Beyond Industry 4.0: Social factors in the adoption of Enterprise Application Systems and the role of Continuous Improvement

Master Thesis

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Symbol
Inspiring people
Improving processes

UNIVERSITY OF TWENTE.

Abstract

This thesis explores the key social factors influencing a successful Enterprise Application System (EAS) adoption in companies using Lean Six Sigma methodologies, particularly in manufacturing firms. While previous research has identified various social factors influencing EAS implementation, this study bridges the gap by examining how these factors can be effectively applied to successfully guide an EAS implementation.

This research integrates a three-phased approach encompassing a literature review, expert interviews, and in-depth case studies with four companies that have recently adopted EAS systems. Key social factors such as leadership, communication structures, employee engagement, and process alignment are systematically analyzed within the pre-implementation, implementation, and post-implementation phases of EAS adoption. Moreover, the role of continuous improvement methodologies like Lean Six Sigma is analyzed, focusing on how tools such as Agile and process mapping foster continuous improvement and align with the objectives of Industry 4.0 initiatives.

This study introduces a conceptual model that illustrates the dynamic role of social factors throughout the implementation of EAS. The model offers new propositions, emphasizing the necessity of strong leadership and transparent communication to build organizational support, structured employee involvement to foster commitment, and continuous process alignment to enhance EAS integration. These insights provide a contribution to the academic literature and provide a practical framework by clarifying the interplay between social factors and successful EAS implementation within Lean Six Sigma contexts.

Keywords: Industry 4.0, Enterprise Application Systems (EAS), social factors, Lean Six Sigma, technology adoption

Content

1. Introduction

Industry 4.0 technologies are becoming more important in today's businesses. Digital technologies are integrated into manufacturing companies and other industries massively. The concept of Industry 4.0 is described as the growing proliferation of digital technologies used in business contexts worldwide (Meindl, 2021). Programs such as Smart Manufacturing are created to enhance the digital transformation of activities within business context (Frank et al., 2019). One of the foundations of Industry 4.0 are Enterprise Application Systems (EAS). EAS are designed to integrate and streamline several processes and systems across an organization. The aim is to facilitate efficiency, productivity, and decision-making (Shibly et al., 2022). EAS embody the basic principles of Industry 4.0 regarding digitalization, connectivity and data-driven decision making (Tortorella et al., 2018). While Industry 4.0 technologies have seen significant advancements, there remains a gap in the literature regarding how social factors specifically influence the adoption process of EAS, especially within organizations using Lean Six Sigma methodologies.

EAS are particularly significant in Industry 4.0, enabling data-driven manufacturing processes and supporting real-time monitoring and problem-solving in factories (Tao et al., 2018). By leveraging technologies such as Internet of Things (IoT), Artificial Intelligence (AI), and cloud computing, EAS create interconnected environments that facilitate interoperability across various information systems (e.g., ERP, CRM, MES), enabling seamless information exchange (Jeschke et al., 2017). This integration not only promotes standardization and operational cohesion but also fosters a robust digital ecosystem (Zhang et al., 2017).

Despite their potential, EAS implementations pose unique challenges, especially related to employee acceptance. Social dynamics, such as fear of the unknown, perceived job threats, and limited understanding, can lead to resistance among employees, hindering EAS adoption and limiting organizational benefits (Shibly et al., 2022). These challenges can negatively impact the effectiveness of the EAS, increase operational costs, and decrease employee happiness (Chang et al., 2008).

While previous research on Industry 4.0 technologies has largely concentrated on technical components—such as integration techniques, advancements, and system capabilities—there has been comparatively little focus on the social dimensions of EAS adoption. Factors like

organizational culture, leadership, and employee acceptance are crucial to the success of EAS implementation (Marcon et al., 2022). Although recent studies acknowledge the importance of these factors, they often examine them in isolation and primarily from a managerial perspective, overlooking the complexities of social interactions and the views of end-users within the implementation process. This selective focus has led to an incomplete understanding of how social and organizational factors influence EAS adoption in dynamic environments.

Previous studies have shown that leadership styles can significantly influence the adoption of Industry 4.0 technologies among employees (van Dun & Kumar, 2023). Shibly et al. (2022) specifically focused on the adoption of EAS and concluded that the adoption of these systems is depending on the technology acceptance among employees of the organization. The technology acceptance of employees is determined by individual factors (perceived ease of use, usefulness, innovativeness, prior experience, enjoyment with innovation), organizational influences (training, managerial support, incentives, organizational culture), social factors (peer influence, image, social network) and industrial constructs (embryonic and changing nature of technology and community size) (Shibly et al., 2022). Other aspects that are important in the adoption of IT systems are organizational readiness and management support (Clohessy & Acton, 2019), expertise (Hameed et al., 2012), cultural change (Ahmad & Pinedo Cuenca, 2013), attitude towards IT (Nair et al., 2019), and cognitive and affective trust and knowledge sharing (Capestro et al., 2024). However, these studies generally examine these factors individually rather than exploring their interactions and cumulative impact throughout the implementation process.

In summary, while substantial research exists on the technical aspects of Industry 4.0 technologies, many studies focus on isolated social factors and often reflect managerial viewpoints, leaving gaps in understanding broader organizational and social influences. This approach limits insights into the multi-faceted social dynamics involved in EAS implementations. Moreover, most studies emphasize identifying factors that affect implementation without addressing how these factors can be leveraged to positively impact the process (Shibly et al., 2022). This study aims to bridge this gap by investigating how a comprehensive set of social and organizational factors, gathered through literature review, expert interviews, and case company interviews contribute to EAS adoption success.

The present study aims to fill a gap in the literature by investigating the social factors that contribute to successful EAS adoption, specifically within organizations that use Lean Six Sigma. Lean Six Sigma combines Lean's emphasis on efficiency and Six Sigma's focus on data-driven quality improvement, creating a structured approach that enhances both process performance and employee engagement. Lean methodology promotes waste reduction and process efficiency, while also fostering a culture of continuous improvement and customer focus (Cifone et al., 2021). Six Sigma complements this by targeting variability reduction and defect elimination through rigorous, data-driven methods (Hahn et al., 1999). By applying Lean Six Sigma principles, organizations can automate their processes, make technological adoptions go smoother and integrate those systems more effective. The integration of Lean Six Sigma principles with Industry 4.0 technologies has demonstrated improvements in problem-solving, cumulative learning and social performance (Frank et al., 2024).

