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Implementing Smart Maintenance in the pulp and paper industry

Developing the strategy development process for Smart Maintenance implementation using action research

Master's thesis in Production Engineering

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CHALMERS UNIVERSITY OF TECHNOLOGY
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Abstract

The manufacturing industry is being digitalized at an ever rapid pace which is changing the rules for what, how, and when things can be manufactured. As manufacturing is being digitalized, the demand for industrial maintenance increases. Maintenance in digitalized manufacturing is called Smart Maintenance, which is expected to lead to a broader spectrum of effects and change the role of maintenance in the companies' strategies. To facilitate its implementation, researchers have developed an iterative strategy development process for Smart Maintenance implementation. However, the strategy development process must be further developed, and specific companies and industries need practical evidence on how to use it. This thesis used action research to promote collaboration between researchers and practitioners in the pulp and paper industry, to test, evaluate, and further develop the strategy development process for Smart Maintenance implementation.

Implementing Smart Maintenance in the pulp and paper industry resulted in a further developed strategy development process for Smart Maintenance implementation. The strategy development process was found to have clear value for facilitating the Smart Maintenance implementation. Furthermore, theoretical frameworks regarding organizational innovation were used to establish practical insights and details of how to use the strategy development process. Organizational change and organizational development are challenging disciplines and vital to take into account to avoid failing with the Smart Maintenance implementation. Maintenance organizations must become learning organizations and the strategy development process should be seen as a long learning process and be realized evolutionary in the pulp and paper industry in order to meet the digitalized future.

Keywords: maintenance; implementation; action research; organizational development; digitalization; Industry 4.0

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Time flies when you have fun. Five years at Chalmers University of Technology are coming to an end. Hence, all credits to family members, friends and teachers who made these years extraordinary. Let us start new adventures. Avancez!

Robin Ferm & Oscar Larsson, Gothenburg, June 2022

Contents

1
Introduction

The following chapter introduces the master's thesis with a background that puts it in a more general context. The need for this thesis is established with a problem description which is further concretized with a purpose and aim as well as two research questions. Finally, delimitations and the structure of the thesis are presented to more easily understand what this thesis is focusing on.

1.1 Background

Development and change are common themes in today's industry, where new technological innovations become available at lower costs and at an ever rapidly pace (Benzell & Brynjolfsson, 2019). Combinations of new technologies such as Big Data, Internet of Things, Additive Manufacturing, and Cyber-Physical Systems help companies embrace the future (Alcácer & Cruz-Machado, 2019). As the development is revolutionizing the manufacturing industry, increasing flexibility, quality, productivity, etc., maintenance tasks are also changing as the need for reliable and high-functioning production systems is increasing (Silvestri, Forcina, Introna, Santolamazza, & Cesarotti, 2020).

In the digitalized future of manufacturing, maintenance is called Smart Maintenance (Bokrantz, 2019). The concept of Smart Maintenance describes how maintenance includes new ways of organizational work and not only new technological solutions. Silvestri et al. (2020) point out, however, that industries and maintenance organizations still need further evidence and clear views on how to carry out their maintenance transformations to meet the demands of the digitalized future. Therefore, recent studies have targeted the aspect of how to implement Smart Maintenance in order to achieve organizational innovation in maintenance (Lundgren, 2021). Lundgren (2021) has proposed an iterative strategy development process for Smart Maintenance implementation, composed of six steps that provide support in structuring the work of developing maintenance organizations. However, more research is needed where the strategy development process is tested and evaluated to further develop the details of its steps to create value-fit for specific companies and industries (Lundgren, 2021).

Svenska Cellulosa Aktiebolaget, hereinafter referred to as SCA, is one of Sweden's largest forestry companies. SCA produces pulp, packaging material, wood products, and biofuels on their many production sites, spread out over the northern parts of Sweden. For a few years now, SCA has invested in expanding and building new plants, which gives the company some of the largest and most modern production sites in the industry. Nevertheless, with new technologies comes not only high productivity but also high demands on reliability and efficiency, since many of SCA's products are produced using continuous manufacturing processes with high flow rates, i.e., process industry. Therefore, maintenance has been a core part of SCA's production sites for a long time. More specifically, in the Sundsvall/Timrå-region, where two of SCA's pulp plants are located close together, a unified maintenance organization operates called SCA Maintenance. SCA Maintenance works as a separate organization but collaborates with the pulp plants' maintenance departments to benefit from shared resources and insights. SCA Maintenance has resources in maintenance engineering, mechanics, electronics, and automation, as well as project and development management.

In line with the development of the industry in general, SCA has digitalization initiatives and visions on a larger company scale. SCA Maintenance is currently establishing how it will contribute to the development of SCA. Smart Maintenance is recognized as an important step, but they have not yet started any active work of its implementation. Therefore, SCA Maintenance is a suitable maintenance organization to test and evaluate the strategy development process for Smart Maintenance implementation presented by Lundgren (2021).

1.2 Problem description

SCA Maintenance recognizes Smart Maintenance as a crucial part of their future contribution to digitalization initiatives within SCA. However, SCA Maintenance needs a clearer view of how to incorporate the development of Smart Maintenance into their organization. From SCA Maintenance's perspective, the strategy development process by Lundgren (2021) must be further developed and detailed before it can be used within the organization.

1.3 Purpose and aim

The purpose of this thesis is to further develop the strategy development process for Smart Maintenance implementation presented by Lundgren (2021). This will also help SCA Maintenance start their Smart Maintenance implementation since developing the strategy development process also involves executing it. Consequently, this thesis' primary aim is to, in a collaborative manner, test, evaluate, and develop the strategy development process for Smart Maintenance implementation in the pulp and paper industry. The thesis' secondary aim is to initiate the Smart Maintenance implementation at SCA Maintenance and thereby support the first steps of their Smart Maintenance endeavor.

1.4 Research questions

The objective of the thesis can be specified by the following research questions:

RQ 1: How can the strategy development process for Smart Maintenance implementation be realized in the pulp and paper industry?

RQ 2: What is the value of adopting the strategy development process for the maintenance organization?

1.5 Delimitations

The strategy development process for Smart Maintenance implementation tested in this thesis comprises six cyclical steps. Since this thesis is limited by time, the last two steps, which include elevating and following up the Smart Maintenance implementation, are excluded from the thesis as those alone are expected to exceed the thesis' time limit. Furthermore, the thesis will only focus on the maintenance organization at SCA's pulp mill, Östrand, located in Timrå, Sweden. Representatives from other plants may be included in the thesis, but the sole focus will always be the Östrand pulp mill. The thesis will also focus on developing and establishing organizational processes for the strategy development process. Outcomes of the strategy process are seen as SCA's property and will not be presented in this thesis.

1.6 Structure of the thesis

The thesis is structured as follows:

Chapter 1, Introduction represents the authors' views on why this thesis is carried out. Hence, background, problem discussion, purpose and aim, research questions, delimitations and structure of the thesis are presented.

Chapter 2, Frame of reference presents the theoretical framework to production processes, digitalized manufacturing, industrial maintenance, Smart Maintenance, Smart Maintenance implementation as well as organizational learning, change, and development.

Chapter 3, Methodology includes abductive reasoning together with research approach, design, techniques and procedure.

Chapter 4, Results describes the results from the research procedure, final semi-structured interviews as well as the further developed strategy development process for Smart Maintenance implementation.

Chapter 5, Discussion discusses implementing Smart Maintenance in the pulp and paper industry and then answers the research questions. In addition, methodological discussions, limitations, future work in conjunction with ethical, societal and ecological aspects are discussed.

Chapter 6, Conclusion summarizes the thesis' major outcomes and presents its conclusions.

2

Frame of Reference

The following chapter presents the frame of reference and includes an overview of production processes, digitalized manufacturing, an overview of industrial maintenance, Smart Maintenance, implementation of Smart Maintenance as well as organizational learning, change, and development.

2.1 An overview of production processes

A process transforms inputs into outputs (Holweg, Davies, De Meyer, Lawson, & Schmenner, 2018). Inputs are all the resources required for the process to function. Output is the result of the purpose of the process. Furthermore, production processes aim to increase the value of the output and efficient production processes can therefore transform few inputs into many outputs, i.e., value creation (Holweg et al., 2018). For value creation to take place as efficiently as possible, production processes are monitored by a management system. For production processes to operate, maintenance is also needed, and the more automated production processes are, the more important maintenance is (Holweg et al., 2018).

Industrial operations also aim to generate value creation, which can be explained by Porter's value chain. According to Porter (2004), operations can either be primary or secondary. Primary operations are value-creating processes, such as manufacturing. Secondary operations are supportive processes, such as maintenance. Both primary and secondary operations, i.e., manufacturing and maintenance, are needed for the value chain to function and obtain value creation for industrial operations (Porter, 2004).

2.2 Digitalized manufacturing

In the industrial digital era, everything becomes digital; business models, environments, production systems, machines, operators, products, and services (Alcácer & Cruz-Machado, 2019). The manufacturing industry already works with concepts like Industry 4.0, fourth industrial revolution, smart factories, and smart manufacturing (Hermann, Pentek, & Otto, 2016; Schuh, Anderl, Gausemeier, ten Hompel, & Wahlster, 2017). Especially Industry 4.0 has become a well-known concept for explaining tomorrow's manufacturing systems and next-generation factories. The concept was first used in Germany in 2011 where it described digitalized manufacturing, which integrates digital technology to achieve higher automation efficiency

(Schuh et al., 2017). The National Academy of Sciences and Engineering (Acatech) defines Industry 4.0 as: *"real-time, high data volume, multilateral communication and interconnectedness between Cyber-Physical Systems and people"* (Schuh et al., 2017). Hermann et al. (2016) clarify the definition by listing four principles on *"how to do"* Industry 4.0: interconnection, information transparency, decentralized decisions, and technical assistance. Interconnection allows machines, devices, sensors, and people to communicate with each other, while information transparency creates more data points that are accessible to everyone. Decentralized decisions are about making smarter decisions based on what happens inside and outside the factory, whereby technical assistance is necessary to help people make these strategic decisions.

Industry 4.0 has become a collective name for a range of new technologies found in next-generation factories, such as Big Data, Artificial Intelligence, Internet of Things, Cyber-Physical Systems, Information and Communication Technologies, Industrial Automation, and Additive manufacturing (Alcácer & Cruz-Machado, 2019; Lu, 2017). Schuh et al. (2017) deem, however, that Industry 4.0 cannot only be achieved with new technologies, but rather organizational structure and culture in combination with digital technologies. Only then will the value creation for Industry 4.0 be significant.

2.3 An overview of industrial maintenance

While the industry is developing and becoming more digitalized and efficient, companies are still experiencing substantial equipment downtime with overall equipment efficiency (OEE) at around 50% (Ylipää, Skoogh, Bokrantz, & Gopalakrishnan, 2017). Ylipää et al. (2017) argue for an increased focus on maintenance as digitalization continues since maintenance plays an important role in keeping production systems running as expected. Maintenance is defined as *"the combination of all technical, administrative, and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function* (CEN, 2017). There are, however, different types of maintenance strategies. Wang, Chu, and Wu (2007) evaluate the different strategies of corrective maintenance, preventive maintenance, and predictive maintenance. With corrective maintenance, maintenance is not performed until failure occurs. Preventive maintenance refers to when maintenance is planned and performed periodically to prevent sudden failures. Predictive maintenance utilizes sensors and measured data to predict the remaining useful life and when failures are most likely to occur for optimizing the company's maintenance efforts.

Intuitively, one can believe that with the general digitalization of the industry, maintenance strategies are evolving toward more predictive characteristics. This is also supported by Garg and Deshmikh (2006) who have studied the development of maintenance management. However, the predictive maintenance efforts that do exist, together with companies' preventive maintenance plans, are still often interrupted by corrective maintenance, making current maintenance practice mainly reactive and the inevitable need for change even more obvious (Ylipää et al., 2017). As various concepts and technologies are being researched, Waeyenbergh and Pintelon (2004) conclude that the lack of common terminology makes it difficult for practitioners to determine the usefulness of a concept and what to focus on. Moving into the digitalized era of maintenance, this obstacle must be overcome.

2.4 Smart Maintenance

This section presents maintenance in digitalized manufacturing, the Smart Maintenance concept, as well as its conceptualization and operationalization.

2.4.1 Maintenance in digitalized manufacturing

Digitalization is changing the maintenance industry and the ambition is to move away from the reactive nature of corrective maintenance into a more analytical and predictive state of maintenance (Garg & Deshmikh, 2006; Ylipää et al., 2017). Maintenance in digitalized manufacturing has been described using many different concepts: predictive maintenance (Carnero, 2005; Wang et al., 2007), E-maintenance (Lee, Ni, Djurdjanovic, Qiu, & Liao, 2006), prognostics and health management (Lee, Wu, Ghaffari, Liao, & Siegel, 2014), Maintenance 4.0 (Kumar & Galar, 2017), and Smart Maintenance (Bokrantz, Skoogh, Berlin, Wuest, & Stahre, 2020c). As Waeyenbergh and Pintelon (2004) point out, there is a need for common terminology, and companies and practitioners need aid in evaluating and choosing among the concepts mentioned above. The research on Smart Maintenance aimed to create a common understanding of what maintenance in digitalized manufacturing is, by utilizing empirically grounded observations to make the implementation as relevant as possible for practitioners. Since the Smart Maintenance concept is both the most recent but also used in further literature covered in this thesis, maintenance in digitalized manufacturing will henceforth be referred to as “Smart Maintenance”.

Bokrantz (2019) explains how Smart Maintenance is *maintenance in digitalized manufacturing*, and that Smart Maintenance is a response to the rapid advancement of digital technologies. Therefore, to stimulate adoption, the questions of how to conceptualize and operationalize Smart Maintenance must be answered (Bokrantz, 2019). In this context, conceptualization should be seen as the invention of ideas, and operationalization as the measurement of ideas (Bokrantz, 2019).

2.4.2 Conceptualization of Smart Maintenance

Bokrantz et al. (2020c) answer the question of *“What is Smart Maintenance”* and how it can be conceptualized with an empirical, inductive research approach. The study uses focus groups and interviews with over 110 industrial experts from more than 20 different companies, and the data is analyzed using a variety of general theoretical lenses. The study defines Smart Maintenance as *“an organizational design for managing maintenance of manufacturing plants in environments with pervasive digital technologies”*, with the aim to achieve effective end efficient decision-making and responsiveness to internal and external components (Bokrantz et al., 2020c).

Smart Maintenance is presented using four core dimensions: data-driven decision-making, human capital resource, internal integration, and external integration. Important to notice is that the research have conceptualized the four dimensions as organizational state variables and not a set of activities or mechanisms. Therefore, further conceptual refinement is needed on how to reach these state variables (i.e., dimensions) (Bokrantz et al., 2020c). Bokrantz (2019) points out that all four dimensions together constitute what Smart Maintenance is, and that all four dimensions support each other and are equally important in achieving Smart Maintenance, and therefore, cannot substitute each other. Figure 2.1 shows the Smart Maintenance concept, and the individual dimensions are further presented below.

