed. These are processed according to the same processing phases, and development continues this basis.

5.3.2 Individual development ideas

Safety walks are part of the practices for monitoring and developing occupational safety in a production unit. However, it is possible to combine this with Gemba walking, which is one of the Lean development methods. The purpose of Safety Gemba is to monitor and develop occupational safety-related considerations by touring production facilities, but it also has a development aspect added to it. Development observations and development ideas made during this walk are recorded in the system and taken for evaluation, in the same way as occupational safety observations, but in a different system. In practice, Safety Gemba involves examining and monitoring the work being done and interacting with assemblers while identifying development targets. This provides one additional possible source of development ideas.

Team development issues could be included as part of the assembly team's morning meeting and status review. The interview results revealed that this is already done in some teams and has proven to be an effective way to hear assemblers' comments on improvements, deviations, and development needs. This is a quick review of ongoing team development activities and strengthens communication with assemblers and increases their participation in development. For a quick status review of development, the CI board presented in the previous CI model could be utilized.

Short workshops lasting a few hours or Kaizen events lasting a few days could be organized for assemblers on a regular basis, with external professionals being included if necessary. These could include, for example, a small number of team members quarterly, or more often if the conditions for development are met. In this case, the focus would be on a specific problem area at a time, and the topic could come from, for example, the CI model presented earlier or from a separate source, depending on the situation. In these events, employees can participate in defining the problem, identifying root causes, and designing solutions using various development tools.

The interviews revealed that some production teams use displays that depict current process data. According to the collected data, such a thing is already being planned in the case unit. But this idea can be taken even further, and the aspect of continuous improvement can be combined with it. In addition to the performance board, a CI board could be introduced into production to monitor the progress of development ideas, and this could be presented, for example, in the form of a Kanban board. The idea of this board is to display all the team's own development ideas from the previously mentioned system. This could show which development idea it is and what the status of the idea is. It could also be linked to efficiency measurement data, which shows the benefits gained from development. An example of such a CI board is shown in Figure 12 (p. 71).

5.4 Expected impact on process efficiency and CI effectiveness

According to McLean et al. (2017, p. 228), if an activity is not tied to goals, it is incorrectly focused, which in turn is detrimental to the performance of the organization. Effectiveness, on the other hand, reflects the relationship between results and goals (Ravelomanantsoa et al., 2019, p. 5028), meaning that the effectiveness of a unit cannot be measured if goals have not been set. In the case of this research, this also means that the improvements achieved cannot be verified. For this reason, table 7 presents an updated version of table 5 (p. 58), which has been supplemented with concrete targets for development objectives, which creates a foundation for systematic development.

Table 7. Development goals (updated).

Theme	Objective	Metric	Target	Comments
Occupational Safety	Reduce accidents in the work environment	-Accident reports -Near-miss reports	-Zero accidents	Clear and actively managed target
Product Quality	-Reduce product deviations -Ensure high-quality output	Recorded product deviations	Defined annual reduction target	Specified target level based on deviation trend analysis
Process Quality	-Reduce process deviations -Ensure stable output	-Process stage-specific "delivery accuracy" - Recorded process deviations -Lead times	-Target level set per process stage -Defined annual reduction target -Defined target of reduced lead time	-Target aligned with expected improvements from CI and maturity -Specified target level based on lead time analysis
CI	Strengthen systematic CI practices	-CI Completion rate -CI activity	-Defined target trends -Identified development potential	Clarifies the level of ongoing CI activity

By implementing the CI model proposed in this thesis and/or individual continuous improvement development ideas, it is reasonable to expect that the unit's efficiency will improve significantly. The literature emphasizes the importance of lean methods and CI in eliminating waste, saving resources, reducing variation, improving problem-solving efficiency, and standardizing processes (Sohal et al., 2025, p. 2593; Lodgaard & Powell, 2021, p. 597; Ma et al., 2018, p. 1944). Less waste means fewer work interruptions, which in turn shortens lead time as time is not spent waiting. This also increases the value-added time of production, meaning more efficient utilization of resources.