This study aims to explore the different social dimensions and how they are influencing the adoption of EAS systems in the context of Industry 4.0 within companies that implement Lean or Six Sigma methodologies. The research question will therefore be:

> *What are the key social factors, and how are they contributing to the successful adoption of Enterprise Application Systems in companies implementing Lean Six Sigma?*

By addressing this question, the study enhances theoretical understanding of social aspects in EAS adoption and offers practical recommendations for organizations. Findings from expert interviews and case studies are synthesized to develop a structured model of influencing factors, providing a practical guide for organizations seeking effective EAS adoption. This framework meets the evolving needs of organizations by emphasizing social factors, offering an alternative to traditional approaches that prioritize technical solutions and may overlook essential social dynamics.

The thesis is organized as follows: The literature review provides a theoretical background on Industry 4.0, EAS, social factors, and continuous improvement methodologies. This is followed by the research methodology, which includes the research design, sampling procedures, data collection, and analysis techniques. Chapter 4 presents the study's findings, followed by the discussion and conclusion.

2. Theoretical background

2.1 Industry 4.0 and Enterprise Application Systems

The different industrial revolutions have shaped the current business world and modern manufacturing through both technological and social changes (Barker & Ishizu, 2012). The first industrial revolution is recognized as the first step to establishment of factories through steaming power (Hoppit, 2011). The second industrial revolution started late in the 19th century. This was when mass production and electrical energy were introduced within manufacturing companies (Coleman, 1956). Around 1960 the third industrial revolution started and was characterized as the digital revolution. This revolution caused automation and used digital techniques and computerization to enhance manufacturing (Mowery, 2008).

In the 21st century, the fourth industrial revolution started, which we know as Industry 4.0. The fourth industrial revolution distinguished itself by the implementation and connectivity of digital technologies, smart and cyber-physical systems that enhance efficiency, productivity and can adapt to changing circumstances (Tinmaz, 2020). This revolution characterizes itself by the adoption of digital technologies such as AI, IoT, robotics, etc. The concept of Industry 4.0 distinguishes itself from the third industrial revolution by the integration of cyber-physical systems and the interconnectivity between those systems. These inventions enhance data processing, decision-making and adaptability (Dalenogare et al., 2018). Industry 4.0 represents a number of key principles (Cañas et al., 2021):

Table 1: Key principles Industry 4.0

Interoperability	Communication and interaction between systems, machines and people.
Real-time processing	Enhance real-time data processing to enhance and improve decision-making.
Adaptability	Systems are more modular and can adapt quicker to the changing environment.
Virtualization	Concepts like digital twins are used to make simulations and replace physical processes.

Decentralization	People and systems are capable of making autonomous decisions by the digital connectivity.

Industry 4.0 consists of several different types of technologies. In the basics, these technologies can be divided into front-end technologies and base technologies. The so-called front-end technologies consists out of Smart Manufacturing, Smart Product, Smart Supply Chain and Smart Working (Frank et al., 2019). The second layer, called base technologies, support al the front-end technologies and include IoT, cloud services, big data and analytics (Tao et al., 2019).

In this study, the focus will be on a specific dimension of Smart Manufacturing named Enterprise Application Systems. EAS are software platforms that streamline and connect a wide range of business processes, such as supply chain management, finance, Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), Human Resource Management (HRM), and many others (Subba Rao, 2000). Organizations can integrate several processes through EAS within their company to increase productivity, efficiency and adaptability. EAS are considered as the backbone of an organization and are critical for managing the operations of a company (Xu, 2011). The types of EAS differ a lot from one company to another. EAS like SAP support almost all processes within a company from ERP to CRM, supply chain management and human resource management. Other EAS systems are focused on specific processes such as production or finance. Enterprise applications can be seen as an Industry 4.0 type technology because of the integration between different processes, departments, systems and people in a company (Capestro et al., 2024). This integration makes it easier to automate processes, and therefore reduce manual effort and decrease errors. Data is centralized and tools can be used to manage this data through data analysis, visualization and real-time processing and decision-making (Al-Mashari et al., 2003). The modern EAS can be customized to meet the needs of a specific organization and is scalable to the required business growth. This adaptability ensures the flexibility needed for the changing business landscape, and ensures data security and compliance (Hong & Kim, 2002). Although EAS is a concept that is used in the context of Smart Manufacturing, it can also be used in other aspect as Smart Supply Chain and Smart Working. Smart Supply Chain includes technologies to support the integration of the organization with external suppliers to improve

the product quality and efficiency. Smart Working includes technologies that provide workers with tools so they can be more productive and flexible within their tasks (Frank et al., 2019). An EAS, such as an ERP system, does provide the company with tools to control the supply chain and therefore benefits the Smart Supply Chain concept. Other EAS, such as quality management tools, can help workers with making their tasks more efficient and with greater ease.

The implementation of EAS provides several benefits for a company. Enterprise applications ensure integration and automation of multiple business processes. This can lead to an increasing productivity and efficiency by reducing cycle time and eliminating redundancies. At the same time, the reduction of unnecessary activities can lead to operational cost reduction (Shibly et al., 2022). Furthermore, the centralization of data provides the company accurate and reliable data in real time, which improves data accuracy management. The availability of accurate data and integrated systems makes it also possible to improve collaboration and communication within an organization (Jeschke et al., 2017). In combination with advanced analytical tools, this ensures that strategic decision-making is made easier through the accessibility of real-time dashboards and performance software, leading to unlimited possibilities to manage the organization (Shibly et al., 2022).

The implementation of EAS provides multiple benefits for an organization, nevertheless there are some critical implications and challenges. The implementation of an EAS that covers the whole organization involves a huge operation. Purchasing, customizing and deploying the system within the current organization has huge implications and requires high investment costs. Especially for small to medium sized enterprises (SMEs) this can be a barrier to invest in EAS (Mabert et al., 2001). The next challenge is the complexity and customization that the implementation of new enterprise systems offers. EAS covers the whole organization and due to their broad scope, this requires a lot of integration and operational changes (Piazolo & Felderer, 2016). Business processes must be revised and aligned with the new EAS software to make sure that all processes are synchronized and integrated with each other. Customization is critical to ensure that the new EAS system is serving the organization’s needs. This can be time-consuming and complex (Mandal & Gunasekaran, 2002). Also, the migration of data to new software platforms is a challenge. The integration of isolated data into one software

system requires accurate and complex thinking to manage data migration and integration effectively (Wood & Caldas, 2001).

Valuable insights on the success of EAS are scarce, despite its maturity. Although, technological factors are critical to EAS, most challenges that come with the implementation of new enterprise software are related to organizational and social factors (Al-Gahtani et al., 2007).

2.2 Social factors in successful EAS adoption

As described earlier, there are several organizational and social factors influencing the successful adoption of EAS. Aspects such as leadership, organizational culture, employee engagement, communication and peer influence are crucial to understand the acceptance and resistance among employees that can foster a successful integration of EAS systems (Markus et al., 2000).