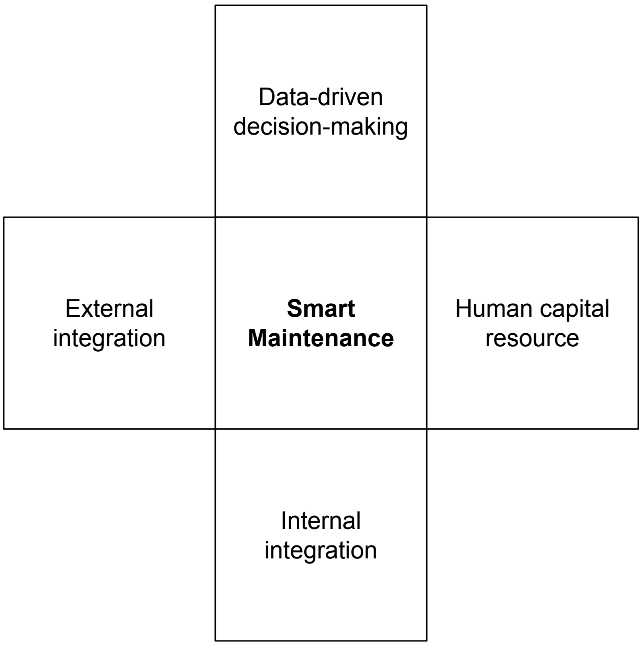

Figure 2.1: The Smart Maintenance concept created by Bokrantz et al. (2020c)

Data-driven decision-making is defined as *"the degree to which decisions are based on data"* (Bokrantz et al., 2020c). Maintenance decision-making is augmented or automated using efficient data collection and analysis with the help of sensors, algorithms, and decision support-systems, with the goal of improving decisions on where, when, and how maintenance should be carried out (Bokrantz et al., 2020c).

Human capital resource is defined as a *"unit capacity based on individual knowledge, skills, abilities, and other characteristics that are accessible for unit-relevant performance"* (Bokrantz et al., 2020c). This dimension is represented by the collective human resources within the maintenance function, where digitalized developments present new demands on data analytic and IT-tools skills, but also social skills and the ability to cooperate within and outside the company (Bokrantz et al., 2020c).

Internal integration is defined as *"the degree to which the maintenance function is a part of a unified, intra-organizational whole"* (Bokrantz et al., 2020c). This refers to the maintenance function being a part of the whole within the company where data and knowledge are shared and collaboration and joint decision-making are made possible with processes, people, and technology (Bokrantz et al., 2020c).

External integration is defined as *"the degree to which the maintenance function is a part of a unified, inter-organizational whole"* (Bokrantz et al., 2020c). External integration refers to data and knowledge sharing as well as collaborations and partnerships outside the company. Maintenance functions must integrate with organizational components outside the company to benefit from innovation, technological development, and larger data and knowledge banks (Bokrantz et al., 2020c).

In their recommendations for future work, Bokrantz et al. (2020c) emphasize the need for further conceptual refinement of how to reach the organizational state variables they used to conceptualize Smart Maintenance. Therefore, they encourage scholars to directly build on their work and identify mechanisms that work toward achieving the four dimensions of Smart Maintenance.

2.4.3 Operationalization of Smart Maintenance

Bokrantz et al. (2020c) focused on understanding the Smart Maintenance concept and the conceptualization of Smart Maintenance. However, in a subsequent study, Bokrantz, Skoogh, Berlin, and Stahre (2020a) point out that the facilitation of the conceptualization, and the understanding of it, requires the ability to measure the four dimensions of Smart Maintenance, or in other words, operationalization of Smart Maintenance. Bokrantz et al. (2020a) conducted two sequential studies that generated items to be measured, assessed their validity, and finally launched an empirical pilot test. The studies resulted in a psychometric instrument that can measure the four dimensions and be used by scholars for theory-testing for further understanding of Smart Maintenance, but also by practitioners that could benchmark Smart Maintenance within their maintenance organizations (Bokrantz et al., 2020a). The instrument consists of several questions, and can be used as a self-administered questionnaire to measure each of the four dimension of Smart Maintenance (Bokrantz et al., 2020a).

The psychometric instrument would later be called SMASh (Smart Maintenance Assessment), and from here on, that is what the instrument will be referred to in this thesis. SMASh is provided freely by the researchers from the original study, and it utilizes a survey answered by people in maintenance organizations to benchmark Smart Maintenance. The result is compiled into a report, that shows how the organization performs according to the four dimensions of Smart Maintenance, but it also provides general recommendations on how to act on the results. See Appendix A for more details and an example of the SMASh results. After the SMASh survey, it is recommended to gather the maintenance team and openly discuss the report to identify possible improvement areas.

2.5 Implementation of Smart Maintenance

The work by Bokrantz et al. (2020c) clarify the Smart Maintenance concept to enable the development of maintenance organizations. Yet, Bokrantz, Skoogh, Berlin, Wuest, and Stahre (2020b) point out that factors like resistance to change, lack of openness to new technology, and a reluctance to invest still make the implementation of Smart Maintenance difficult. In their study on how maintenance tasks and maintenance management strategies are changing with the digital transformation, Silvestri et al. (2020) conclude there is far too little research on how to support organizational development for maintenance in digitalized manufacturing. Instead, the authors found that researchers tend to focus on the technological challenges of maintenance development. This leaves a research gap regarding organizational development in maintenance. A gap the study by Lundgren (2021) intended to fill.

In line with the recommendations on future work by Bokrantz (2019), Lundgren (2021) has studied how maintenance organizations can reach the four dimensions of Smart Maintenance by facilitating its implementation. Lundgren (2021) acknowledge that Smart Maintenance already is observable and measurable, which means that Smart Maintenance, to some extent, already exists in organizations. However, there are many ways of working with Smart Maintenance, and the implementation of the concept will differ between plants (Lundgren, 2021). Therefore, Lundgren (2021) sees Smart Maintenance from a perspective of organizational innovation and how its implementation may be facilitated by considering the innovation characteristics: relative advantage, compatibility, complexity, trialability, and observability. Lundgren (2021) continues by explaining how the whole company must believe in the benefits of Smart Maintenance and its *relative advantage* in order to succeed with the implementation. Furthermore, Smart Maintenance must fit the existing values and norms of the organization, where *compatibility* increases the likelihood of innovation and change. *Complexity* is decreased and *trialability* is increased by performing change initiatives in smaller steps using a mixture of top-down and bottom-up approaches, which leads to higher chances of successful innovation. Finally, by communicating and visualizing the results, *observability* is increased where results are easy to see which further boosts the likeliness of a successful implementation of Smart Maintenance.

Lundgren, Bokrantz, and Skoogh (2021b) combine the findings from a cross-case analysis with a theoretical framework based on strategy development. As a result, the authors propose a strategy development process for Smart Maintenance implementation aimed to support organizational innovation, which contributes to a new perspective on maintenance strategies. Lundgren et al. (2021b) discuss how maintenance strategies are not limited to a plan for equipment repair, but also include an overview plan for organizational development. Hence, Lundgren et al. (2021b) provides a structured, step-by-step process for developing such strategies. The strategy development process is iterative and consists of six steps: benchmarking of the maintenance organization 1), setting clear goals 2), setting strategic priorities 3), planning key activities 4), elevating implementation 5), and follow-up 6). The strategy development process for Smart Maintenance implementation is visualized in Figure 2.2 and each step is explained below.

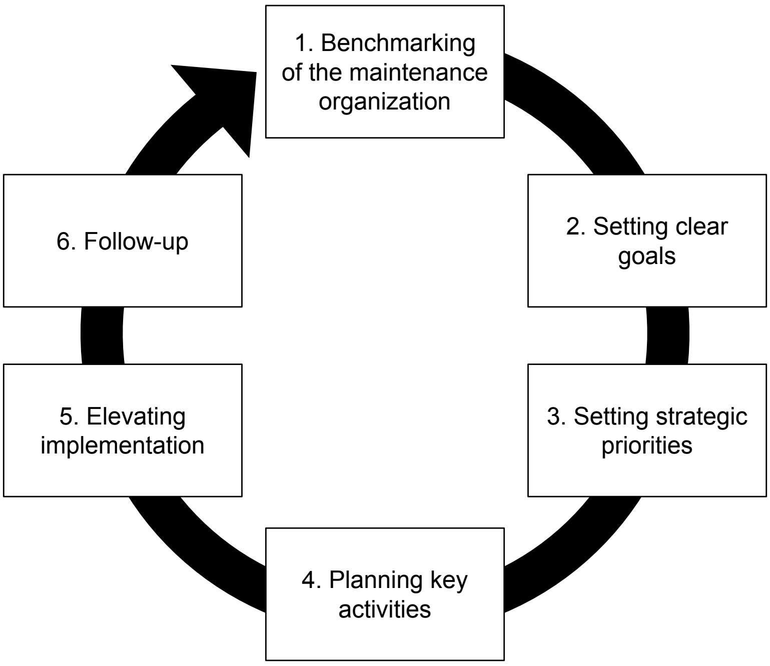

Figure 2.2: The strategy development process for Smart Maintenance implementation by Lundgren et al. (2021b).

1. Using the SMASh instrument developed by Bokrantz et al. (2020a) to benchmark the maintenance organization gives the employees a better understanding of the four dimensions of Smart Maintenance within their organization which helps them identify improvement areas (Lundgren et al., 2021b). The authors further explain how employee engagement and intense discussions are created by visualizing the result from the SMASh instrument, which enables a mixture of top-down and bottom-up approach strategy development.

2. Lundgren et al. (2021b) point out how companies should set clear goals for the desirable outcomes of Smart Maintenance. To maintain employee engagement, there must be a strategic alignment between the maintenance strategy and the company's overall goals. The internal communication of the Smart Maintenance goals is crucial to engage the entire organization.

3. There is an interplay among the four dimensions of Smart Maintenance. Therefore, it is important to establish strategic priorities to help with planning and scheduling of activities and to make sure that the activities are performed in the correct order (Lundgren et al., 2021b).

4. To reach the goals, the organization must identify and plan activities (Lundgren et al., 2021b). Dialogue and employee engagement are created by bringing people together in a brainstorming workshop where key activities are identified.

The planning and scheduling of activities, as well as internal communication, are further facilitated by visualizing the activities in a roadmap (Lundgren et al., 2021b).

5. The next step is to elevate the implementation by executing the planned key activities (Lundgren et al., 2021b). However, the authors remind us that assessing factors like culture, leadership, technology investments, and IT security, and thus, identifying possible strengths or obstacles, could ease the implementation.

6. Finally, companies must link the effects of Smart maintenance to the company's overall goals by following up on the activities and their effects (Lundgren et al., 2021b). This can be done with a broad set of performance indicators. Employee engagement will be maintained by highlighting accomplishments from all of the four dimensions of Smart Maintenance.

Lundgren et al. (2021b) focused their research on developing a strategy development process to facilitate the implementation of Smart Maintenance. However, the research did not include testing and evaluation of the strategy development process, something that is mentioned as necessary for future work. Therefore, their recommendation to other researchers was to test and evaluate the proposed strategy development process, as well as to develop its steps with further details, to continue facilitating the Smart Maintenance implementation.

Important factors of the the strategy development process are visualization of results and promotion of employee engagement. Factors someone needs to be responsible of (Lundgren, 2021). From the proposed strategy development process for Smart Maintenance implementation, we learned the importance of visualizing results and creating employee engagement, and these are factors someone needs to be responsible for leading (Lundgren, 2021). Therefore, beside the strategy development process, Lundgren (2021) studied the field of managing Smart Maintenance initiatives. One way of managing Smart Maintenance initiatives is through the visualization of results and follow-up of the effects of Smart Maintenance (Lundgren, Bokrantz, & Skoogh, 2021a). The study by Lundgren et al. (2021a) shows that a change in strategy, which Smart Maintenance is, also requires a change in performance indicators (PIs). The authors present 170 PIs that could be used to measure the effects of Smart Maintenance. Furthermore, Lundgren et al. (2021a) emphasize alignment between the maintenance organization's PIs and the overall company strategy as Smart Maintenance is expected to lead to a broader spectrum of effects compared to the traditional view of maintenance (i.e. repairing equipment). Lundgren (2021) also points out that Smart Maintenance changes the role of maintenance managers. New technologies, and change in general, may attract new employees and inspire already existing ones, but resistance to change is likely to arise among the more conservative employees (Lundgren, 2021). Therefore, Lundgren (2021) concludes that *"the role of a maintenance manager is changing from being a technical manager to a leader of people within an organization in change"*.

2.6 Organizational learning

Learning organizations are organizations creating, acquiring, and transferring knowledge, something that in the long run will improve the organizations' efficiency (Garvin, 1993). Organizational learning should therefore be seen as a transforming process as it develops the organization's culture, experience, and working methods (Huzzard & Wenglén, 2019). Dixon (2017) argues that organizational learning is crucial for survival and foregrounds the importance of team learning because it is the team that put the strategy into action. It is thus essential to take advantage of all situations, or even create situations, to learn. However, organizational learning is a complex learning process as the learning changes the individual's view of themselves (Huzzard & Wenglén, 2019). To better understand the complexity, Weick and Westley (1999) present learning and organizing as an oxymoron, a concept with opposite meanings. The authors deem that learning creates order and continuity in the organization, as well as disorder and change. As learning takes place through social contact, language is a crucial factor for learning and organizing (Weick & Westley, 1999). For example, a study by Cummings (2004) found that external knowledge sharing created more effective teams and organization performance than internal knowledge sharing.

According to Senge (1990), organizational learning consist of five disciplines: systems thinking, personal mastery, mental models, shared vision, and team learning. Systems thinking is about seeing the organization as a unit and not as several units. This is required to create a common overview of the organization's situation and understand the consequences of single actions. Personal mastery is about the individual needing to master goals to achieve the organization's vision. This requires a clear idea of where the organization is and where it is going. Mental models are about the organization's values being in line with the individual's values. The organization needs genuine support from its individuals to be able to develop faster than its competitors. A shared vision must thus combine visions of individuals and the organization, which creates intrinsic motivation throughout the entire organization (Kotter, 1995; Senge, 1990). Team learning is about creating a winning team that focuses on achieving the organizational goals and vision. This requires a "we-feeling" in the team, in which individuals see each other as colleagues and not rivals. Senge (1990) believes that if each discipline is addressed, organizational learning will exceed the sum of its disciplines. For this to happen, (Senge, 1990) deem real learning has to get to the heart of what it means to be human.

2.7 Organizational change

Organizations need to relate to the world's changeable relations to minimize the risk to disappear. Beer and Nohria (2000) argue that changing relations are increasing and that organizations must change with these or die. This demands an increased rate of organizational change (Weick & Quinn, 1999). Furthermore, Burke (2017) deem organizational change is most often explained as revolutionary or evolutionary.

Revolutionary change is comprehensive and happen discontinuously. Evolutionary change is instead incremental and happen continuously.

Previous research shows how organizational change often fails. According to Collins (2007), *"organizational life is complex, ambiguous and so difficult to navigate"*. The complexity is due to the fact that organizations consist of a combination of multiple entities (Delmas & Toffel, 2008). Beer and Nohria (2000) discuss the failure rate for organizational changes and estimate that 70% of these implementations do not achieve the required result. However, Hughes (2011) counter-argues this statement and believes that there is no scientific basis for how many organizational changes succeed or fail. There are thus several perspectives on what successful organizational change is. In any case, Law (1986) confirms the significance of continuously adding new energy to it. If not, organizational change will cease and thereby fail.

Child (2015) presents external and internal drivers of organizational change. External drivers are the forces to shape the basic rules of which the company in the long run cannot ignore (Child, 2015). However, companies always react differently to external drivers. The difference between these reactions can be explained by the company's internal drivers (Child, 2015). Internal drivers are about leadership and how to lead strategy development and organizational innovation forward (Child, 2015). According to Sveningsson and Sörgärde (2019), external drivers are interpreted in different ways by managers and employees, and the authors sum up eight external drivers to organizational change: political, technological, cultural, demographical, economical, emergent of new knowledge, changed competition, and industry regulations. Sveningsson and Sörgärde (2019) further concludes that external drivers do not necessarily control the organizational development, since internal drivers are influential. For example, Moss Kanter (2011) explains how "good organizations" think differently and combines financial goals with social or institutional logic to be successful. This can be seen as an internal driver in which affect the strategy development and organizational innovation.