Increasing effective working time reduces process variability, which makes the process flow more stable. CI of operations reduces the number of production deviations. Although the operations of the production unit do not have influence on all types of deviations, some deviations can be minimized. This means that the full potential cannot be realized by the unit's own operations alone. The proposed CI model also emphasizes the importance of root cause investigation, and its implementation would strengthen the unit's root cause work.

Table 6 (p. 66) showed that the lack of visibility of CI in the production unit prevented it from achieving the highest process maturity level. This can be influenced by increasing the CI maturity of the unit. Table 8 shows the assumed CI maturity levels based on the improvements this thesis proposes at two levels: partial implementation, which means only the implementation of individual improvement proposals, and total implementation, which also includes a comprehensive systematic CI model.

Table 8. CI Maturity levels (updated).

Production unit CI maturity - Partial implementation				
Maturity	**Description**	**Achieved (✓)**	**Not achieved (X)**	**Notes**
Level 1	Basic CI tools are used (5S, Kanban, OEE, SMED), but practices are tool-focused rather than systematic.	✓		
Level 2	CI routines exist (Kaizen events, CI teams, Gemba), but improvement is still event-driven and not embedded in daily work.	✓		
Level 3	CI is part of daily operations (training, team boards, KPI monitoring), and teams solve problems regularly.	✓		
Level 4	CI is embedded in culture; improvement is continuous, scientific thinking is applied, and work aligns with purpose and customer value.		X	Insufficient employee involvement. The threshold for participation remains high. The transparency of the handling of initiatives is questionable.

Production unit CI maturity - Total implementation				
Maturity	**Description**	**Achieved (✓)**	**Not achieved (X)**	**Notes**
Level 1	Basic CI tools are used (5S, Kanban, OEE, SMED), but practices are tool-focused rather than systematic.	✓		
Level 2	CI routines exist (Kaizen events, CI teams, Gemba), but improvement is still event-driven and not embedded in daily work.	✓		
Level 3	CI is part of daily operations (training, team boards, KPI monitoring), and teams solve problems regularly.	✓		
Level 4	CI is embedded in culture; improvement is continuous, scientific thinking is applied, and work aligns with purpose and customer value.	✓		CI is part of daily work. Development is systematic and goal-oriented.

The implementation of the proposed CI model can achieve the highest CI maturity level. It ensures process transparency, ensures monitoring in relation to goals, which lowers the threshold for assemblers to participate. Individual improvements significantly increase CI maturity, but simply presenting data, discussing the topic, and irregular problem solving does not create a systematic development model for the team. The high threshold for participation and transparency problems highlighted in the research results will still exist unless a comprehensive CI system is implemented.

The development ideas in this thesis ensure that development focuses on the right targets. A shorter development lead time speeds up their implementation, and this also increases the completion rate, meaning more developments are completed. In addition, the more efficiency increases, the more space and time there is for CI implementation, meaning they complement each other. As a result, CI makes the process more stable and of higher quality and makes the operating model more sustainable and predictable.

6 Conclusions

6.1 Answers to the research questions and the key findings

Regarding the first research question, it can be stated that continuous improvement exists, but its visibility in daily work is questionable. The assembly team lacks its own development responsibility, and the handling and implementation of development initiatives is entirely up to the receiving party. This means that there is no structure for CI and development responsibility lies entirely with management. Development is currently mainly focused on 6S and occupational safety issues. Development is project-based, not goal-oriented, which means that improvements are made, but without a development entity and goal state. Also, CI projects are not tied to any development strategy. This current state can be enhanced by implementing a systematic CI model that is based on the existing safety development model, but only from a CI perspective. This model involves employees in daily development, makes the development process transparent, and enables monitoring of results in relation to goals.

Regarding the second research question, the research focused on examining waste and its effects on the total working time. The results showed that the average working time spent waiting is 23% of the total daily working time. This was found to be due to the regularity of production deviations. The development potential is therefore seen in the non-value-added time of a production unit.