The foundation of this study is built on several behavioral models, which are deeply rooted in the field of behavioral sciences. These models serve as the backbone for many newly developed theories and frameworks. The Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975) is the most important underlying framework for this and other behavioral frameworks. TRA is a foundational framework in social psychology to understand the relationship between beliefs, attitudes, and behavior. In 1988 Azjen developed the theory into the Theory of Planned Behavior. The core of TRA comprises that the behavioral intentions of a person are determined by the attitude towards behavior and subjective norms (Ajzen, 1985). In 1992 Bagozzi & Warshaw developed the Technology Acceptance Model (TAM), which describes technology adoption behaviors of people. TAM focuses on two determinants to explain these behaviors. One is the perceived usefulness and the other is the perceived ease of use (Bagozzi & Warshaw, 1992). These two determinants are directly influencing the attitude of an individual toward using a technology. This model was developed by Venkatesh and Davis and resulted in the Unified Theory of Acceptance and Use of Technology model (UTAUT). Venkatesh and Davis integrated elements from eight models of technology acceptance, including TRA, TPB and TAM, and developed a new model with four core determinants of behavior. Performance expectancy, effort expectancy, social influence and facilitating conditions are the four determinants of this model (Venkatesh & Davis, 2000).

Building on these theoretical foundations, Shibly et al (2022) and Taqi et al. (2023) identified several social, organizational, and behavioral factors that influence the adoption of EAS. These two models will serve as the primary theoretical frameworks for this study. The key factors of these two models are put in a table to provide clarity about these factors.

Table 2: Factors influencing EAS adoption according to Shibly (2022) and Taqi (2023)

Factor Category	**Factor**	**Explanation**	**Mentioned by**
Social factors	Peer influence	The extent to which a person is influenced by peers (colleagues, etc.) to adopt an innovation (Oster & Thornton, 2012).	Shibly (2022) & Taqi (2023)
	Image	The degree to which the use of a new technology positively influences the image of a person (Moore & Benbasat, 1991).	Shibly (2022) & Taqi (2023)
	Social Network	The social process of conversations with other people influences the adoption of a new technology (Rogers, 1995).	Shibly (2022)
Organizational Factors	Training	Both on- and off-the-job training significantly influences the adoption of new technologies (Shibly et al., 2022).	Shibly (2022) & Taqi (2023)
	Managerial Support	The social support of management within the organization can positively influence the adoption of new technologies (Shibly et al., 2022) (Tulasi et al., 2019)	Shibly (2022) & Taqi (2023)
	Incentives	This refers to any financial or non-financial incentive that motivates employees to adopt new technologies (Shibly et al., 2022). It is important that the evaluation and reward system match the employee efforts for adopting I4.0 (Tortorella et al., 2020).	Shibly (2022) & Taqi (2023)

	Organizational Culture	The culture of an organization (work conditions, ethics, trust, fairness) has a huge impact on the adoption of new technologies (Shibly et al., 2022). Shared beliefs, assumptions and concepts of an organization influence the support of employees regarding I4.0 adoption (Taqi et al., 2023).	Shibly (2022) & Taqi (2023)
	Teamwork and Communication	The fast advancement of technology in factories requires extensive teamwork and collaboration within companies (Chowdhury & Murzi, 2020). Effective communication is a big part of it and crucial for a successful implementation of new technologies (Hwang et al., 2022).	Taqi (2023)
	Trust and transparency	Trust and transparency is another crucial factor for adoption, I4.0 technologies such as Blockchain can enhance the transparency within an organization (Raj et al., 2020).	Taqi (2023)
Behavioral Factors	Perceived Ease of Use	This contains the degree to which a technology is perceived as being difficult to use (Moore & Benbasat, 1991)	Shibly (2022) & Taqi (2023)
	Perceived Usefulness	The degree to which a person thinks that something will enhance his or her performance (Davis, 1989).	Shibly (2022) & Taqi (2023)
	Personal innovativeness	The time in which a person adopts an innovation (early stage, later on, etc.). This has to do with the characteristics of a person regarding innovation or stability (Rogers, 1995).	Shibly (2022)

	Prior experience	This refers to the person's previous experience with a similar innovation (Fuller et al., 2006).	Shibly (2022)
	Enjoyment with Innovation	This refers to the perceived delight a person gets from a certain innovation (Al-Gahtani & King, 1999).	Shibly (2022)
	Motivation	The reason why for employees of an organization is crucial to consider their adoption to a certain innovative technology (Taqi et al., 2023).	Taqi (2023)

Several factors from Shibly's research are corresponding with those from Taqi's research. Perceived ease of use, perceived usefulness, and managerial support are critical factors in both frameworks (Shibly, Abdullah, Murad, 2022; Taqi et al., 2023). Taqi et al. (2023) and Shibly et al. (2022) both stressed the importance of the culture and strategic orientation of the organization, especially how values and beliefs affect the attitude of employees towards adopting new technologies. Several other researchers highlighted the importance of social factors in the adoption of IT systems. Capestro et al. (2024) emphasized the importance of trust and knowledge sharing to foster a sustainable environment for technology adoption. This aligns with the trust and transparency factors mentioned by Taqi et al. Clohessy & Acton (2019) underscore the importance of organizational readiness, which corresponds with the organizational culture mentioned by Shibly and Taqi. Ahmad & Pinedo Cuence (2023) confirm that cultural change has a huge impact on the adoption of technology among employees, supporting Shibly's focus on organizational culture and Taqi's focus on motivation and communication. The expertise level of employees can be another determinant for the adoption of new technologies (Hameed et al., 2012), which can be improved by training initiatives (Shibly, Abdullah, Murad, 2022; Taqi et al., 2023). Moreover, Nair, Chellasamy & Singh (2019) mentioned that the attitude that employees have towards IT impacts the adoption of those technologies. This attitude is closely related to the behavioral factors that Shibly et al. (2022) describes in his book.

By integrating the models from Shibly and Taqi, and combining those with insights from other researchers, it becomes evident that a successful EAS implementation requires a multi-faceted

approach. Individual characteristics should be combined with organizational dynamics, and social factors to create the perfect condition for a successful implementation. These factors are examined in detail through qualitative research in this study, which will result in a comprehensive model that emphasizes the most critical factors for a successful implementation.

2.3 Time phases EAS implementation

The adoption of EAS within manufacturing companies implementing Lean Six Sigma methodologies can be significantly influenced by time measures. Traditional studies often overlook the importance of time and their influence on social and behavioral factors (Roe, 2008). A longitudinal approach that examines factors across different time phases can provide deeper insights and explain how these factors evolve over time (Claessens et al., 2004).