The opposite of drivers is resistance, which is a natural part of organizational change (Sveningsson & Sörgärde, 2019). Dawson (2002) believes that people resist organizational change due to five factors: change in skill requirements, threat to employment, psychological threat, new work arrangements, and redefinition of authority relationships. According to Dawson (2002), self-interest, misunderstanding and lack of trust are the most common causes of resistance. Furthermore, clashing interests, relationships and coordination are important dynamics to consider. Dent and Goldberg (1999) believe that it is not the organizational change itself that constitutes the resistance, but rather the threat the change is associated with. It is, therefore, important that organizations in change communicate their purpose, i.e., explain why and how the change is implemented for the employees.

Both drivers and resistance to organizational change are influenced by individuals' motivation. The self-determination theory explains how the human needs of autonomy, competence, and relatedness are required for optimal motivation to occur (Deci

& Ryan, 2012). Autonomy is the individual feeling free to decide what and how the work should be performed. Competence is the individual feeling stimulated by the work task and developing over time. Relatedness is the individual feeling needed and appreciated in the workplace. If one of the three basic needs fails, the optimal motivation drops to suboptimal motivation (Fowler, 2014). For example, organizational change can affect work arrangements and skill requirements for the employees, overhauling the motivational outlooks within the organization, risking to increasing the resistance to the change. Moreover, Daft (2015) clarifies how resistance to change is created when employees do not understand or are improperly informed. The self-determination theory thus proposes that employees should be given free choice, stimulated by self-developing activities, and appreciated in the organization in order to gain optimal motivation (Fowler, 2014). Therefore, involving the employees in organizational change is crucial for successful change implementation.

2.8 Organizational development

Organizational development can be either planned or emergent. Planned development are characterized by planned modules in which the management team is the leading actor (Child, 2015). These developments take place over a longer period of time and need long-term teamwork (Sveningsson & Sörgärde, 2019).

Over time, emergent development have become more common. Child (2015) states that planned development is a requirement for emergent development. Emergent development originate from the evolutionary perspective and the organization is continuously developing due to internal changes, product development, and innovations (Sveningsson & Sörgärde, 2019). Emergent development changes are characterized by continuous processes in which the employees are the main actor (Sveningsson & Sörgärde, 2019). This requires that the employees are authorized to implement changes themselves. The manager's role therefore changes to support employees so that they can develop the organization continuously through everyday commitment, motivation and knowledge (Burnes, 2004). However, Sveningsson and Sörgärde (2019) argue that the efforts of managing planned and emergent developments are underestimated, because these changes are more or less impossible to plan. Weick and Quinn (1999) conclude that change never begins because it never ends. Consequently, "change" should be renamed to "changing" as it is an emerging process and not something that could be implemented only once (Weick & Quinn, 1999).

A well-known planned change model is Lewin's three-stage process model, consisting of the three stages: unfreezing, transition, and freezing (Child, 2015). Unfreezing occurs before the organizational change and is about preparatory activities and planning. Transition highlights the change work. Freezing occurs after the organizational change and is about recreating a stable situation so that the change remains. Lewin's three-stage process model is therefore a general planned change model, suitable for all types of changes as it is methodical and easy to understand.

Another, and more detailed, planned change model is Kotter's eight-stage process model (Kotter, 1995). The idea is to increase drivers and decrease resistance in organizational change. The model guides changing organizations by dividing the transformation into eight steps: establishing a sense of urgency 1), forming a powerful guiding coalition 2), creating a vision 3), communicating the vision 4), empowering others to act on the vision 5), planning for and creating short-term wins 6), consolidating improvements and producing still more change 7), and institutionalizing new approaches 8). Below is a short summary of each step, based on Kotter (1995).

1. Establishing a sense of urgency, evaluates the organization's starting point and creates motivation for the organizational change. The information must be communicated widely and dramatically. It is easier to change when there is a sense of urgency, such as a crisis or time-limited opportunity.

2. Forming a powerful guiding coalition, of three to five people, will lead the organizational change forward. The organization's management needs to be involved to prevent the change from encountering authorization problems. It is also advantageous if a union representative is included in the group.

3. Creating a vision, that is linked to the organizational change and its strategies is important. Without a vision, the organizational change will fail or take the wrong direction. The vision is often created by one individual, whereby the coalition develops it for a few months. A sensible vision should be able to convince the employees in less than five minutes.

4. Communicating the vision, aims to convey the vision to all individuals in the organization. The vision must be communicated by a factor of ten and all communication channels must be used. The vision needs to be integrated into everyday operations, as well as communicated with both words and deeds.

5. Empowering others to act on the vision, requires the organization to eliminate all obstacles that hinders the change. A common obstacle is that individuals experience organizational changes as a threat to their employment. However, all obstacles must be removed, in order to remain the credibility and momentum of the organizational change.

6. Planning for and creating short-term wins, highlights the importance of achieving short-term wins. This requires goal breakdown, where different goals win early in the change process. This usually needs to be done within one to two years. Involved individuals must be rewarded while the goals are achieved. Short-term wins and a certain level of stress create commitment to accelerate the organizational change.

7. Consolidating improvements and producing still more change, is about not declaring victory in advance, a phenomenon that risks slowing down the speed of the organizational change. Short-term wins should be used instead. Usually, the organizational change takes five to seven years to complete.

8. Institutionalizing new approaches, is to anchor the organizational change in the company culture. This requires that social norms and values are rooted in the organization's behavior and attitude. This also requires that the next generation of leaders are convinced of the benefits of the organizational change.

Kotter (1995) further asserts the importance of changing gradually and in small steps (i.e., evolutionary change), since taking too big steps, or skipping steps, might lead to failure. However, changes are messy in reality and difficult to plan, which makes planned organizational development easier said than done (Kotter, 1995). The author, therefore, emphasizes the importance of having a vision, which reduces resistance and guides organizational change when turbulent times arise.

3
Methodology

The following chapter describes the research methodology, including abductive reasoning, research approach, design, techniques, and procedure.

3.1 Abductive reasoning

The research methodology has an abductive reasoning which is a mixture of a deductive and inductive reasoning that allows the selection of theory to be controlled by switching between theory and practice (Patel & Davidson, 2019). An deductive reasoning means that the researcher first chooses an appropriate theory, after which the researcher collects data and draws a conclusion (Patel & Davidson, 2019). An inductive reasoning takes place in the opposite order, the researcher first collects data, after which the researcher chooses an appropriate theory and draws a conclusion (Patel & Davidson, 2019). Kvale and Brinkmann (2014) explain the abductive reasoning as a suitable form of research reasoning when you want to understand or explain something. Working abductively can therefore be seen as a flexible research approach for real practice, since the researcher can alternate between theory, practice, and reflection to gain new ideas and perspectives (Alvehus, 2019). Hence, Alvehus (2019) believes that an abductive reasoning should not be seen as an intermediate variant of deduction and induction, but as another type of research logic.

An abductive reasoning was considered appropriate in this thesis because the strategy development process for Smart Maintenance implementation is iterative and can lead the research to unexplored areas. With an abductive reasoning, it was possible to continuously revise the theoretical framework through feedback from the empirical framework. The ability to design the literature study in parallel with the research procedure was vital, to broaden the view of what should, and should not be included. The idea of the abductive reasoning has been visualized in Figure 3.1.

3.2 Research approach

The research approach used in this thesis was action research. Action research is a collaborative research method that aims to understand and solve problems through critical thinking. Instead of just working theoretically, action research allows practitioners to address the problems that are closest to them (Ferrance, 2000). Action research is about observing, understanding and ultimately changing the situation, while reflecting on actions, which creates the direction of the research (Dickens &

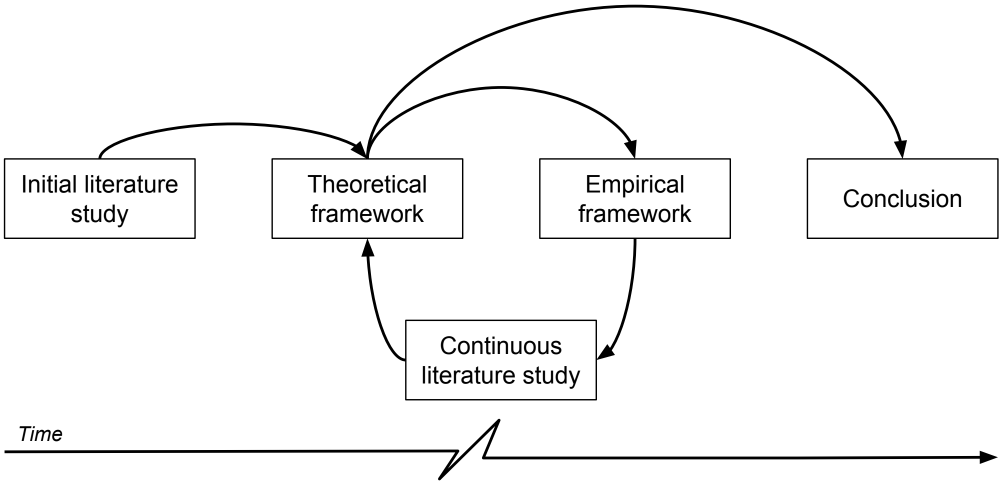

Figure 3.1: The abductive reasoning.

Watkins, 1999). Thus, action research is a research method that is used in the field, where researchers and practitioners work together (Patel & Davidson, 2019). The idea of action research is that the researcher begins with a loop of asking questions, collecting data, reflecting and then deciding on a course of action (Ferrance, 2000). These actions are repeated until the researcher and practitioners have solved the problem. The practitioners should therefore not be seen as the object or subject of the research, but as co-researchers to the researchers (Dickens & Watkins, 1999). Consequently, action research can be described as the dual purpose of achieving practical transformation and promoting knowledge (Huxham & Vangen, 2003).

Action research was developed by Lewin (1946) with the aim to research intergroup relations, i.e., organizational environments. Lewin (1946) initially reports action research as a composed circle of overall planning, execution and reconnaissance. Overall planning is about planning the research and determining the research objective. Execution is about conducting the research, i.e., realize the overall plan with actions. Reconnaissance, or fact-finding, is about evaluating research and understanding whether the research objective has been achieved, which enables the researchers to gain new insights and thereby modify the overall plan for the next circle. Dickens and Watkins (1999) rethink Lewin's composed circle using five phases: planning, acting, observing, reflecting, and reconceptualization, see Figure 3.2. The updated definition of action research presented by Dickens and Watkins (1999) is hereinafter referred to when action research is mentioned.

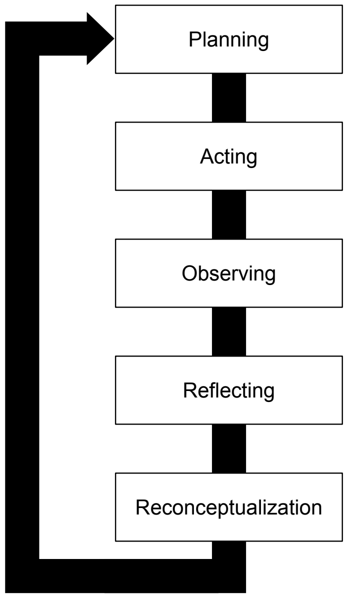

Figure 3.2: The five phases of action research by Dickens and Watkins (1999).

Dickens and Watkins (1999) point out that without cooperation practitioners engage in an uninformed act, researchers develop theories without application, and none of the groups obtain successful results. The five phases of action research are explained as follows:

- **Planning** identifies the problem and what needs to be investigated. However, action research should only be used to solve complex problems. It should, therefore, not be possible to answer the problem with a yes or no, nor should it already have an answer. When there is an understanding of the problem, planned actions can be set.

- **Acting** implements the planned actions and collects data. This is done in the field, i.e., research in action. This can thus be seen as the experiment phase.

- **Observing** collects more data by further understanding the actions taken. Observing is performed simultaneously as the planned actions are carried out.

- **Reflecting** evaluates the collected data, reviewing the result and reflecting whether the problem has been solved and the objective achieved. Reflecting is an analytical phase that aims to find patterns in the data. Hence, reflecting takes place after the planned actions using the data from the observing phase.

- **Reconceptualization** draws lessons learned about what happened and decides if the problem is solved or if the problem and objective need to be redefined so that a new loop of action research can be implemented. Reconceptualization is thus the final phase that determines whether one can leave the loop of action research or not.

However, there are many different definitions of action research (Ferrance, 2000). There is, therefore, no definitive approach to how action research should be conducted. This can be seen as its strength as well as weakness (Dickens & Watkins, 1999). Unlike traditional research, action research does not focus on limiting or controlling an experimental situation, but approaches the problem in its natural stage (Trist, 1976). It is therefore essential that research and actions are close to each other in order for the research to be able to adapt as the situation changes, as a result of the implemented actions (Huxham & Vangen, 2003). Huxham and Vangen (2003) further state that action research is based on the needs of practitioner and the researcher is engaged in supporting these needs.

Action research was considered appropriate in this thesis because it is a suitable research method for solving complex problems in organizational environments. With action research, it was possible to integrate researchers and practitioners to test, evaluate, and further develop the strategy development process for Smart Maintenance implementation, on site at SCA. The researchers, i.e., the students, asked questions and encouraged the practitioners, i.e., the employees at SCA Maintenance, to get involved and improve when it comes to Smart Maintenance. When the researchers and practitioners worked together, it was possible to adopt the strategy development process for Smart Maintenance implementation to the daily operations at SCA, and thus research the Smart Maintenance implementation in a real industrial setting.

As action research requires interactivity between researchers and practitioners, both parties were considered to be equally important. Therefore, a group was established consisting of the students and representatives from SCA, four maintenance engineers and one maintenance planner. This group enabled close collaboration between the researchers and practitioners throughout the thesis an will hereinafter be referred to as the research group. Hence, knowledge was developed through practical usability, dialogue, and mutual learnings from both disciplines, which bridged the gap between academia and industry.

To simplify the handling of action research, the researchers created an action research guideline. The guideline aimed to continuously support the researchers through the five phases of action research. The guideline consisted of statements and questions that were important to consider before, during, and after conducting each action research phase. These statements and questions could also be used to reflect on the strategy development process in retrospective. The action research guideline was based on theory from the initial literature study and are presented in tabular form in Appendix B.

3.3 Research design

The thesis utilized action research to test and evaluate the strategy development process for the Smart Maintenance implementation and further develop its steps for the pulp and paper industry. The action research method allowed the thesis to practically and collaboratively realize the strategy development process together with SCA Maintenance. Figure 3.3 shows the interconnection between the five phases of action research and the strategy development process for Smart Maintenance implementation. The interconnection made it possible to loop the research several times if needed. In other words, the strategy development process for Smart Maintenance implementation was the subject of the action research, and action research was the method used to test and evaluate the process by Lundgren et al. (2021b).