Finally, regarding the third research question, the financial development potential identified based on the research results is 3 049 800€. This is the share of the time wasted on the average total revenue generated by the team. Additional waste can be identified by using more in-depth process analyses by including analysis tools, such as Value Stream Map (Figure 9, p. 67). By implementing systematic and goal-oriented CI, this development potential can be realized at least partially by reducing non-value-added time through continuous daily improvements.

6.2 Practical implications and business case for continuous improvement

The implementation of the development suggestions proposed by this thesis requires changes in the process, management, and tools. However, not everything needs to be changed; for example, the existing initiative system can still be utilized if it is felt that the development idea has high potential but is difficult to process by the unit. And in parallel with this, a systematic CI model implemented independently by the unit should strengthen its own development responsibility. The model also ensures that all development ideas, including smaller ones, are evaluated. Existing practices will be linked to this model, which will change the current CI process. The importance of management is emphasized due to the management of the development idea processing process, daily reviews, and individual CI methods. Management has been partially responsible for development activities until now, but in time, this has become informal and unsystematic, and these improvements in CI will transform these existing practices into a systematic operating model. The proposed improvements also require the implementation of new tools and methods, such as a CI board or workshops.

With the new development model, continuous improvement is organized through a new system intended for that purpose. The management of the assembly team monitors and evaluates development ideas and makes decisions on their handling according to the presented model. The implementation of CI is measured in relation to the process goals, such as possible lead times and deviation-reduction goals. In practice, first the process management selects which performance indicators to monitor. Concrete targets are set for these indicators. Then the measurement results are reported and from this, the impact of CI on performance can be summarized and assessed, including impact on financial and other KPIs. CI also has its own goals related to the number of development proposals and finally implemented ideas. The data of these efficiency indicators is continuously monitored, which also shows the effectiveness of the CI implementation.

The results of this thesis show that there is a significant financial development potential for enhancing CI. Based on previous analyses and calculations, the total impact is at best approximately 3 M€. The calculated potential consists of the total amount of non-value-added time in the production unit. In addition to the direct potential financial benefits, systematic CI enhances production performance and employee well-being, thereby product quality and customer satisfaction. If improvements are not implemented, development will continue unsystematically and its effects will be unconscious, leading to variable process performance. Systematic enhancement of CI is therefore an operationally and strategically significant measure for the organization.

The interviews for the study showed that CI practices vary from team to team. However, the teams and their processes are fundamentally similar. This means that the results of this thesis and the development suggestions proposed based on them are fully applicable to other production teams in the organization, depending on their own CI maturity. This would lead to an organization-wide enhancement of the culture of CI, which would increase the financial development potential by many times over.

6.3 Limitations of the study

The most significant limiting factor of this research is the limitation to one production unit and its employees. This was especially evident in the reliability of the interview results, as there is probably information related to the process and its goals that is not known to the employees of the production unit. Most of the people in the unit tend to be practical, and they do not necessarily have a true picture of the unit's goals and indicators. And because the research results are based only on their views, the data is more practice-based, in the form of examples, which can partly hinder the reliability of the research.

The number of assemblers in the production unit under this study is also relatively small, and the fact that only half of them responded to the survey negatively affects the quality and reliability of the data. Due to the limited sample size, the results and the calculations made on their basis are more indicative than precise.

The main idea of the thesis is to reduce production deviations by enhancing the efficiency of continuous improvement. The production unit's own operations do not have the opportunity to influence all types of deviations. Realizing the total development potential would also require the development of other departments that affect the unit's operations. And because this thesis focuses only on what can be done within this production unit, only some of the deviations can be influenced through CI, depending on their root causes.

The implementation of the comprehensive systematic CI model proposed in this thesis may be expensive for the company, and therefore the total implementation of the results in only one production unit may not be cost-effective. Although this work focused on only one unit, it is worth considering the implementation of such a model for all production teams. Therefore, considering the limitations of this work, the comprehensiveness of the development proposals may prove to be a limiting factor in terms of total implementation.