Several studies have examined different time phases related to the implementation of EAS or other IT systems. Cooper and Zmud (1990) proposed a six-stage model for IT implementations. They distinguished six successive phases: initiation, adoption, adaptation, acceptance, routinization, and infusion (Cooper & Zmud, 1990). Additionally, other research introduced a four-phase model for the implementation of EAS, which includes the phases of chartering, project, shakedown, and onward and upward (Markus, M. L., & Tanis, C. 2000). While several studies present different phases for implementation processes, they do share the same fundamental structure. Most of the identified time phases can be distinguished in three main stages: pre-implementation, during implementation and post-implementation (Dance & Richard, 1996). Therefore, this study employs a longitudinal approach where the adoption of EAS will be measured during these three time phases. This approach aims to delve deeper into the different time phases to examine how the key social factors are contributing to each specific timeframe.

2.4 EAS, social factors and Lean Six Sigma

The concept of social factors within the adoption of EAS is investigated in the context of Lean Six Sigma. The interviews are conducted within companies that use Lean or Six Sigma methodologies, or a combination of both.

Research has shown that several methods used within Lean companies such as 5 s provides process visibility and transparency. This can contribute to avoid implementation errors, reduce waste and focus on integration strategies (Bueno et al., 2023). Creating predictable and flexible processes is an important step in Lean Manufacturing, which can enhance the adoption of I4.0 type technologies. Flexibility and adaptability is crucial to adopt new technologies (Bueno et al., 2023). On the other hand, Industry 4.0 technologies can enhance the effectiveness of Lean Six Sigma methodologies. Technological innovations can provide real-time data, minimize errors and improve decision-making by more deliberate, predictable and accurate data (Ibrahim & Kumar, 2024).

Beside the synergies that Lean and Industry 4.0 are offering, there are also a few tensions. Most of the tensions are related to social factors. Industry 4.0 technologies can be used to automate activities, which can lead to the perception by employees that their roles are marginalized. Industry 4.0 technologies can be complex and may cause technostress among employees. Therefore it is again important to provide easy-to-use interfaces and create trust among employees (Frank et al., 2024).

This chapter provided a theoretical understanding of the social factors influencing the adoption of EAS in the context of Industry 4.0 and Lean Six Sigma. Multiple benefits and challenges regarding EAS adoption are identified and the focus on social and organizational factors is explained. The most important factors influencing the adoption of EAS systems are analyzed from previous research and are synthesized and merged into the most critical determinants, as summarized in Table 10 (Appendix D).

While previous research has provided valuable insights into influencing factors, it has primarily examined these factors individually and from a managerial perspective, often overlooking their interaction across different implementation phases within a Lean Six Sigma context. A gap in the literature exists regarding how organizations can apply these social factors to navigate the various phases of EAS implementation. Through empirical research, this study synthesizes and integrates these factors to address the need for a structured guideline on leveraging social factors for a successful implementation. This study contributes a model that incorporates both managerial and employee perspectives, as further explained in Chapter 3.

3. Methodology

3.1 Research design

This research employed an interview method to investigate the different social factors that are influencing the successful adoption of EAS within companies using Lean and/or Six Sigma methodologies. A qualitative research design is employed because of the exploratory nature of this research (Klenke, 2016). The aim of this research is to identify the most crucial social factors for EAS adoption and to understand how these factors contribute to this adoption. The novelty of this study lies in investigating how companies can effectively leverage these factors for adopting EAS. Where previous studies have primarily focused on identifying factors influencing adoption, this research adopts an exploratory approach, allowing for the discovery of novel ways in which social factors can contribute to the successful implementation of these systems. Therefore, the study employed two distinct types of interview methodologies. The research design consists of three different phases which are described in Figure 1.

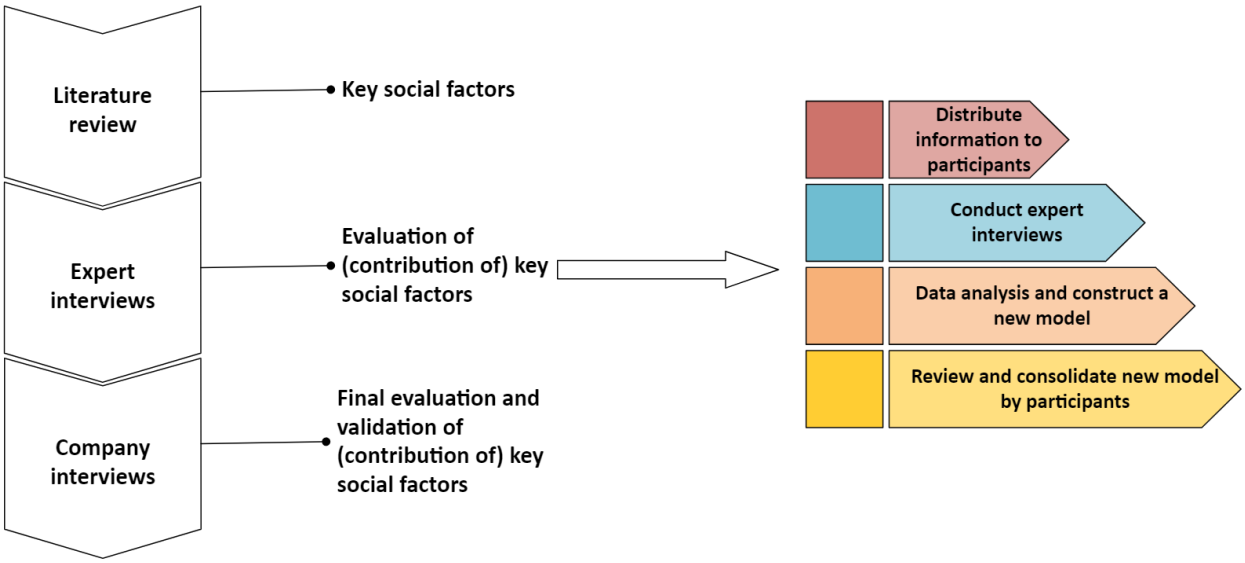

Figure 1: Research design steps

The study began with a literature review to identify the key social factors contributing to the successful adoption of an enterprise application system. This has been addressed in the theoretical background of this thesis. The key social factors identified from the literature are further explored in practical research. Then, six interviews were conducted with experts in the

field of EAS implementation across several companies. These interviews were semi-structured and the goal was to present these experts with factors derived from the literature for evaluation (Adeoye-Olatunde & Olenik, 2021). The objective was to develop a comprehensive model highlighting the crucial factors through different time phases across EAS adoption. The adoption phase is split up in pre-implementation phase, during implementation phase and the current situation/post-implementation phase. By incorporating different phases, the factor of time is considered to gain a better understanding of the influencing factors (Roe, 2008). For this research phase, the Delphi method is used. The Delphi method consists of three stages; information is collected and distributed among the participants. This is followed by several rounds of questionnaires. The gathered information is then shared with the participants, leading to a group discussion to develop a cohesive understanding of the various concepts. The researcher makes a comprehensive model of this information, which is sent to the participants for review and consolidation (Dalkey & Helmer, 1963). The Delphi method is slightly adjusted. Because of practical limitations, individual interviews are conducted instead of using a group discussion. The four phases of the Delphi method used in this research are shown in Figure 1.