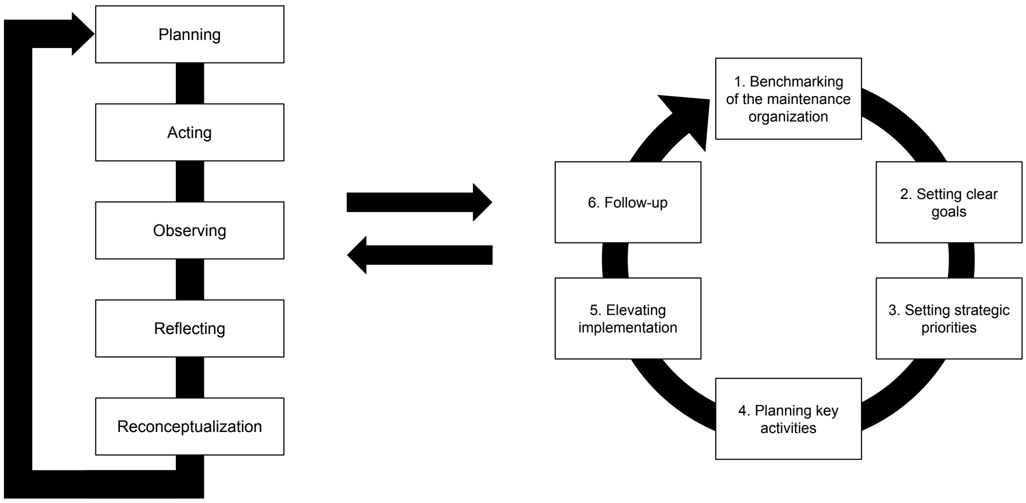

Figure 3.3: The research design.

The research design can also be described by a research strategy. The research strategy was formed by abductive reasoning, as it was feasible to switch between the theoretical and empirical frameworks as learning progressed. Hence, the research strategy made it possible for the research group to alternate between theory and practice, continuously update the research procedure through reflections, collect appropriate empirical data to answer the research questions and thus fulfill the purpose and aim of the research. The research strategy is visualized in Figure 3.4, and describes the continuous exchange between theory and practice, which is used to create qualitative data, i.e., research input, that answers the research questions and draws a conclusion, i.e., research output.

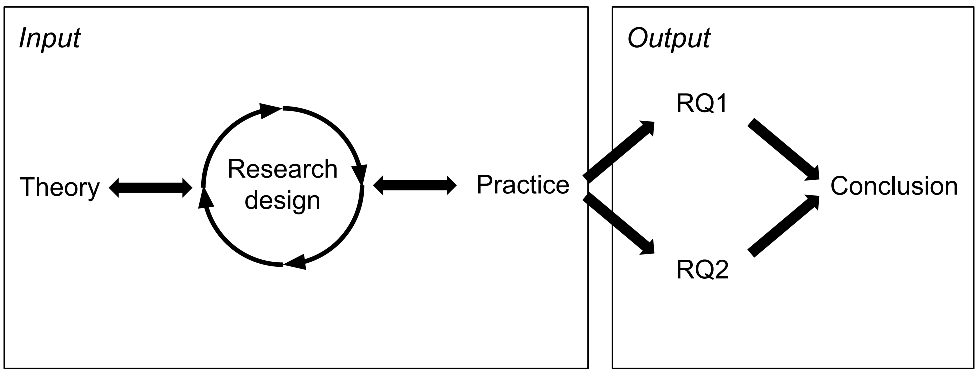

Figure 3.4: The research strategy.

The theoretical framework consisted of an extensive literature study. The literature study was divided into two phases, an initial phase and a continuous phase. The literature study consisted of primary sources, mainly scientific papers, but also textbooks and articles (both in Swedish and English). According to Patel and Davidson (2019), it is beneficial to use scientific papers if the research area breaks new ground, something that was believed true for the concept of Smart Maintenance. Just as Patel and Davidson (2019) recommend, only peer-reviewed scientific articles were selected to get suitable search results. The scientific papers and textbooks were obtained via Chalmers Library and the scientific database Scopus. Scopus was used since it is recommended by Chalmers Library as one of the leading and most important scientific databases for quality-assured literature within all scientific areas.

The initial literature study aimed to initiate the broad meaning of Smart Maintenance, its implementation, and this thesis' research methodology. Since the research's purpose and aim was based on future work recommendations by Lundgren (2021), which was descended from Bokrantz (2019), these two doctoral theses, with appended papers, constituted the baseline of the initial literature study. In addition, research methodology and action research were studied, see Table 3.1. After completing the initial literature study, the continuous literature study started.

Table 3.1: The initial literature study.

Field	**Type**	**Detail**
Smart Maintenance	PhD theses, Scientific papers	Conceptualization, Operationalization, Implementation
Research methodology	Scientific papers, Textbooks	Methods, Techniques
Action research	Scientific papers, Textbooks	Approach, Procedure, Variants

The continuous literature study aimed to close knowledge gaps that arose in the implementation, based on the actions implemented by action research. The continuous phase generally covered production processes, digitalized manufacturing, industrial maintenance, organizational learning, organizational change and organizational development, see Table 3.2.

The empirical framework consisted of qualitative data. The data gathering included four fundamental research techniques: internal documents, semi-structured interviews and focus groups, unstructured observations, and workshops. These techniques are separately explained in Section 3.4. To conduct qualitative research, the researchers needed to understand how the qualitative analysis should answer the research questions. The thesis, therefore, applied a process, presented by Creswell and Guetterman (2021), for how qualitative data should be analyzed, something that assisted the researchers through qualitative research. The analysis process is explained in six steps: prepare data by making transcripts, explore data by reading the transcripts, improve transcripts by encoding them, shape the code with visuals

Table 3.2: The continuous literature study.

Field	Type	Detail
Production processes	Scientific papers, Textbooks	Definition, Value creation, Value chain
Digitalized manufacturing	Scientific papers	Digital development, Industry 4.0, Smart technologies
Industrial maintenance	Scientific papers	Definition, Maintenance strategies, Obstacles
Organizational learning	Scientific papers, Textbooks	Previous studies, Five disciplines
Organizational change	Scientific papers, Textbooks	Definition, Previous studies, Drivers, Resistance, Motivation
Organizational development	Scientific papers, Textbooks	Planned, Emergent, Change models, Organizational governance

or narratives, interpret the result through personal reflection and comparison with theory, and validate the result using appropriate strategies. Creswell and Guetterman (2021) believe, however, that the researchers do not need to strictly follow the given order but can cycle back and forth between the steps. Qualitative analysis can thus be carried out in as many ways as there are qualitative researchers. This motivated the researchers to design a research to suit SCA Maintenance. Creswell and Guetterman (2021) point out further how qualitative analysis is an interpretation and that the researchers can interpret data inversely, as the interpretation is based on the researchers' previous experience. However, this does not mean that one interpretation is better than the other. The researchers needed to be aware of this and therefore followed the instructions by Creswell and Guetterman (2021), using mixing forms of qualitative data. This is called the multitrait or multimethod approach (Campbell & Fiske, 1959). By combining different types of qualitative research techniques, new traits were developed and research validity increased. The choice of research technique was then governed by the five phases of action research. The empirical framework is visualized in Figure 3.5, and illustrates how the four fundamental research techniques were used to collect, prepare, read, encode, shape, interpret and validate the qualitative data.

3.4 Research techniques

The following section presents the research techniques used in this thesis. The research techniques are summarized in short paragraphs in order to explain how each technique works and how they were used in this research.

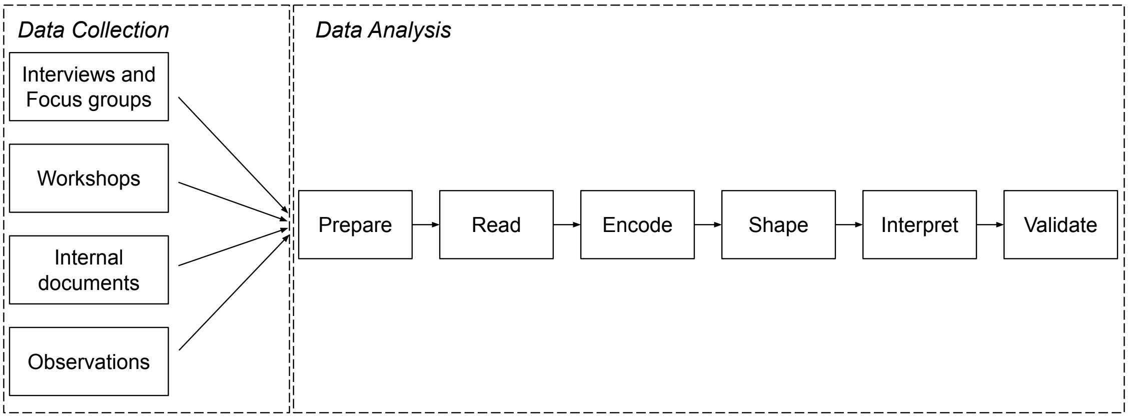

Figure 3.5: The empirical framework design.

3.4.1 Internal documents

Internal documents, or just documents, are a research technique within qualitative research. Documents aim to gather existing data for interpretation (Patel & Davidson, 2019). Documents can either be private or governmental archives and collections (Patel & Davidson, 2019). Documents are thus an important source of information for organizations and institutes, regardless if its in written or digital format (Bowen, 2009). Hence, documents need to be reviewed to determine the organization's starting point. According to Bowen (2009), documents constitute an important part of qualitative research. However, it is necessary to find out where and when the document was created, since not taking its origin into account can make the results misleading. Documents can be either primary and secondary sources. The benefit with documents as research technique is that they are cheap way to obtain empirical data (Bowen, 2009). Documents are often of high credibility, as they combine data from both interviews and observations and thus reduce bias (Bowen, 2009). Documents can therefore be seen as a trustworthy research technique as it improves thick description to the qualitative analysis. Thick description is an expression to demonstrate contextual details and social coherence in qualitative research (Mills, Durepos, & Wiebe, 2009). However, Bowen (2009) explains that documents are not a "stand-in" for other research techniques, but should be seen as a complement. Bowen (2009) also recommends thematic analysis or grounded theory to analyze documents.

In this action research, documents were reviewed to support the upcoming focus groups and workshops. The researchers had access to SCA intranet, i.e., organizational archives and collections, and could thus collect existing data about the maintenance organization internal operations. Documents that were reviewed were, for example, goal documents for 2020, 2021 and 2022. Other examples were strategy documents as well as overall guidelines for SCA. Hence, the researchers were able to understand the maintenance organization's starting point and what the upcoming focus groups and workshops had to address to initiate the strategy development process for Smart Maintenance implementation.

3.4.2 Semi-structured interviews and focus groups

Interviews are used to gather qualitative information about how individuals think, feel and act in different situations (Alvehus, 2019). According to Patel and Davidson (2019), interviews are suitable to use when the researcher wants to discover and identify characteristics and conditions. Interviews are appropriate to use when the analysis needs to include thick descriptions (Patel & Davidson, 2019). A common interview technique is a semi-structured interview, which allows the interviewer and the interviewee to shape their conversation on a predetermined theme (Alvehus, 2019). This creates a flexible discussion and is considered useful when different people within an organization are to be interviewed. The interviewee then has greater opportunities to influence the conversation. Patel and Davidson (2019) believe that a semi-structured interview is suitable to use in abductive research. In some situations, however, an in-depth interview may be a preferable technique (Kvale, Brinkmann, & Torhell, 2009). This creates a deeper understanding of the interviewee's perception of reality. Regardless of the type of interview, it is advantageous as an interviewer to be well-informed about the interview theme or topic (Patel & Davidson, 2019). Patel and Davidson (2019) also point out the importance of mastering language use, gestures and body language in order to "go native", which means that the researcher mimic the interviewee's way of communicating. Furthermore, Alvehus (2019) points out that an interview is not about producing answers, but asking and listening. It is therefore important not to have too many questions, so that the focus on the interviewer's story is not replaced by the focus on the number of questions answered. If more than one person is to be interviewed, focus groups is an appropriate interview technique (Patel & Davidson, 2019). A focus group usually consists of 6-12 participants who, via a moderator (the researcher), discuss a number of issues. Most often, these issues are centered around a particular theme, similar to the structure of the semi-structured interview.

Semi-structured interviews were used to analyze how each step in the strategy development process for Smart Maintenance implementation was experienced according to the maintenance managers. The researchers were thus able to inventory how the maintenance organization consistently reacted to the organizational development. Semi-structured interviews were also applied to the research group at the end of the thesis to assess the strategy development process as well as the research design to test and evaluate it. Furthermore, focus groups were used as research technique within the research group to discuss the process through the lens of action research. The researchers then acted as moderators while the members of the research group acted as co-researchers.

3.4.3 Unstructured observations

Observations aim to gather information about what is happening in a particular situation, i.e., field notes (Creswell & Guetterman, 2021). Observations are thus used to collect qualitative data. Observations are mainly used when researchers want to study behaviors or everyday events. The observation cannot be random but must be carried out systematically to be useful (Patel & Davidson, 2019). There are two different types of observation techniques, structured and unstructured observations (Patel & Davidson, 2019). Structured observations are used when the problem is well specified and the researchers understand what is to be observed. Unstructured observations have a more exploratory character and is used when the researchers want to gather more information about the problem. Regardless of the type of observation, the observation must be prepared. According to Spradley (2016), the researchers should pay attention to space, actor, activity, object, act, event, time, goal and feeling. Before the observation is to be carried out, the researchers also need to decide how to relate to the observation. The researchers can participate or non-participate, and be known or unknown, to those observed (Patel & Davidson, 2019). Furthermore, Wolfinger (2002) reminds that observations can be affected by bias, as the researchers may have already decided what to research. An advantage of observations is that they often require a low degree of cooperation and are thus relatively "easy" to conduct. A disadvantage is that the observation itself can be time consuming and thus expensive (Patel & Davidson, 2019).

Unstructured observations were used in this thesis alongside the other research techniques to collect qualitative data on the perceived reality. Unstructured observations were made, for example, alongside focus groups and workshops within the research group, interviews with maintenance managers and other visits at SCA Östrand pulp mill. The purpose of the unstructured observations was to analyze everyday events as the implementation developed. Each event's observation was compiled in a digital diary. One of the researchers therefore acted as secretary and noted what was observed. Because the action research was conducted without a hidden agenda, the researchers participated and were known to those observed.

3.4.4 Workshops

Workshops are a research technique in which researchers and practitioners meet and solve problems. According to Cambridge Dictionary (2022), workshop is *"a meeting of people to discuss and perform practical work in a subject or activity"*. Osborn (1953) first mentioned the word "workshop" to explain a group for problem-solving. In other words, workshops are a place to learn (Ørngreen & Levinsen, 2017). Workshops aim to challenge the practitioners domain knowledge and provoke reflection (Ørngreen & Levinsen, 2017). Hence, workshops helps researchers and practitioners to identify blind spots of knowledge and thereby solve problems. Workshops often involves practitioners from the same organizational domain (Ørngreen & Levinsen, 2017). Hence, workshops fits in well with action research due to its iterative process (Ørngreen & Levinsen, 2017). Chambers (2002) deem the best way to gain experience is through action, by making and recognizing mistakes. In the book *Participatory Workshops*, the author presents sets of ideas and activities to broaden the view of how workshops could be conducted. Since the main idea of workshops is to give practitioners the opportunity to act, participation is crucial and has to be promoted. There are several things to consider, organizing and managing proper workshops. Chambers (2002) highlights do's and dont's and a preparation checklist for the researcher. Chambers (2002) further gives suggestions on how to plan, conduct and analyze different workshops. Some of the author's tips and tricks consider how to best form groups, energize them, arrange seats, avoid lecturing and help all practitioners to learn from each other and in the workshop.

In this action research, several workshops have been conducted in the realization of the strategy development process for Smart Maintenance implementation, i.e., to meet and solve problems through practical work. Workshops were chosen as research technique when materials needed to be created, for example setting goals. Workshops were conducted with the research group or the maintenance managers depending on the type of material that needed to be created. This was also considered beneficial as workshops often involve practitioners from the same organizational domain. Larger workshop was designed according to Chambers (2002).

3.5 Research procedure

This section explains how the thesis was carried out. The thesis aimed to test, evaluate, and further develop the strategy development process for Smart Maintenance implementation. This was performed using action research. In the strategy development process, action research was used to plan, act, analyze, and further develop each step. The research procedure can be visualized by embedding the action research phases into each step of the strategy development process, see Figure 3.6. Each step, i.e., Steps 1-4, was executed using an individual action research loop. Hence, four separate action research loops were initially scheduled. The procedure for the action research loops was, however, similar for all four steps, and this procedure is explained in more detail below.