Finally, the lack of a pilot phase in this study makes the conclusions hypothetical. Meaning that the potential effects of the improvement proposals are only assumed based on the literature and research data. The real benefits will only emerge once they have been tested in practice and the results measured in relation to performance. However, this thesis attempted to justify the assumptions as thoroughly and reliably as possible.

6.4 Suggestions for future research

When examining the limitations of the study, the issues that emerged showed that it is not possible to realize all the potential without also combining the activities of other departments of the organization with the activities according to the model proposed in this work. Therefore, it would be desirable to investigate and expand the results of this study also to other production assembly teams and support departments of the organization. In this way, instead of making the operations of one production unit more efficient, the culture of continuous improvement of the entire organization could be strengthened. If different teams are given similar CI operating methods, the cooperation between them will probably also be more efficient.

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Appendices

Appendix 1. Interview questions

Goals

1. How would you describe the goals of your company and team?

Leadership

2. How are these goals reflected in your daily work?
3. What kind of goals are there for development, and how is their implementation monitored? (possible additional question: what metrics have been used?)

Development

4. What kind of development projects have been carried out in the past year?
5. What concrete results have been achieved through development, e.g. by 2025?
6. How is continuous improvement reflected in your daily work and team activities?
7. In what ways can employees bring up development ideas? And what usually happens to them?

Efficiency, waste

8. What kind of problems or work slowdowns occur at work, and how do you react to them?

9. If you could change something in development or work efficiency, what would it be?

Appendix 2. Survey

Part 1: Informed consent

- The survey is anonymous and volyntary.
- The purpose is to assess the smoothness of work and the implementation of continuous improvement to facilitate work.
- The answers will only be used for this study and the development of the unit.
- The survey does not evaluate employee performance.

By continuing with the survey, I agree to participate.

Part 2: Continuous improvement

Likert 1–5

1. It is clear to me what continuous improvement means in my own work.
2. I have the opportunity to bring forward my own development ideas.
3. My development suggestions are viewed constructively.
4. My development suggestions are handled efficiently.
5. I know what happens to the development suggestions my team makes.
6. Workflow fluency and improvements are discussed regularly within my team.
7. The goals of continuous improvement are clear to me.
8. I feel that continuous improvement has positive effects on my work.

Part 3: Process and workflow fluency

Likert 1–5

9. The work instructions and processes are clear and they support my work.
10. Up-to-date work instructions and other documentation are always available.
11. My work usually goes without long interruptions.
12. I know what to do when problems arise.

Part 4: Work slowdowns

Likert 1–5

13. I feel that there are situations in my work that slow down my work from time to time.

Multiple choice

14. How often is your work interrupted due to some external factor (e.g. material shortages, unclear instructions, waiting)?

- Rarely – less than 1 time per month
- Occasionally – 1–2 times a month
- Quite often – 1–2 times a week
- Often – almost daily
- Almost constantly – several times a day

Multiple choice (choose 1–2):

15. What situations slow down your work most often?

- Waiting for materials or tools

- Interruption of work due to clarification of an issue
- Unclear work instructions
- Delay of the previous work phase
- Something else (open-ended)

Part 5: Time management

Multiple choice

16. In your estimation, how much of your working time (8 hours) is typically spent waiting or clarifying issues that are not caused by your own work?

- 0–30 minutes
- 30–60 minutes
- 1–1.5 hours
- 1.5–2.5 hours
- 2.5–3.5 hours
- more than 3.5 hours

Part 6: Development potential

Likert (1–5)

17. I feel that even small changes can significantly improve the smoothness of work.
18. I feel that developing continuous improvement would benefit my own work.

Open-ended questions

19. What is the biggest factor that slows down the flow of work in your everyday life?
20. What concrete changes do you think would enable the development of your own work or your team?