The second round of interviews are conducted within manufacturing companies. This research is conducted on behalf of a consultancy firm, and therefore clients of this company are interviewed who have recently undergone an EAS implementation. Interviews are conducted with managers/implementers and operational employees/users of the EAS of the companies. This approach aims to gather valuable insights into the EAS adoption process from both managerial and user perspectives. A total of nine company interviews were conducted, including six users of the EAS system and three implementers.

The model created from the expert interview findings is utilized during the company interviews. The essential factors highlighted by the experts for successful implementation were examined alongside the actual implementations in the organizations, with a focus on these aspects. This approach connects the crucial factors identified by the experts and the ones that implementers intend to apply to the factors deemed important by users of the EAS.

3.2 Sampling procedure

As described in the last subchapter, two types of interviews were conducted. Therefore, different types of sampling were used.

3.2.1 Expert interviews

Initially, six experts are selected with extensive knowledge about the topic. Purposive sampling is used to 'select respondents that are most likely to yield appropriate and useful information' (Bourgeault et al., 2010). Given the nature of this part of the study it is important to select people who have different and important views about the topic and need to be included in the sample (Robinson, 2014). Six experts from various companies were interviewed to gather a comprehensive understanding of the influencing factors. The experts that were selected should meet several criteria; the expert must have extensive knowledge and experience with implementing or transforming EAS within organizations. The participant should have been involved in at least three implementation or transformation processes. The expert should be familiar with Industry 4.0 concepts like integrating digital technologies or platforms. Experience in leading at least one implementation process as a project leader, consultant, or in a similar role is needed. Furthermore, it would be advantageous if the expert possesses extensive knowledge and insights on both the technical and social aspects of EAS adoption. Understanding the significance of social factors in this implementation process is paramount. Additionally, it would be beneficial if the expert has some experience in the field of Lean and/or Six Sigma methodologies. The aforementioned criteria were met for all six experts. Table 3 provides a detailed description of each of the six experts.

Table 3: Sample description expert interviews & company interviews

Expert interviews					
Expert	Gender	Age (years)	Background	Company	Function
Expert 1	Male	25-40	ICT	IT consultancy	Account manager
Expert 2	Male	40-55	Applied mathematics	Manufacturing	SAP consultant
Expert 3	Male	25-40	Mechanical engineering	Organization consultancy	Organization consultant
Expert 4	Male	40-55	Mechanical engineering	Organization consultancy	Operations manager
Expert 5	Male	40-55	IT & Process management	Organization consultancy	Organization consultant
Expert 6	Male	25-40	Civil engineering	Software development	CCO

Company interviews							
Company	Size employees	System type	When	Gender	Age	Function	Role during implementation
A	50 - 250	ERP	2022	Male	40-55	Director	Implementer
A	50 - 250	ERP	2022	Male	40-55	Plant manager	User
B	50 - 250	QMS	2023	Male	40-55	Quality manager	Implementer
B	50 - 250	QMS	2023	Male	25-40	Quality engineer	User
C	50 - 250	ERP	2018	Male	40-55	Manager Analytical Laboratory	User
C	50 - 250	ERP	2018	Male	40-55	Continuous Improvement Engineer	User
D	50 - 250	ERP	2018	Male	40-55	Shareholder	Implementer

D	50 - 250	ERP	2018	Female	40-55	Purchaser	User
D	50 - 250	ERP	2018	Female	40-55	Purchaser	User

3.2.2 Company interviews

For conducting interviews with employees from various manufacturing companies, the sampling selection followed the four-step approach by Robinson (2014). The sample universe is homogeneous in a sense that four companies were selected that have undergone an EAS implementation process in the last six years, and they are using Lean and/or Six Sigma methodologies. These four companies compete in the manufacturing industry and are classified as mid-sized to large enterprises. Mid-sized enterprises are defined as having 50 to 250 employees, while large enterprises have more than 250 employees [1]. The focus was on manufacturing companies within these categories. The heterogeneity stems from variations in hierarchical structures, cultures and other organizational factors, as these aspects are the determinants of this study (Abrams, 2010). The decision to focus on mid-sized to large manufacturing companies is because most clients of the consulting firm fall within this category. The sample size was determined based on the quantity sufficient for drawing meaningful conclusions, constrained by limitations in resources and time. Four companies were selected, with contributions from implementers and users of the EAS.

The sampling strategy is a mix of convenience and purposive sampling. In a sense, the strategy can be called convenience sampling because the network of clients of the consultancy firm was used and companies were selected who were available to the researcher (Emerson, 2015). An argument can also be made for the strategy of purposive sampling. A selection criteria is made by selecting manufacturing companies ranging middle-sized to large companies (Robinson, 2014). Additionally, these companies should utilize Lean and/or Six Sigma methodologies and should have undergone an EAS implementation process in the past six years. Finally, the sample was sourced by using the client network of the consultancy firm to identify four manufacturing companies. The participants were selected in consultation with the contact person within each company to ensure diversity among the participants. The participants were informed about the objectives of the study and had the possibility to review

[1] https://ec-europa-eu.ezproxy2.utwente.nl/eurostat/statistics-explained/index.php?title=Glossary:Enterprise_size

the findings of the study. The goal was to interview both an implementer/manager and an user/operational employee of the EAS from each company, facilitating cross-case generalities (Robinson, 2014). Due to various circumstances, this was not possible. In one organization, two system users were interviewed, but no implementer. In another organization, two end users and one implementer were interviewed. Table 3 provides a detailed description of the three implementers and five users of the system who were interviewed.