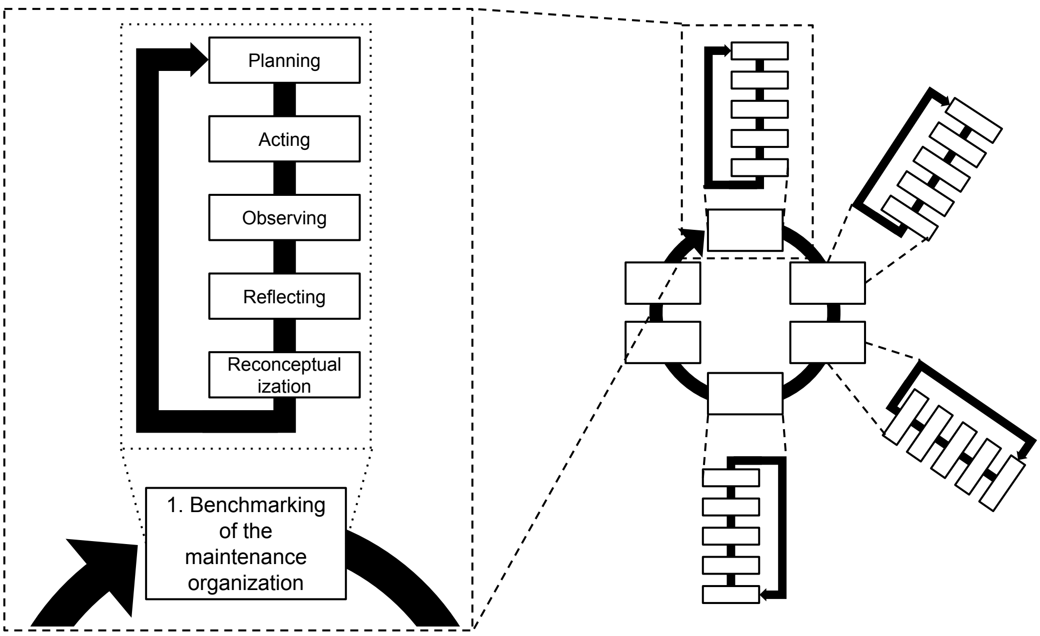

Figure 3.6: Action research was used to perform each step in the strategy development process for Smart Maintenance implementation.

3.5.1 Planning

The purpose of the planning phase was to plan how to carry out, analyze, and develop the individual steps of the strategy development process for Smart Maintenance implementation. The research group worked together and followed the action research guideline, see Appendix B, to determine the problem of the step and how to solve it. Internal documents such as organizational charts, goal documents, and strategy documents were studied as preparation, and the research group shared their experiences and views during focus groups. Semi-structured interviews were also conducted with the maintenance director and managers to help with the planning or as a final quality control before moving on with the acting phase. The planning phase resulted in a set of activities that would help the researchers execute and analyze each step of the strategy development process.

3.5.2 Acting

The researchers executed the planned activities during the acting phase. The different steps in the strategy development process included workshops and focus groups that were organized according to SCA participants' daily schedules, meaning the acting phase could take several weeks. The acting phase was where the actual strategy development process for Smart Maintenance implementation was carried out. The results from the acting phase, as well as the execution itself, were later analyzed and further developed during succeeding phases.

3.5.3 Observing

The observing phase took place at the same time as the acting phase. Here, the researchers observed what happened during the acting phase. The purpose was to identify interrelationships between the planning and acting phases and whether anything had changed. The observing phase further aimed to gather more data regarding the execution of the acting phase. All observations were performed as unstructured observations and documented in a digital diary where each acting item was distinguished based on actor, time, and date. If possible, feeling and "underlying tones" were also noted.

3.5.4 Reflecting

In the reflecting phase, the researchers analyzed whether or not the acting phase had solved the problem initially identified in the planning phase. If the acting phase had not gone as planned, the researchers searched for a possible cause. Unstructured observations, together with the action research guideline, supported the reflection. Semi-structured interviews with the maintenance director and managers presented further insights regarding the acting phase. Furthermore, focus groups allowed the research group to discuss the acting phase and whether or not they would have changed anything if given a chance. All reflections were documented and formulated in sentences allowing the researchers to use them later in the research procedure. The reflections were also used to compare the theoretical framework with the empirical framework.

3.5.5 Reconceptualization

In the reconceptualization phase, the researchers extracted lessons learned using the empirical data and reflections from previous phases. The learned lessons were thus more specific reflections on how the planning and acting phase could be improved. This was used to reconceptualize the activities generated in the planning phase, resulting in a fine-tuned procedure for how the strategy development process steps could be implemented next time. All lessons learned were considered equally important and were therefore not ranked.

3.5.6 Final semi-structured interviews

The research ended with final semi-structured interviews for all the individuals in the research group. The final semi-structured interviews were used to support empirical data for RQ1, as well as to collect empirical data for RQ2. Thus, the final semi-structured interviews aimed to evaluate as well as validate the research. A semi-structured interview guide was created based on seven questions, see Appendix C. Conducting semi-structured interviews were beneficial in several aspects. The researchers needed an interview design to shape the discussion based on the individual's experiences. The researchers also needed to take a less static approach so as not to disturbed the team spirit in the research group, something that is essential in collaborative action research. Hence, a classic interview would have risked distancing the researchers from the practitioners.

All final semi-structured interviews were later transcribed. These were read and thematically analyzed, i.e., color-coded based on the seven questions. Subsequently, all comments and insights were interpreted and grouped based on clear synergies and other similarities. This created clusters of like-minded comments and insights in which important categories emerged. The important categories were then summarized for answering for RQ1 and RQ2.

4
Results

The following chapter presents the results from the action research procedure and the final semi-structured interviews. All results are then formed into a further developed strategy development process for Smart Maintenance implementation, which is presented in the end of the chapter.

4.1 Lessons learned from the strategy development process

This section explains the results from the research procedure, as described in Section 3.5. Important to notice is that this thesis focuses on testing, evaluating, and developing the procedure of the strategy development process for Smart Maintenance implementation by Lundgren et al. (2021b). Consequently, all results focus on the procedure of the strategy development process and its impact. This section presents how the procedure of the strategy development process was planned, implemented, and analyzed. The strategy development process' *products*, e.g., benchmarking results, Smart Maintenance goals, and activity plans, will not be presented as they are SCA Maintenance's property. These *products* are also irrelevant to how the procedure was planned, implemented, and analyzed, as long as they were accepted by SCA Maintenance. However, to give the reader an understanding of what the different steps could produce, a set of examples (for Step 1-4) are presented in Appendix D. Note that these examples are entirely made up and have nothing to do with SCA Maintenance.

4.1.1 Step 1: Benchmarking of the maintenance organization

Planning. When planning Step 1, the research group considered the recommendations from the SMASh instrument as well as the description by Lundgren et al. (2021b). Firstly, participants had to be chosen and invited to answer the SMASh survey. Together with a maintenance manager, the research group decided that a total of ten people should answer the survey, representing the maintenance director, four maintenance managers, four maintenance engineers, and one maintenance planner. Secondly, the whole maintenance team had to be gathered where the results could be visualized and discussed to identify improvement areas. This was planned to take place at a follow-up meeting in the form of a focus group. Besides those who answered the survey, representatives from other functions of the maintenance organization were invited to the focus group as well to further increase the understanding of Smart Maintenance and employee engagement throughout the maintenance organization. The planned procedure for Step 1 is visualized in Figure 4.1.

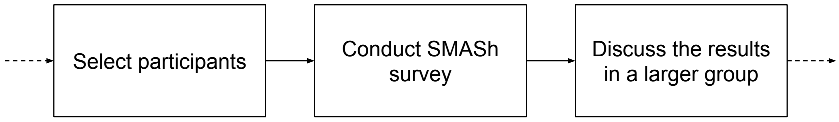

Figure 4.1: The planned procedure for Step 1.

Acting. The selected participants were invited via e-mail to answer the SMASh survey. A focus group was scheduled to take place one week later in the form of a digital meeting due to the current COVID-19 restrictions. The SMASh result was shared with all focus group participants before the focus group allowing them to reflect on the result beforehand. During the focus group, the researchers presented the SMASh result and then encouraged everyone to share their thoughts on the result and ideas for potential improvement areas. The researchers documented topics and questions brought up. Table 4.1 shows the main topics covered and comments raised during the focus group.

Table 4.1: The main topics discussed in the focus group.

Topics covered	**Comments**
The definition of Smart Maintenance and its dimensions	*"What is high levels of Data-driven decision-making?"*
How many that answered the survey	*"Who answered the survey, and how many were they?"*
How the SMASh results are generated	*"How did you summarize the results?"*
Requests for examples	*"Can you exemplify Data-driven decision-making?"*

Observing. Out of the ten that were invited to answer the SMASh survey, only six answered. During the focus group, the researchers struggled with creating the discussion that was expected. Most of the participants were quiet during the digital discussion meeting, and the ones that actively participated in the discussion mostly asked about and shared their thoughts on the SMASh survey itself and not the results. The group expressed difficulties regarding understanding the questions and how to answer them.

Reflecting. The researchers did not see the effects described by Lundgren et al. (2021b), i.e., how the SMASh instrument would increase the employees' understanding of Smart Maintenance, and how engagement and discussion are created by visualizing the benchmarking results. Upon reflecting on the focus group, the researchers concluded that the lack of discussion during the digital discussion meeting was the result of a combination of different factors. The expectations for the meeting differed between the researchers and the participants. Though it had been made clear that the aim was to discuss the results together, most participants expected they could call in and “listen” as they thought it to be a presentation of the benchmarking results. Furthermore, when evaluating the acting phase together with the maintenance director, it became clear that the digital discussion meeting was scheduled with too short notice for people to prepare properly, but also that the digital format was sub-optimal and similar discussion meetings should be held physically in the future. The group composition was also not optimal, as the researcher had gathered managers and employees that usually do not connect with each other, making discussion even more difficult.

Compared to how Lundgren et al. (2021b) describe Step 1, the researchers struggled with conducting the benchmarking process, mainly due to the unfamiliarity with the Smart Maintenance concept among the participants. Definitions of Smart Maintenance’s dimensions, and how to interpret different questions were some of the only topics discussed during the focus group, which indicates that there is not only a lack of general knowledge of Smart maintenance but also a lack of a clear vision of what Smart Maintenance is for SCA.

Reconceptualization. The lessons learned from the reconceptualization of Step 1 are presented below.

- **Smaller groups:** Discussion meetings should be held in small groups within each department of the maintenance organization. Just as Kotter (1995) suggests, small groups are powerful when organizations are transformed. Smaller groups also make it easier to discuss department-specific issues and promote a more open discussion as unnatural hierarchical levels do not affect the discussion meeting.

- **Choice of environment:** The format of the discussion meeting plays a crucial role in how the benchmarking results are adopted. Discussion meetings should therefore not be conducted digitally or held in an environment that challenges employees’ ability to discuss benchmarking results openly.

- **Sufficient understanding:** Lack of general knowledge of Smart Maintenance hinders the ability to discuss relevant improvement areas. Consequently, there needs to be a certain level of Smart Maintenance understanding before relevant improvement areas can be identified.

- **Common vision:** When there is no vision of Smart Maintenance, it is challenging to get a consensus on which improvement areas that are needed. Similar to the third step by Kotter (1995), it is thus central for the maintenance organization to state why Smart Maintenance should be implemented.

The updated procedure for Step 1 considers the experienced challenges in this thesis. After selecting the participants for the SMASh survey, a sufficient understanding of the Smart Maintenance concept must be ensured, both generally and company-specific. Otherwise, the employee engagement, discussion of results, and bottom-up perspectives of the transformation will suffer. After conducting the SMASh survey, the results should be discussed in physical discussion meetings and smaller and department specific groups, since the digital discussion meeting format inhibits constructive discussions. Figure 4.2 shows the updated procedure for Step 1.

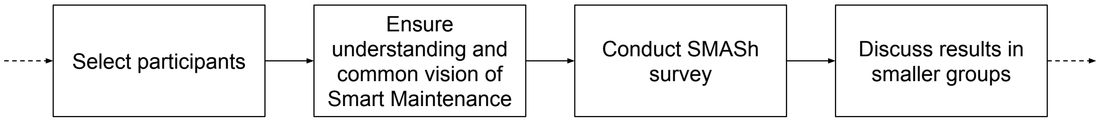

Figure 4.2: The updated procedure for Step 1.

4.1.2 Step 2 & Step 3: Setting clear goals and Setting strategic priorities

Step 2 and Step 3 of the strategy development process for Smart Maintenance implementation were performed in the same action research loop, and are therefore presented together. The researchers made this decision because setting goals and prioritizing them could be conducted simultaneously since both steps involved the same individuals.

Planning. The research group divided the problem into four activities. The first activity was to schedule a workshop with the usual goal-setting body in the maintenance organization, which in this case was SCA Maintenance's management team. The second activity was to inform and train the management team on how to set clear goals for Smart Maintenance. Clear goals were planned to be formulated according to the SMART model, which is a model that makes goals specific, measurable, attainable, realistic, and time-bound (Doran, 1981). The third activity was to conduct the goal-setting workshop with the management team, during which, the goals were generated and prioritized using the benchmarking results from the SMASh survey. The fourth and final activity was to communicate the Smart Maintenance goals to the maintenance organization.

Before entering the acting phase, two semi-structured interviews were conducted with the maintenance director and one maintenance manager to review the planning phase. The maintenance manager then suggested that the activity of training managers in setting clear goals using the SMART model should be removed. The maintenance manager said: *"these are experienced leaders and conducting a training session on how to formulate goals will probably do more harm than good"*. There was an uncertainty of how this would be received by the other managers, potentially creating resistance and damaging the commitment to participating in subsequent activities. The maintenance manager also suggested bringing support material to the goal-setting workshop to not start from scratch, thus, saving time. Therefore, the activity of training the management team in using the SMART model was replaced with a workshop for the research group where suggestions for Smart Maintenance improvement areas were generated. The planned procedure for Step 2 and Step 3 is visualized in Figure 4.3.

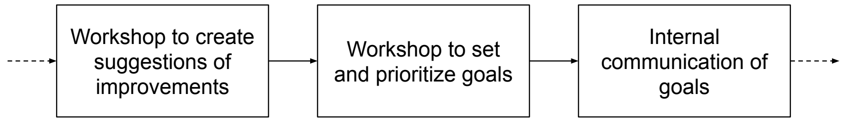

Figure 4.3: The planned procedure for Step 2 and Step 3.

Acting. The first activity was a workshop with the research group where suggestions for Smart Maintenance improvement areas were generated. These suggestions were based on the benchmarking results from Step 1. The suggestions were later brought into the goal-setting workshop and presented to the management team. The researchers worked together with the maintenance managers during the workshop to transform the improvement areas into clear goals. However, general discussion regarding Smart Maintenance kept coming up during the workshop, and the time ran out. One maintenance manager, therefore, suggested returning to the research group since *"they had better knowledge of Smart Maintenance than the management team"*, to continue the work of transforming the improvement areas into goal suggestions. These could later be revised and approved by the management team at a follow-up meeting, in the form of a focus group. The research group, therefore, conducted another workshop to formulate a set of clear goals. Before returning to the management team for a follow-up meeting, the goals were shown for one maintenance manager to review the general quality. After approval, the follow-up meeting with the management team was conducted, and the goal suggestions were revised and the strategic priorities set. A timeline was also created to visualize the goals and facilitate internal communication. The goals were strategically prioritized according to how they related to each other. Some goals had to be completed before others, giving them higher priority. The process of setting strategic priorities was, therefore, relatively straightforward.