3.3 Data collection

3.3.1 Expert interviews

To avoid biases and maintain a broad perspective, the initial step in data collection was to conduct expert interviews. These experts have been involved in multiple EAS adoption processes and are able to reflect on them with a broad perspective, offering an objective assessment of how these implementations progressed. Semi-structured interviews with an appreciative approach were used for conducting the expert interviews. Research has shown that this approach suits well the concept of information systems research. Appreciative interviews do focus on building a positive relationship between the interviewer and participant and remove any obstacles (Schultze & Avital, 2011). This approach suits this study very well, as it ensured an open dialogue between the interviewer and interviewee, without any barriers to communication. Moreover, the emphasis on identifying potential solutions, opportunities, and contributions to a successful EAS adoption, underscores the importance of an appreciative focus in discovering these possibilities. The objective of this first round of expert interviews was to identify the most important social factors for a successful EAS adoption through examining factors identified in previous research and potentially introducing new ones.

3.3.2 Company interviews

When the initial round of expert interviews was finished, the interviews with implementers and users of the EAS started. Recent studies, such as Taqi et al. (2023), have focused on the influencing factors from the perspective of implementers only. In contrast, this study aimed to identify how key social factors contribute to the successful adoption of EAS by incorporating insights from both managerial and operational employees. In these interviews, again a semi-structured interview guide was employed to explore the influencing factors derived from the

literature and expert interviews through the scope of implementers and users involved in the implementation. In these interviews, the focus was placed on specific EAS implementation processes and the link was made to the influencing factors within the three phases (pre-implementation, during implementation and current situation). In the interviews with the implementers, their perspectives on strategic decision-making, resource allocation, and offering support for the adoption was discussed. In the interviews with the users of the system, the day-to-day experiences with the implementation of the EAS was discovered on topics as training, usability, peer influence, etc. For these interviews the appreciative approach was used again to ensure an open dialogue and encourage participants to share their experiences and feelings (Schultze & Avital, 2011).

3.4 Data analysis

Given the exploratory nature of this research, the interviews were coded and categorized. For the expert interviews the method of Thematic Analysis (TA) of Braun & Clarke (2006) is used. In social sciences TA is utilized to identify, analyze, and interpret patterns or themes within qualitative data, making it particularly well-suited to this research due to its flexibility. During the first round of interviews, specific themes are sought. Thematic analysis is applied in the initial phase of data analysis, following rigorous steps (Braun & Clarke, 2006):

1. Familiarizing with the data: Transcribing the data, reading the data and noting down your initial ideas.
2. Generating initial codes: First start with generating codes from the relevant data.
3. Searching for themes: The generated codes are grouped together in potential themes.
4. Reviewing themes: At this step the themes are checked if they work in relation to the initial codes, and a potential ‘map’ is drawn.
5. Defining and naming themes: The themes are finalized, and names are giving to the themes.
6. Producing report: The final report/map is developed.

This method resulted in a thematic map with the most relevant and important social factors, and how these factors can be leveraged during an EAS adoption process.

The data structure is visualized using the Gioia methodology, which is also applied in the second round of company interviews. The Gioia methodology follows a systematic approach, similar to Thematic Analysis. The first step involves grouping data into 1st order concept, similar to open coding in the Grounded Theory (Flick, 2013). These first order concepts are then transformed into 2nd order themes, where patterns and themes are identified to organize the concepts. Finally, these themes are aggregated into broader dimensions. This last step results in a set of aggregated dimensions, which are structured into a cohesive a data structure (Gioia et al., 2013). With this method for data analysis, the developed model from the first round of interviews is checked and new data is identified.

For the data analysis, a combination of deductive and inductive coding was applied. As outlined in the theoretical background of this thesis, the implementation process is divided into three distinct phases. These three phases represent the aggregated dimensions of the study. This approach was chosen because previous research, as discussed in Chapter 2, has demonstrated that these phases are essential for the EAS implementation process. Therefore, deductive coding was used to establish the aggregated dimensions. Inductive coding was employed to develop the concepts and themes. This approach was selected to identify the most critical factors for successful implementation and understand how they can be applied. By combining deductive coding to define the aggregated dimensions based on prior research and inductive coding to generate concepts and themes, the study aims to develop a robust new model for guiding a successful EAS implementation process.

This method was intended to analyze the influencing factors identified through the literature review and test them in the interviews. The data analysis has helped to concretize these influencing factors and allow for the addition or adjustment of new factors.

The goal of this data analysis is to conduct a comparison analysis. Crucial factors for a successful implementation are identified through the eyes of experts. Then, specific implementation processes within companies are investigated. A comparison is drawn between the perspectives of the system implementers and the system users. This research approach aims to determine whether the implementers' objectives align with the users' perceptions of the implementation.

3.4.1 Expert interviews

The first round of interviews with experts is used to analyze key themes and create a thematic map from those results. The transcripts are analyzed using coding software. This approach tested the factors derived from the literature review, while also allowing the emergence of new insights (Sætre & Ven, 2021). The generated codes were grouped together in potential themes, which were reviewed and refined to ensure that they capture the data. After that, the themes were named and resulted in a thematic map. This map provides a comprehensive overview of the crucial factors identified by the experts.

3.4.2 Company interviews

Within those companies, a specific EAS implementation/transformation was highlighted and the model resulting from the expert interviews was tested and redefined through the different implementation stages. To analyze this data, the Gioia methodology was applied. The results from the company interviews were mapped against the created model from the expert interviews, and consistencies and discrepancies were highlighted across the different adoption phases. The four interviewed companies were also evaluated on the effectiveness of their EAS implementation process and their Lean Six Sigma maturity level. This assessment was conducted using a qualitative approach through interview questions, utilizing an ordinal scale. The effectiveness of the implementation was rated on a scale ranging from 'Bad' to 'Excellent,' while the Lean Six Sigma maturity level was rated from 'Low' to 'High,' based on the responses and outcomes of the interviews.

3.4.3 Triangulation and validation

The used research methodology includes data triangulation and validation to ensure reliability and validity. Triangulation is achieved through two types of interviews: expert interviews conducted over three rounds, followed by company interviews. These methods together ensure robust data triangulation (Flick, 2017). Validation is ensured by sending the constructed model from the results of the expert interviews to the experts for review and consolidation. Afterwards, the results are further tested and validated through the company interviews. Data triangulation and validation is ensured using this specific methodology.

4. Results

This chapter presents the findings from the expert interviews and the company interviews. These two methods led to two different data structures, and the results chapter is organized accordingly these two different research methods.

4.1 Expert interviews

The Delphi method is employed to conduct the expert interviews. Key factors were identified through the literature review, and this information was shared with the participants prior to the interviews. Interviews were then conducted with six experts in the field of EAS adoption. These interviews provided insights on the key social factors for a successful EAS adoption, how those factors can be applied, and the relevance and use of Lean Six Sigma methodologies. Based on the analyzed data, a model was constructed and shared with the experts for further refinement. The model is divided into three phases and is presented in Figure 2 below.