Observing. Different perspectives on the goal-setting process existed within the maintenance organization. The research group's perspective on the goal-setting process was that *"goals are set at the top by the managers and then trickled down the organization"*, while the management team said that *"goals could easily be suggested by employees within the organization"*. Furthermore, it was difficult for the management team to set clear goals for Smart Maintenance, although the planned procedure was changed in their favor. The lack of time was mainly due to the unfamiliarity with the Smart Maintenance concept, combined with a high interest in learning more. Additionally, the goal-setting workshop took place at an early stage of the Smart Maintenance implementation. The combination of unfamiliarity, high interest and early stage generated much-needed but time-consuming discussions. Therefore, it became clear that the support material was not sufficiently adapted to the management team's current knowledge of Smart Maintenance, which resulted in additional workshops.

Reflecting. The time it took to set clear goals for Smart Maintenance was underestimated by the research group, the maintenance director, and the maintenance managers. Consequently, the workshop was designed on the wrong premises. During the workshop, it became clear that the goal-setting process occurred at a premature stage in SCA's Smart Maintenance implementation. The management team had not previously been offered the opportunity to reflect on Smart Maintenance and was unsure of what Smart Maintenance was all about. The support material was therefore not sufficient, which favored a general but educational discussion. A reflection is, therefore, that Step 2 and Step 3 created intense discussions and employee engagement that were intended to be created at the end of Step 1. Hence, it seems to be a delayed effect of intense discussions and employee engagement in the strategy development process of Smart Maintenance.

The acting phase showed that the management team needs to obtain a certain level of knowledge of Smart Maintenance in order to set clear goals. Therefore, another reflection is that low knowledge of Smart Maintenance requires more precise support material. To avoid this, the management team needs to be offered enough time to discuss the improvement areas, i.e., the benchmarking of the maintenance organization, before these can be transformed into clear goals for Smart Maintenance.

When the research group formulated goal suggestions, due to the recommendation from the management team, the researchers observed that there was a strong commitment to formulate goals and thus help the management team. It became evident that clear goals also can be formulated in smaller groups alongside the management team. This strengthened the employees' engagement and brought the goals closer to the daily operations in the maintenance organization. However, this must always be approved by the management team, so as not to encounter authorization problems. Given that the research group already obtained a certain level of knowledge about Smart Maintenance, no precise support material was needed. Furthermore, the research group expressed an interest to be more involved in other goal-setting processes: *"it was inspiring and really reflective to generate these goals"*. However, this mainly applied to the goals that were related to the "everyday activities" in the organization. The research group expressed, for example, that organizational goals were difficult to relate to and thus formulate, which is why the researchers believe that maintenance managers and employees need to work together to find Smart Maintenance goals at all levels of the organization. However, time was once again a limiting factor when the research group formulated goal suggestions. Therefore, enough time is crucial to set clear goals for Smart Maintenance.

Reconceptualization. The lessons learned from the reconceptualization of Step 2 and Step 3 are presented below.

- **Take advantage of workshops:** Workshops can be difficult to set up but are a good place to learn. Therefore, take advantage of workshops to teach employees about the Smart Maintenance implementation.

- **Provide support material:** There is an advantage in producing support material for Step 2 if the management team is not familiar with the Smart Maintenance concept. The support material needs to be more or less precise depending on knowledge levels of Smart Maintenance.

- **Utilize smaller groups:** Goal suggestions can be formulated in smaller groups alongside the management team. However, these must be approved by the management team, so as not to encounter authorization problems. There is a strength in combining expertise from different levels within the maintenance organization to set clear goals for Smart Maintenance.

To accelerate the strategy development process for Smart Maintenance implementation and to promote employee engagement and bottom-up initiatives, suggestions for Smart Maintenance goals should be created in smaller groups alongside the management team. These goal suggestions are later brought into a main goal-setting workshop to set and prioritize goals. Finally, internal communication of the Smart Maintenance goals will further aid in engaging other parts of the maintenance organization. Figure 4.4 shows the updated procedure for Step 2 and Step 3.

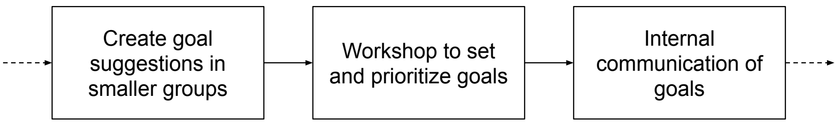

Figure 4.4: The updated procedure for Step 2 and 3.

4.1.3 Step 4: Planning key activities

Planning. The main goal for Step 4 was to plan key activities for the Smart Maintenance goals and visualize them with a roadmap. The research group divided the problem into three activities: a workshop for brainstorming key activities, a subsequent workshop for creating a roadmap, and finally a focus group for compiling an activity plan. The brainstorming workshop would generate ideas for key activities to the Smart Maintenance goals. The roadmapping workshop would visualize these ideas in several roadmaps. The focus group would then compile all data into an activity plan for what, how, who, and when the key activities would be performed. Since the research group was familiar with Step 2 and Step 3, they were selected to carry out Step 4. The planned procedure for Step 4 is visualized in Figure 4.5.

Figure 4.5: The planned procedure for Step 4.

Acting. The research group worked together during the first workshop to generate a set of independent activities that were required to achieve each Smart Maintenance goal. These activities were later used in a roadmapping workshop that created a visual representation of how each goal was broken down into activities. Finally, a focus group validated the roadmaps and created a detailed activity plan containing responsibilities and deadlines.

Observing. Even though the management team already approved the Smart Maintenance goals, the brainstorming workshops suffered from a lack of authorization. Checkpoints were, therefore, added to the activity plans so that management could give their approval. Furthermore, brainstorming of new key activities continued during the roadmapping workshop, which was not planned. During the focus group, the researchers observed that the research group appreciated Step 4 and looked forward to Step 5. The research group reflected deeply on the activity plans and wanted to be given more responsibility for implementing them.

Reflecting. Several times during the workshops, the research group hesitated about their authorization to decide on how and by whom the planned key activities could be carried out. The research group also expressed concern about the importance of deciding who can carry out the planned key activities. One individual said: *"If we don't assign appropriate responsibilities there is a huge risk of activities not being completed on time"*. As Lundgren et al. (2021b) point out, it was therefore helpful to visualize the planned key activities in roadmaps, which created consensus in the research group. Even though roadmapping workshops were unfamiliar to some, the research group concluded that the roadmapping workshops are vital for Step 4.

Furthermore, the procedure of working with all goals at the same time complicated the roadmapping workshop. The research group had to remind themselves of what had been said and done earlier. One said: *"It would have been better to work with one goal at a time, from start to finish"*. It would therefore be an advantage to plan goals separately. Finally, Step 4 seemed to increase the engagement of the research group. The research group now participated in planning activities that themselves would later take part in, and on reflected: *"the more theoretical work from Step 1, 2, and 3 is now taken into action, which is exciting"*.

Reconceptualization. The lessons learned from the reconceptualization of Step 4 are presented below.

- **Ensure authorization:** In order for Step 4 to be time efficient and avoid unnecessary checkpoints, authorization needs to be ensured for the individuals who plans the key activities.

- **Involve right people:** It is important that the individuals who are to carry out the key activities are involved in planning them. This increases employee engagement.

- **Do not skip roadmaps:** It is critical to visualize the planned key activities so that all individuals understand them. This is best done in a roadmapping workshop and should therefore not be overlooked.

- **Plan goals separately:** It is advantageous to plan each Smart Maintenance goal separately from “start to finish”. This reduces confusion between individuals about which goal is being processed.

The procedure of having three separate activities is updated to one workshop where all activities take place for one goal at a time. Brainstorming of activities, roadmapping, and aggregation of the final activity plan is completed for each individual goal before continuing with the next. The group should also have sufficient authorization to plan activities without having to confirm the results with management. Figure 4.6 shows the updated procedure for Step 4.

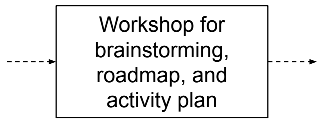

Figure 4.6: The updated procedure for Step 4.

4.2 Final semi-structured interviews

The researchers mapped a total of 167 comments and insights from the final semi-structured interviews. The qualitative data were encoded based on the seven semi-structured questions, its advantages and disadvantages were also encoded. A total of 90 comments and insights were encoded as advantages, while 77 were encoded as disadvantages. There was thus a balance in the semi-structured interviews to determine what worked well and what could be improved for the strategy development process for Smart Maintenance implementation.

The results from the semi-structured interviews are summarized in Figure 4.7. The “comments and insights” column highlights the codes from the semi-structured interviews, while the “derived categories” show clear synergies and other similarities in the qualitative data. The four rows, i.e., perception, challenges, significance and improvements, corresponded to four themes of the five semi-structured questions related to the evaluation of the strategy development process. The remaining two semi-structured questions concerned the research design and procedure and will therefore be discussed in Section 5.3, Methodological discussion. Since all codes are based on the individuals’ experiences in action research, there is an internal connection between codes and categories. Therefore, codes and categories should not be studied separately, but seen in their entirety and with each other. The lessons learned are as follows:

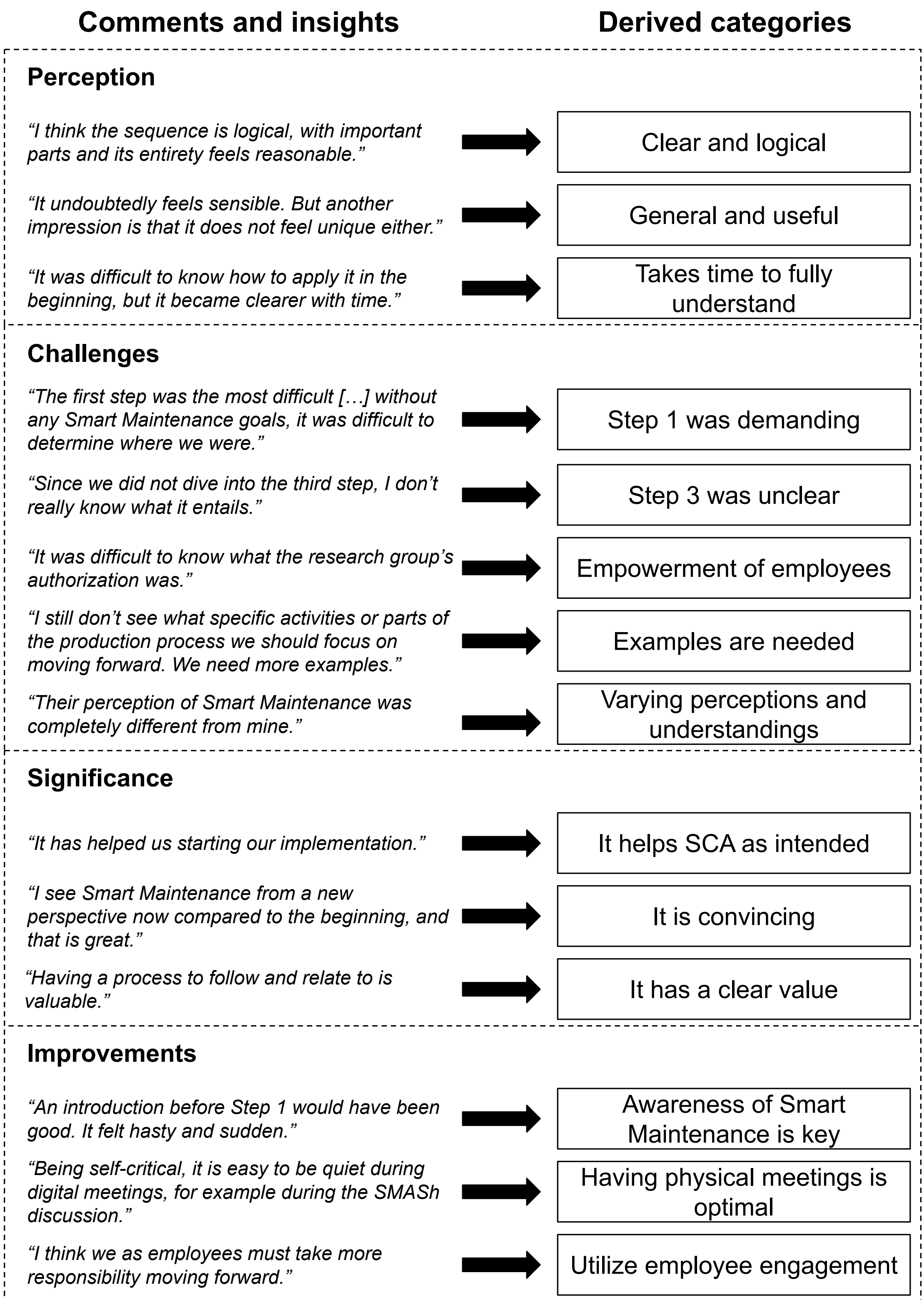

Figure 4.7: Lessons learned from final semi-structured interviews.

- **Perception:** The strategy development process was perceived as “clear and logical” and “general and useful”. The individuals pointed out that it had an easy-to-understand structure and was perceived as meaningful. It was also pointed out that it was similar to other generic development processes and thus had a wide range of applications. A disadvantage that emerged was that individual steps of the strategy development process was, however, time-consuming to understand. The individuals felt that there was a gap between theory and practice, making it difficult to know what type of goal they were looking for and how discussions easily drifted away from the topic.

- **Challenges:** Step 1 was the main challenge in the strategy development process. It became obvious that Step 1 took place early in the thesis and was overwhelming. Another challenge was Step 3. It appeared that Step 3 was perceived as unclear since it was not included in the action research method to the same extent as the other steps. Three other general challenges were the issue of authorization, the need for education, and involvement of more employees. The issue of authorization was about the need for clear leadership, internal communication and who does what in the strategy development process. The need for education was about filling the gap between theory and practice about the Smart Maintenance implementation. Involving more employees aimed at increasing employee engagement throughout the maintenance organization.

- **Significance:** All individuals considered that the strategy development process helps SCA Maintenance to advance their Smart Maintenance implementation. Additionally, the belief grew that the strategy development process was the right way to go as the implementation progressed. A recurring insight was that the perception of Smart Maintenance had changed since day one. Thus, everyone in the research group agreed that there is an increased value in continuing to use the strategy development process even after the end of the thesis.

- **Improvements:** Because Step 1 was challenging, Step 1 needs to be revised. More specifically, the implementation of SMASh could be done differently. More individuals should be involved in the SMASh survey, and everyone should receive some kind of introduction to Smart Maintenance beforehand. Furthermore, it is important to do meetings on site. As experienced in this thesis, physical meetings create better discussions. Another improvement is to give the research group gradually more responsibility for the implementation of Smart Maintenance as the research progressed. The individuals emphasized that this would prepare them to continue to drive the implementation forward.

4.3 Further developed strategy development process for Smart Maintenance implementation

The realization of the strategy development process for Smart Maintenance implementation is created using the insights and lessons learned from the action research method and the final semi-structured interviews. The updated procedures, Figures 4.2, 4.4, and 4.6, are combined and added to Figure 2.2 to visualize the newly suggested set of activities for the first four steps in the strategy development process for Smart Maintenance implementation. The result is demonstrated in Figure 4.8. Below are each step presented in further detail.