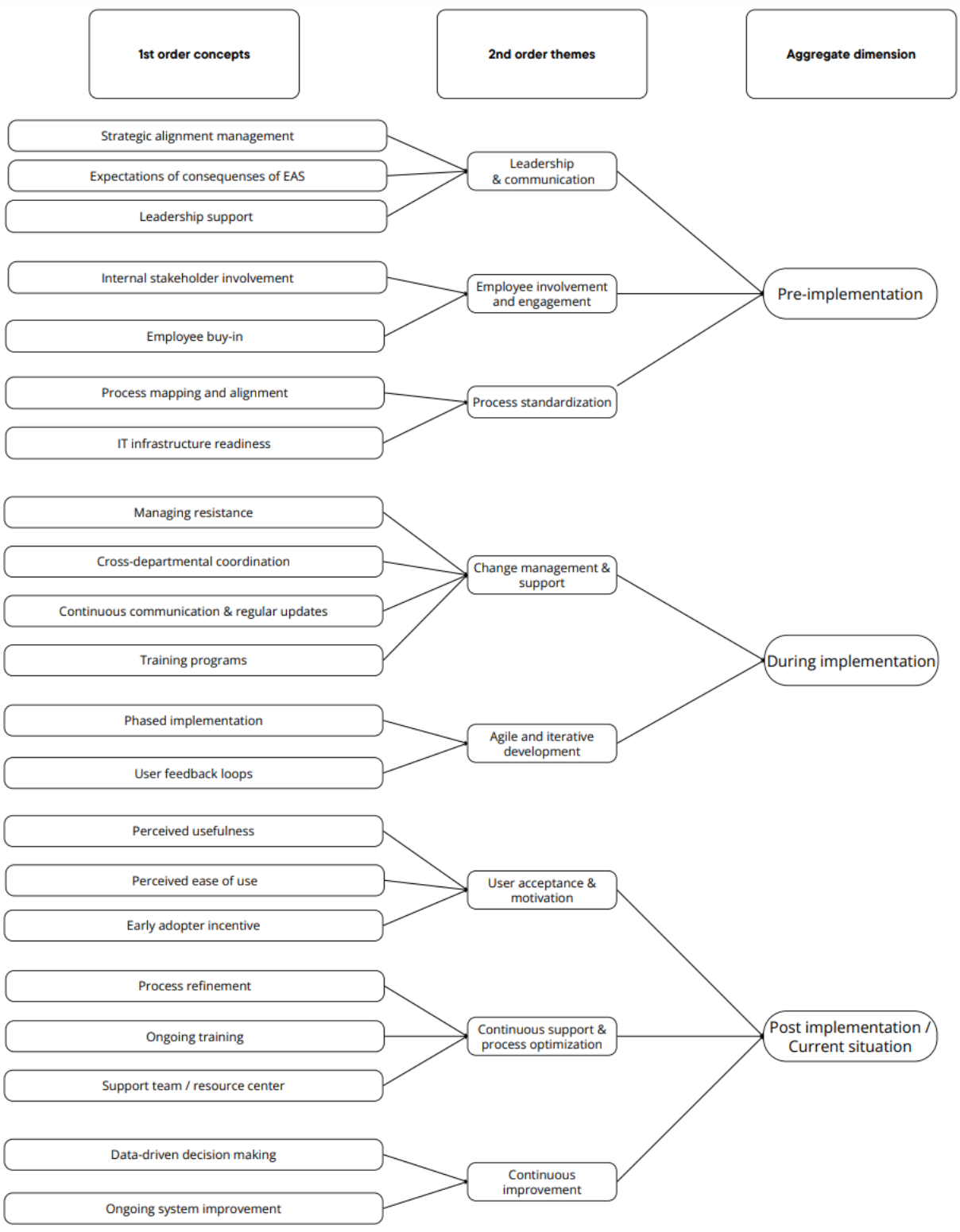

Figure 2: Model expert interviews

4.1.1 Pre-implementation

The research was conducted based on three different phases in the adoption process. The first phase is the pre-implementation phase. This is where the choice is made to search for a new

EAS, the selection procedure will start and where preparations are made. Through the expert interviews, information is gathered on how these key social factors can be applied during the pre-implementation phase, to perform a successful implementation. The first aggregated dimension of the model is the pre-implementation phase, as shown in Figure 2. This stage is crucial, because the choice for a specific system is made and the preparations and planning for the project are determined. This phase revolves around two key socio-technical aspects: “Leadership & Communication” and “Employee involvement and engagement”. “Process Standardization” is focusing on existing processes and workflows.

The role of leaders and their communication within the organization is crucial for the pre-implementation phase. Strong leadership from the management of the organization underscores the importance of the EAS project across the organization. Experts concluded that this top-down support is crucial to secure resources and reach optimal employee buy-in. It is important that **the organizational strategy is aligned with the adoption of a new EAS**, and this implementation should be prioritized. Expert 5 stated: *“It has to be an added value to the strategy you have deployed at that time. That just has purely to do with, okay, implementing a tool takes time and money. And especially that time, that's what I'm talking about. Someone often wants to put down money, but at some point you say to all departments, yes, you have to work with this too. Yes, but we don't have time for that. We don't have the priority for that. Why not? We've got that... And then the only correct answer has to be, we've laid that down in the strategy, so you have to have room for that.”* For the employees of a company, it is important that the leaders support the implementation of this new system. Experts mentioned that without the **support of the leaders** it is impossible to create support within the rest of the organization. Expert 2 mentioned the following: *”Support from the top management is crucial. When you choose for a new ERP system, it should be part of the strategy of the company. The implementation should involve strategic decisions and must be fully supported by the management.”*

Communication of the leaders should be transparent detailing both the expected benefits and challenges of the implementation. Expert 4 stated: *“The role of Organizational Behavior Management is paramount for the first phase. The implementation of a new system will create consequences for the employees, those consequences can be positive or negative. Important is*

to be transparent on both the positive and negative consequences and try to highlight the positive consequences. This will help you to reduce employee resistance."