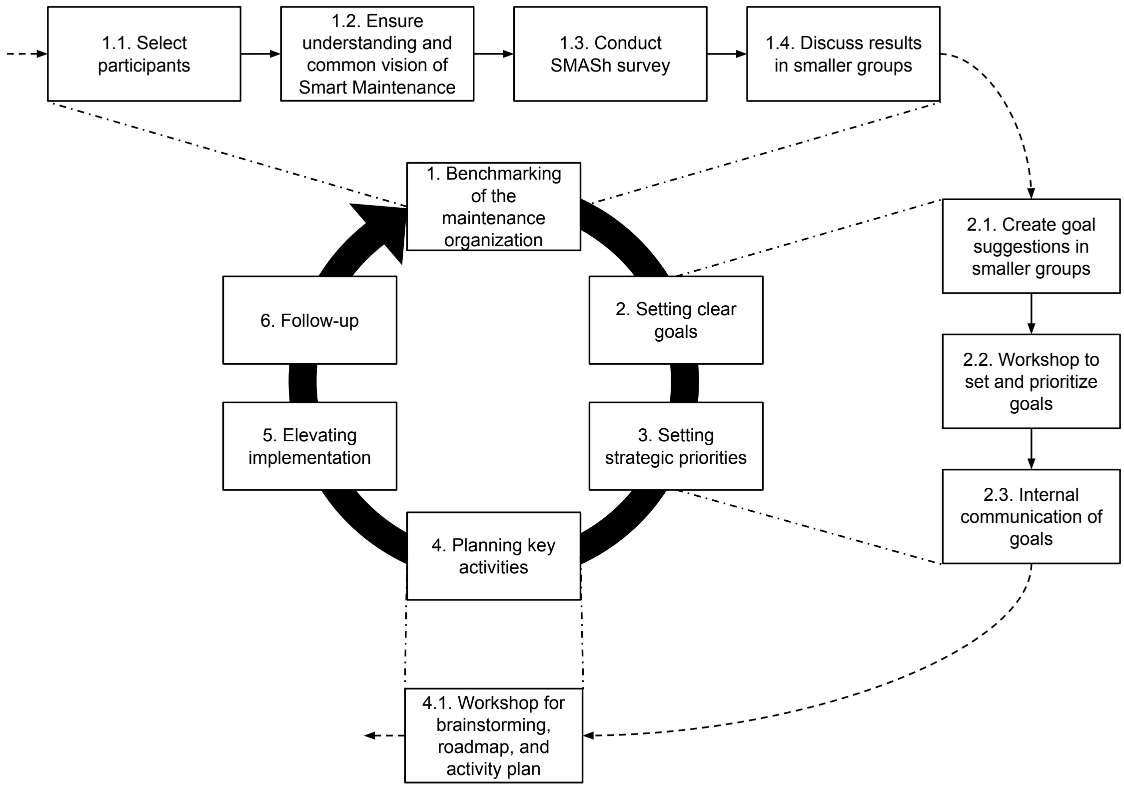

Figure 4.8: Further developed strategy development process for Smart Maintenance implementation.

4.3.1 Step 1: Benchmarking of the maintenance organization

Step 1 begins with selecting the participants for the SMASh survey (activity 1.1). It is important to choose participants from several parts of the maintenance organization, and both managers and employees should be represented. Furthermore, the participants must have a common understanding of the Smart Maintenance concept as well as a clear vision of Smart Maintenance within their maintenance organization. If this is not the case, activity 1.2 should give the participants an introduction or training in Smart Maintenance and its four dimensions. The next activity, 1.3, is the conducting of the SMASh, where the participants individually answer the survey. This is followed up with activity 1.4, where the results are discussed in smaller groups in physical meetings, where strengths and possible improvement areas are identified. The results can be discussed by the entire maintenance team or parts of it, and preferably with other functions within the plants as well (e.g., production) to increase the internal integration dimension of Smart Maintenance. By creating smaller discussion groups with people that normally work together, such as specific teams or departments, relevance is increased and intense discussions and employee engagement are promoted.

4.3.2 Step 2 & Step 3: Setting clear goals and Setting strategic priorities

Step 2 and Step 3 begin with activity 2.1, where Smart Maintenance goal suggestions are created in smaller groups. The goal suggestions are generated using the improvement areas identified in activity 1.4. There is a benefit to treating activity 2.1 as an extension of activity 1.4, and thus merge activity 1.4 and 2.1. The goal suggestions are then brought to a goal-setting workshop (activity 2.2), where clear Smart Maintenance goals are set and prioritized. A schematic timeline of the goals will help with internal communication of the goals in activity 2.3. Activity 2.3 aims to engage other parts of the organization and not only the maintenance function.

4.3.3 Step 4: Planning key activities

The Smart Maintenance goals are then brought into Step 4, where key activities are planned and scheduled. In one single workshop, activity 4.1, key activities are identified, a roadmap is created, and an activity plan is generated with responsibility and deadlines. Individuals that will be involved in the implementation of the activities should also participate in the planning of the activities to promote employee engagement. The workshop should also plan one goal at a time, from identifying activities to the final activity plan, to minimize confusion and increase efficiency. Furthermore, the workshop needs to have enough authorization to not have to double-check with management regarding the outcome.

5 Discussion

This chapter provides a general discussion of implementing Smart Maintenance in the pulp and paper industry. It continues by answering the research questions together with a methodological discussion. The discussion ends with limitations of the thesis, recommendations for future work and ethical, societal and ecological aspects.

5.1 Implementing Smart Maintenance in the pulp and paper industry

Researchers have focused on conceptualizing and facilitating Smart Maintenance to develop maintenance organizations in digitalized manufacturing (Bokrantz, 2019; Lundgren, 2021). The research establish a strategy development process for how Smart Maintenance is to be implemented. However, both Lundgren (2021) and Silvestri et al. (2020) point out that practitioners need further evidence on how to transform the maintenance organizations to meet the demands of the future. This thesis collaborated with SCA Maintenance to further develop the strategy development process for Smart Maintenance implementation in the pulp and paper industry. The results show how the strategy development process has been further developed according to SCA Maintenance's conditions and needs. However, challenges along the way are identified as managing organizational aspects relating to change. Communication of a vision and the creation of a small but powerful group that leads the change are challenges both pointed out by Kotter (1995) and Dixon (2017), and also observed in this thesis. Furthermore, the effects described by Lundgren et al. (2021b) of how the strategy development process will increase fundamental understanding of the Smart Maintenance concept and create employee engagement are witnessed in this thesis. A better understanding of the strategy development process itself is also established from the evaluation, and the practical perception of the strategy development process differs from the theoretical one. In reality, the strategy development process requires more time than it might first appear. The thesis' procedure makes several updates to the initial plan resulting from the action research method, prolonging the different implementation steps.

Smart Maintenance implementation is not something that is done overnight. The strategy development process for Smart Maintenance implementation is iterative and has no end. Hence, the strategy development process needs to be treated as evolutionary change, i.e., incremental changes implemented continuously (Burke, 2017).

This is necessary for the strategy development process to function as intended and to be integrated into everyday operations in the maintenance organization. An evolutionary change also demands an increased rate of organizational change. Smart Maintenance should thus not be implemented too quickly or too slowly in the maintenance organization. Just as Weick and Quinn (1999) and Beer and Nohria (2000) assert, the rate is crucial for organizational change, and organizational change is crucial for the survival of the organization. Therefore, an uneven rate may have been the reason why the research group found the steps to be varying in challenge. However, there is no single solution for how the strategy development process for Smart Maintenance implementation is to be implemented (Lundgren, 2021). This makes the strategy development process valuable but time-consuming, as each organization needs to implement it from the ground up since there is no one-size-fits-all solution. Taking into account the following reasoning, maintenance organizations need to implement Smart Maintenance at their own rate. Consequently, it is up to the organization itself to decide the rate of the Smart Maintenance implementation, as long as it is challenging but reasonable for the maintenance organization.

There is no uncertainty that external and internal drivers affect organizational change (Child, 2015; Law, 1986; Sveningsson & Sörgärde, 2019). Technology, knowledge and competitiveness are examples on external drivers that obviously shape the Smart Maintenance implementation, i.e., basic rules of which the maintenance organization in the long run cannot ignore. In the same way, leadership and employee engagement in the maintenance organization are important internal drivers to manage these external drivers. Just as Lundgren (2021) suggests, the maintenance manager must become leader of people and organizations in change. Therefore, managing both external and internal drivers efficiently is crucial to avoid common mistakes in the the strategy development process for Smart Maintenance implementation. Accordingly, leadership and employee engagement are examples of important internal drivers that also shape the Smart Maintenance implementation, i.e., how to add new energy to the strategy development process. Step 2 and Step 3 supported this, when the research group continued the goal-setting workshop, which increased their autonomy as well as motivational outlook. Understanding the employees' needs are therefore central to support the Smart Maintenance implementation. By managing autonomy, competence, and relatedness, the maintenance manager can strengthen the internal drivers in the maintenance organization and strategically influence the strategy development process for Smart Maintenance implementation. It is, therefore, reasonable to say that motivation theory presented by Daft (2015); Deci and Ryan (2012); Fowler (2014), is an important tool for the maintenance manager avoiding organizational change failure.

To overcome resistance in the strategy development process for Smart Maintenance implementation, the maintenance manger has to consider the common causes of resistance, for example misunderstandings and mistrust (Dawson, 2002; Dent & Goldberg, 1999; Sveningsson & Sörgärde, 2019). Maintenance managers as well as employees thus need to continuously communicate the purpose of the Smart Maintenance implementation, i.e., why and how it is implemented. In line with what Kotter

(1995) claims about undercommunication, the Smart Maintenance implementation should be communicated by a factor of ten to clearly show what the maintenance organization wants to achieve. This was noticed in Step 1, when the researchers did not fully achieve to communicate its full purpose. As a consequence, misunderstandings followed along the way, which affected the rate of the Smart Maintenance implementation. The maintenance manager therefore needs to overview the maintenance organization to identify resistance in the strategy development process for Smart Maintenance implementation. However, it is once again important to mention that resistance is a natural part of organizational change. Therefore, the maintenance manager should not take resistance to change as organizational change failure. Even so, the researchers believe that more drivers than resistance are desirable for the Smart Maintenance implementation to be successful.

5.2 Answering the research questions

Based on the results and the discussion of implementing Smart Maintenance in the pulp and paper industry, the research questions are answered:

RQ 1: How can the strategy development process for Smart Maintenance implementation be realized in the pulp and paper industry?

Implementing Smart Maintenance in the pulp and paper industry resulted in a further developed strategy development process for Smart Maintenance implementation, see Section 4.3. The further developed strategy development process was the sum of the thesis' reconceptualization phases and final semi-structured interviews. Each step is detailed by combining theory and practice, using abductive assumptions as well as trial and error. Furthermore, developing the strategy development process for Smart Maintenance implementation is complicated and time-consuming. The entire maintenance organization must change to fully embrace Smart Maintenance. Therefore, the strategy development process cannot only further developed practically, i.e., how each step can be carried out. The development of the strategy development process must thus be established in fundamental organizational theory.

As Lundgren (2021) points out, it was noticed that there was an interplay among the dimensions and all goals created needed to be in line with SCA, i.e., strategic alignment. There was an interrelation between the implementation steps which was difficult to plan for. However, lessons learned created a synergy effect between the implementation steps. Hence, the strategy development process for Smart Maintenance could be seen as a long learning process which grew stronger over time. Similar to the argumentation by Garvin (1993), the strategy development process created, acquired, and transferred knowledge within the maintenance organization which was used as a tool to become a learning organization. The strategy development process for Smart Maintenance implementation affected the five disciplines for organizational learning, presented by Senge (1990). It was central to include all employees who wanted to be included in the learning process and make them understand why Smart Maintenance was implemented, to reduce resistance as Daft

(2015) explains. This was vital as Smart Maintenance implementation cannot be seen as a threat within the maintenance organization, but as an enabler for a better workplace and increased competitiveness within the pulp and paper industry. It is therefore necessary to become a learning organization to implement Smart Maintenance, and the strategy development process could aid organizations in this aspects since it act as a long learning process that should be realized evolutionary.

Drivers and resistance arise as a natural part in organizational change. These forces have to be taken into account, when realizing the strategy development process for Smart Maintenance implementation. The strategy development process for Smart Maintenance implementation was thus developed using theory in organizational change as well as organizational development, for example Kotter's eight-step process model. Both Lundgren (2021) and Kotter (1995) stated the importance of understanding the organization's starting point before implementation. However, Kotter (1995) also emphasized the importance of creating a small but powerful group and vision before implementation. The research group can be seen as the small but powerful group needed to drive Smart Maintenance implementation forward. However, they need a vision to lean on, something that leadership is responsible for. In addition, Lewin emphasized importance to unfreeze organizations in change (Child, 2015). Therefore, the strategy development process had to be gradually developed into the maintenance organization's daily operations, which is evident in how the various steps evolved due to the combination of theory and practice in the action research method.

It also became clear that the implementation must be fed with new energy in order not to cease, similar to what Law (1986) precise. Therefore, the maintenance manager has to understand how to motivate the employees as well as how to best communicate the strategy development process for Smart Maintenance implementation. Just as Dawson (2002) argue, there is no room for misunderstanding or mistrust. As Lundgren (2021) points out, leadership plays a key role to create intense discussions and employee engagement, i.e., increased motivational outlook. The maintenance manager has to create a "we-feeling" within the maintenance organization to enable organizational learning. Hence, building small but powerful groups to drive the implementation forward is vital for the strategy development process for Smart Maintenance organization. The strategy development process should thus be managed as emergent organizational development. This means that the strategy development process is implemented step-by-step and involves all the employees in the maintenance organization. Sveningsson and Sörgärde (2019) believe that such organizational development cannot be planned for. Based on this reasoning, it is easier to understand why the strategy development process for Smart Maintenance implementation was perceived as complicated and time-consuming by the research group. Explanation by Weick and Quinn (1999), makes it clear that emergent organizational development is not change that happens once but all the time. Giving employees the authorization to work with the strategy development process in parallel, supported by leadership, will thus be crucial for the success of the Smart Maintenance implementation in the pulp and paper industry.

RQ 2: What is the value of adopting the strategy development process for the maintenance organization?

As a final part of the thesis, a set of semi-structured interviews evaluated the strategy development process for Smart Maintenance implementation. The results from the interviews can be put into the perspective of organizational innovation used by Lundgren (2021). The strategy development process for Smart Maintenance implementation considers organizational innovation and its five characteristics: relative advantage, compatibility, complexity, trialability, and observability (Lundgren, 2021). The interviewees expressed how the strategy development process had clear value and that it had undoubtedly helped SCA Maintenance with its Smart Maintenance implementation. Thus indicating a great perceived relative advantage. The strategy development process' clear and logical structure also made it easy for the participants to follow the procedure and observe the progress in its individual steps, indicating high levels of trialability and observability. However, the interviews also revealed that the strategy development process did not appear unique and that it probably could be used for other concepts than Smart Maintenance. This could increase both relative advantage and compatibility as the strategy development process might be easier to incorporate into existing organizations in more than one scenario. The strategy development process for Smart Maintenance implementation could therefore be valuable for all manufacturing industries as it is general and can be shaped for the specific need. This makes it complex and time-consuming to understand at first, but value creation increases when it is integrated into the maintenance organization over time.

Although it was found valuable in the end, the interviewees also pointed out that both the concept of Smart Maintenance and the strategy development process were difficult to understand in the beginning, indicating higher levels of complexity. The importance of a common vision and understanding was therefore noted, which is a vital part of learning organizations (Senge, 1990). Furthermore, the need for cooperation within SCA was highlighted throughout the thesis, where the maintenance function must be a part of the entire system, working together with other functions such as production (Bokrantz et al., 2020c; Porter, 2004; Senge, 1990). Similarly, various perceptions of both the Smart Maintenance concept and the strategy development process were observed, which needs to be overcome as various terminologies and understanding interfere with organizational change (Kotter, 1995; Waeyenbergh & Pintelon, 2004).

5.3 Methodological discussion

In the planning of this thesis, three stakeholders were identified. One was academia which wants to see further theoretical contributions to the Smart Maintenance concept and the development of its implementation. Another was the industry which asks for practical insights into Smart Maintenance and how to transform theory into practice. The third was the students that want to expand their knowledge and prepare for future careers. Therefore, when designing the research, a method that covered both theory and practice was sought. The chosen research method was action research which provides a guideline that allows the researchers to work collaboratively with practitioners (i.e., SCA) to achieve practical transformation and increase theoretical knowledge (Huxham & Vangen, 2003). Combined with the abductive reasoning, as it is described by Alvehus (2019), which allows researchers to alternate between theory, empiricism, and reflection, action research is both theoretically rigorous and practically relevant for all stakeholders. The thesis' theoretical and empirical frameworks are combined in the planning phase of action research. In turn, the testing of the strategy development process for Smart Maintenance implementation in the acting phase of action research expands the empirical framework. The theoretical and empirical framework is again combined in the three later action research phases (i.e., observing, reflecting, and reconceptualization).

The master's thesis' ambition was to combine developing the strategy development process with initiating Smart Maintenance implementation at SCA Maintenance. The thesis' practical relevance was therefore of utmost importance. Representatives from SCA participated in all action research phases to integrate the thesis into SCA Maintenance's daily operations as much as possible. Additionally, the master's thesis was viewed as a start to SCA's Smart Maintenance implementation, with the company having the ambition to continue building on this thesis' results. Figure 5.1 visualizes the master's thesis' ambition for Smart Maintenance implementation at SCA, where the thesis begins alongside SCA and then gradually grows into SCA's daily operations and future vision.

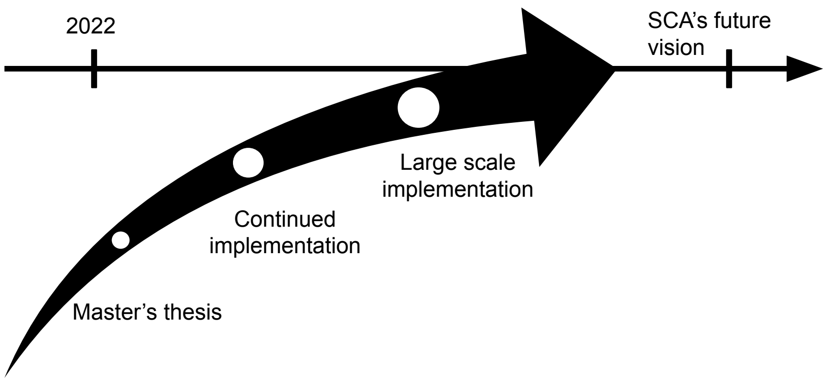

Figure 5.1: The master's thesis' ambition for Smart Maintenance implementation at SCA.

Furthermore, the research group played a vital role in increasing the practical relevance of the thesis. The research group consisted of the students (i.e., the researchers) and representatives from SCA (i.e., the practitioners), and functioned similar to the learning group described by Dixon (2017). Together they utilized theoretical knowledge and practical experience in the best way to shape the strategy development process to SCA's prerequisites and needs. All participants said that the collaboration worked well and was very useful. Internal evaluations revealed that it increased the practitioners' knowledge of Smart Maintenance and made them more comfortable taking their own initiatives outside this thesis. However, it was also pointed out that the practitioners' role in the research group was unclear in the beginning but it became clearer along the way. A thorough introduction to both Smart Maintenance and the research procedure was suggested as a possible improvement for similar studies. The introduction in this thesis was, however, consciously designed according to COVID-19 restrictions at the beginning of the thesis. The first month was characterized by COVID-19 restrictions which prevented the research group to meet in person. The thesis relied on digital meetings at the beginning instead which limited the research group's interaction with each other.

The research group's participants were a mixture of maintenance engineers and maintenance planners. No leaders actively participated in the action research as their schedules were generally busier. This was also a try to spread employee engagement as far out the maintenance organization as possible. Although the research group's composition provided greater flexibility and more operational experience, the research group sometimes suffered from similar authorization uncertainties as in Step 4, see Section 4.1. Before the action research procedure could move on to the acting phase for every step of the strategy development process, the research group showed what they had planned for either the maintenance director or a maintenance manager to make sure the acting phase would be relevant. That made the whole process longer, as it became similar to trial and error at some times. The entire research group discussed how including a leader in the research group would have been beneficial if a similar study would be conducted again.

5.4 Limitations

As the industry demands further evidence on how to transform its maintenance organization, this thesis tested the strategy development process for Smart Maintenance implementation specifically within one company from the pulp and paper industry. Although the results might be applicable in other companies and industries, it was not tested in this thesis. Furthermore, the thesis' focus was on the procedure of the strategy development process for Smart Maintenance implementation and not its results, i.e., the thesis did not directly analyze the impact of the SMASh results, Smart Maintenance goals, and activity plans. Whether or not the results of the strategy development process will have a positive long-term impact on SCA's Smart Maintenance implementation remains to be verified.

Lastly, only the first four steps of the strategy development process were tested in this thesis. Due to the limited time of a master's thesis, and the fact that implementing change within an organization can extend over long periods of time, SCA Maintenance was left with performing the last two steps on their own. However, that leaves room for future work to test the combination of the entire strategy development process with the further developed steps presented in this thesis.

5.5 Future work

Just as this thesis tested the original strategy development process for Smart Maintenance implementation by Lundgren et al. (2021b), future work could test the further developed version presented in this thesis. Both within other companies and industries outside the pulp and paper industry. Furthermore, only the first four steps of the strategy development process were tested in this thesis, leaving room for future work to analyze the entire process, including Step 5 and Step 6.

Also, this thesis only performed one iteration of the first four steps of the strategy development process. More research is needed to study the long-term impact of the strategy development process, where several iterations of the process are applied. This allows the strategy development process to be studied even more, and the overall effects of the process and Smart Maintenance to be measured with performance indicators presented by Lundgren et al. (2021a).

5.6 Ethical, societal and ecological aspects

In this section, various ethical, societal, and ecological aspects regarding this thesis are discussed. They are divided into two parts. One regarding the research execution and one regarding the research outcome.

5.6.1 Concerning the research execution

The thesis considered ethical aspects regarding anonymity. As the goal was to engage representatives from SCA to increase the practical relevance of the thesis, both surveys and interviews were kept anonymous. Without anonymous surveys and interviews, there would have been a risk that the employees did not give their honest opinions, since their words would been shared with both the public and the company. Furthermore, it was important to continuously ensure a work environment free from negative pressure from the employer, research group, and other employees. Implementing Smart Maintenance, which is organizational development, is sensitive to drivers and resistance. Establishing anonymity and a “we-feeling” among the participants minimized the risk of biased drivers and resistance in organizational change.

The thesis also had to consider the company policies when dealing with internal documents. SCA openly shared various resources with the students, which in turn had to be handled with secrecy. The students therefore signed an agreement which meant that the students undertook certain commitments to the company, including not sharing internal documents. This meant that critical information could not be published outside the company or in any other way used to disadvantage the company’s competitiveness within the pulp and paper industry. At the same time, it was important to remember that the thesis was owned by the Chalmers University of Technology and also had to be carried out to benefit the academia.

5.6.2 Concerning the research outcome

Smart Maintenance plays a crucial role in the transition to digital manufacturing. Smart Maintenance will change the way the maintenance organization works. Meaning that in the future, some jobs may disappear while other jobs will be added. In the long run, this transition will benefit the Swedish manufacturing industry, creating competitiveness and thus more jobs. However, this might lead to resistance and unwillingness to change among the research's participants, and is, therefore, an important aspect to consider.

Smart Maintenance means an improved manufacturing process, something that will increase social, ecological, and economic sustainability. Smart Maintenance will lead to a better work environment for the maintenance team, mainly in the form of less stress during corrective maintenance and better safety. Smart Maintenance will lead to a reduced climate footprint, optimizing maintenance operations and making the factory more efficient, with less downtime. Spare parts do not need to be unnecessarily replaced. Smart Maintenance will therefore result in improved profitability for the entire company. By implementing Smart Maintenance, revenues will increase and costs will decrease.

In other words, Smart Maintenance is a crucial component for realizing digital manufacturing, something that is required to move from mass production to lot-size-one. It is therefore reasonable to say that Smart Maintenance is an enabler for both an advanced and sustainable manufacturing system to work. The more production processes are automated, the more important Smart Maintenance is. Waiting to implement Smart Maintenance thus increases the risk for the manufacturing industry to miss the flight to the future.

6 Conclusion

Implementing Smart Maintenance in the pulp and paper industry resulted in a further developed strategy development process for Smart Maintenance implementation, see Section 4.3. The strategy development process was complicated and time-consuming to further develop, however, lessons learned from the implementation steps created synergy effects. The strategy development process should therefore emerge into the maintenance organization and gradually be developed into the daily operations. Correspondingly, the strategy development process for Smart Maintenance should be seen as a long learning process that grows stronger over time. Every learning situation should thus be taken advantage of and include all employees that want to be included in the Smart Maintenance implementation. Consequently, the maintenance organization must become a learning organization which, in turn, is facilitated by the strategy development process for Smart Maintenance implementation.

In any case, organizational change and organizational development are challenging disciplines and vital to take into account to avoid failing with the Smart Maintenance implementation. The maintenance manager must manage drivers and resistance as well as continuously motivate and communicate the strategy development process for Smart Maintenance implementation within the maintenance organization. Although leadership is central to the Smart Maintenance implementation, employees must be authorized to work with the implementation themselves. The strategy development process for Smart Maintenance implementation should therefore be realized evolutionary in the pulp and paper industry so as not to create a feeling of confusion and deprioritization of employees. Representatives from SCA expressed that the strategy development process created a high value for them and helped SCA Maintenance to start implement Smart Maintenance, see Section 4.2. In conclusion, the implementation of Smart Maintenance at SCA Maintenance resulted in a further developed strategy development process. It is shown to have a high value, indicating a large perceived relative advantage. However, organizational theory is a challenging discipline and is important to take into account when implementing Smart Maintenance in the pulp and paper industry.

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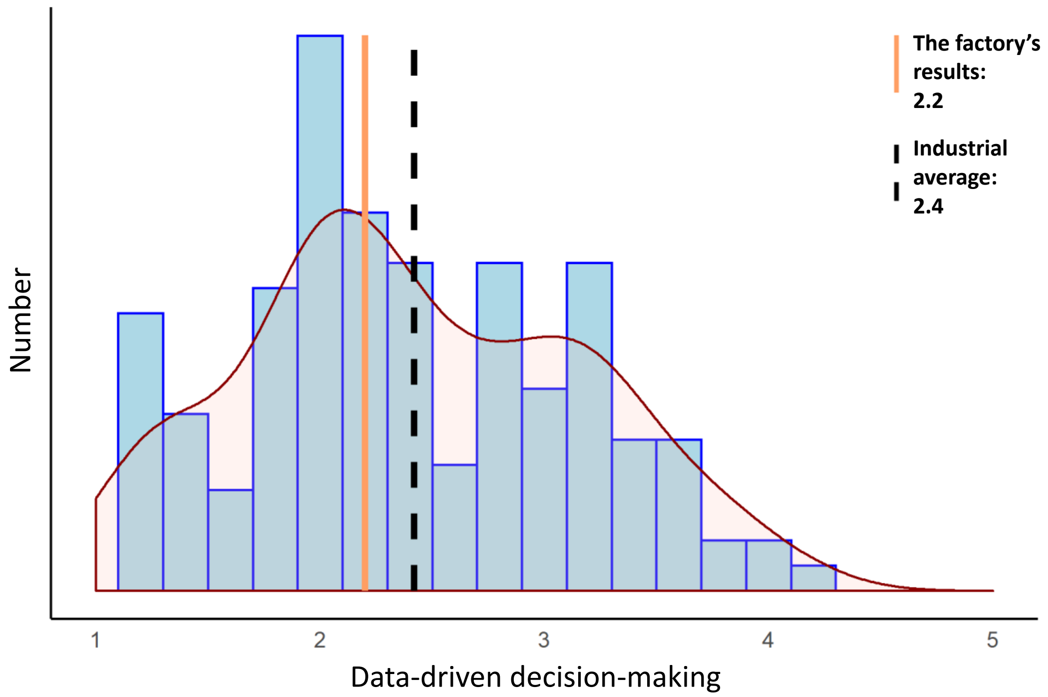
A

Example of SMASh results

The SMASh report shows the factory's SMASh results in comparison with 150 other factories in the Swedish manufacturing industry. The SMASh results include the four dimensions of Smart Maintenance: data-driven decision-making, human capital resource, internal integration and external integration. For each dimension, a benchmarking figure with results are given. Below is an example figure and instructions how to interpret the SMASh results.



How the results should be interpreted for your factory:

- Compare your factory's results (orange line) with the industrial average (black line) to determine if this dimension is a strength or weakness for your factory.
- Compare your factory's results for all four dimensions of Smart Maintenance to identify which part or parts that are most important to prioritize.

B
Action research guideline

Planning	Acting	Observing	Reflecting	Reconceptualization
Identify the problem in its context	*Execute planned actions*	*Collect more data*	*Evaluate the execution*	*Capture the learnings*
Consider the following:	Consider the following:	Consider the following:	Consider the following:	Consider the following:
- What is the problem?	- Check the progress.	- Has anything changed?	- What did I expect to happen?	- Is the problem solved?
- How does the problem affect the organization?	- Collect the information.	- Take the opportunity to learn.	- What actually happened?	- Can we move on, or do we have to start over and redefine the problem?
- Who should be included in the action research team?	- Check the implementation.		- Why did it happen?	
- How much time is needed?			- What is the next step?	Control questions: - How should SCA execute the step themselves?
- Other perspectives of the problem?				
- What is the goal?			Control questions: - Are the milestones and goals fulfilled?	
- What are the milestones?				
- Any other people or resources that needs to be involved? - Are there any obstacles? - Avoid non-valued-adding-work!				
Control questions: - How do we get there? - Overall plan? - What is the next step? - Do everyone agree?				

C
Semi-structured interview guide

1. What is your general opinion about the strategy development process for Smart Maintenance implementation?
2. What are the challenges with the strategy development process for Smart Maintenance implementation? Is something missing?
3. Do you think that the strategy development process for Smart Maintenance implementation has helped SCA to accelerate their development journey towards Smart Maintenance?
4. Do you see any value in continuing to use the strategy development process for Smart Maintenance implementation?
5. How do you think our action research method has worked out?
6. What would you have done differently if this thesis was repeated?
7. Do you have another question or thought that you want to share?

D

Product examples from the strategy development process

To give the reader an understanding of what the different steps in the strategy development process for Smart Maintenance implementation could produce, a set of made up examples (for Step 1-4) are presented:

In **Step 1, Benchmarking of the maintenance organization**, it was suggested that the maintenance organization must improve on the collection of vibration data for Machine A in order to improve the Smart Maintenance dimension of data-driven decision-making. There are currently no sensors installed that makes data collection possible.

In **Step 2, Setting clear goals**, a clear goal was formulated for the improvement suggestion: "Before the date X, the maintenance organization must install Y sensors at Machine A to collect vibration data possible".

In **Step 3, Setting strategic priorities**, it was determined that the dimension of data-driven decision-making was indeed a weakness for the maintenance organization, and the goal created in Step 2 was prioritized.

In **Step 4, Planning key activities**, activities for reaching the goal were identified and planned. Two examples were, "Selection of sensors" and "Installment of sensors".

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