The experts highlighted the importance of **involving internal stakeholders** within the pre-implementation phase. Early involvement of employees in the selection procedure, participation in decision-making processes and workshops are crucial to create ownership among the employees of a company. Expert 4 mentioned: *"It is important to know who the users are because an enterprise system has many different users at different points in the process chain. The employees should be fully convinced of the value of the system in achieving their goals. It's about being genuinely involved in the process and doing everything possible to make it successful, not just pressing the buttons."*

Another key aspect is that operational employees are able to identify problems or solutions in the EAS that higher placed managers do not consider. Expert 3 highlighted the importance of having multiple layers of the organization represented in the implementation: *"The implementation team consisted of several departments and layers of the organization. Not only the higher management, but also the operational employees from the work floor, who have extensive knowledge of the processes, were involved. So, it were not only people setting up the process, but also people who know how the processes actually work."*

The second part of this key aspect is about the **engagement of the employees** within the implementation process, this is called "**Employee buy-in**". Experts highlighted the importance of employees really investing in the system, and not "just pressing the buttons" as expert 4 mentioned. Expert 1 mentioned the importance of employee buy-in with the following statement: *"The employees should reserve time and energy to be involved in the project. The involvement of the employees is key to make the implementation a success and this starts in the preparation phase. Everyone should be involved within the project and must support the implementation and understand decisions that are made."* Expert 4 describes how you can enhance this employee buy-in: *"You should give ownership to the employee who feels the process as their own project. Those people should feel responsible for making the best process as possible. It is important to make sure that everybody, besides knowing which buttons to press, also makes sure that the outcome of the process is optimal."*

Another key aspect within the pre-implementation phase is process standardization. The standardization and documentation of processes is key for a successful implementation, this

should be done through **process mapping and alignment** before the new EAS can be implemented. One of the most common mistakes made in EAS implementations is pointed out by experts as the lack of alignment between the processes of an organization and the capabilities of the EAS. Therefore, it is important to standardize and document all the operational processes. This is where Lean methodologies such as process mapping can be used. Expert 5 did mention the importance of knowing your internal processes related to a specific implementation process that he managed: *"They wanted to implement this new system, but they didn't knew their processes. So, my question was, what requirements should this system meet? If you know your processes, then it is easier to link risks to those processes and to the new system. Process mapping is key for the selection of a new tool, otherwise the system won't work"*

Another key organizational aspect within the preparation phase is that the **IT infrastructure of the organization is ready** for the new system. It is important that the technical backbone of the organization is ready to work with the new systems and therefore avoid technical problems during the implementation. Evaluating the current IT infrastructure and making preparations for required updates are key in this phase. Expert 6 stated: *"You should have a solid test plan during the preparation phase. Things like aligning the current IT system with the new EAS, and data conversion are often overlooked. Organization often don't know how to properly manage that, or they don't recognize the importance of it."*

4.1.2 During implementation

The second aggregated dimension is the "During implementation" phase. This is where the choice for a certain system is made and the implementation will start with training programs, implementation trials and feedback sessions. The model for this phase is also displayed in Figure 2.

During the implementation phase, the role of change management is crucial. This can be underscored through the lens of four different factors. This starts with **managing resistance** to the implementation of a new system. The experts highlighted that resistance arises due to fear of the unknown and new workflows, this is underscored by expert 2: *"Employees are resistant to change and instantly think that the old system was better. For example, with the old system they only had to fill in three field, and with the new one they have to fill in five field, which they think is unnecessary."* Resistance is often created by a lack of communication through the

process. Therefore, the role of **continuous communication and updates** is crucial to reduce uncertainty about the system. Employees should be updated regularly about progress of the implementation and address problems they are facing. Expert 6 is a consultant and has managed several ERP implementations, he mentioned the importance of communication and updates: *"We use a structured methodology, where we start and end the day with a progress update. This ensures that everybody knows what is happening and problems and issues can be addressed instantly."*

A frequently seen problem is that departments operate in silos, which can be a significant thread to a successful implementation. The **communication and coordination between different departments** is therefore critical to ensure that all the departments have the same goals and are pointing in the same direction. According to expert 3 you should have ambassadors of all the departments: *"In big organization you should have employees who act as an ambassador of their department. It is important to have strong representatives who can communicate on behalf of their department and also report back to their department."* Another crucial part during the implementation phase is the role of training programs. Experts mentioned that **relevant and timely training** results in skilled employees who know how to work with the system and feel confident in using the new EAS. Tailored training programs should be arranged to facilitate different users within the organization. Expert 2 mentioned that training is not arranged in a good way: "The training aspect is often neglected in large implementations. Technically, you have a good ERP system, but the people are not able to work with it. They lack experience, and that is where things go wrong." Expert 1 mentioned that guidance and training can result in employees who are more familiar with the system and see the usefulness of it: *"Sometimes an extra day of guidance or training can be needed to make sure that all the users know how the system works. The employees can get more confidence and recognize the value and usefulness of the system."*

Another aspect of implementation which is often mentioned by experts is Agile and iterative development of an EAS implementation. Implementing a new EAS is not a one-time event, but more an ongoing process that requires flexibility and adaptation from the organization. Introducing the EAS in stages helps the organization to manage risks by breaking the implementation into smaller parts. An Agile approach can provide the organization with a structure to **apply a phased approach**. Expert 3 mentioned the importance of applying a

phased approach to discover issues earlier in the implementation process: *"Later in the process we founded out that not everything within the ERP system worked well. That meant that we needed some iterations. In general, it is better to catch a mistake earlier in the process, as the error can be fixed and the support for the system will be stronger. The later the mistake is found, the bigger the impact will be."* Expert 1 mentioned the use of Scrum to underscore the importance of a phased implementation: *"We use a certain aspect of Lean in our projects. Scrum is on the basis of our approach, which allows us to work flexibly and efficiently. Different functionalities are delivered in sprints at different times. This phased implementation allows us to discover problems within the system early and correct them. This approach does also give the users more feeling with the system and make them feel more comfortable with it."* Another key element of this Agile and iterative development is the incorporation of **user feedback loops**. It is essential to identify problems early before they can cause major damage to the EAS and the organization. User feedback loops allow the organization for continuous improvement and align the system with the needs of the users. Experts mentioned that incorporating these feedback loops helps to gather feedback early and frequently to refine the system. Expert 6 mentioned the impact of these feedback loops on the technical implementation of the EAS, but also on the motivation of the employees: *"Methods like Agile working have the advantage that you can gather a lot of feedback early in the process and adapt the system. This helps with the technical implementation, but also with the motivation of the employees and internal communication. It is impossible to predict in detail how the implementation will go, so therefore it is important to apply a lot of feedback rounds within the process."*

4.1.3 Post-implementation / Current situation

The final stage of the EAS adoption process is referred to as the 'Post-implementation' or 'Current Situation' phase, representing the last aggregated dimension. This is the phase where the system is being rolled out and implemented across the entire organization. Like described earlier, an EAS is never perfect, so even after implementation there are plenty factors to consider.

The first part of the post implementation / current situation phase is about enhancing user motivation and user acceptance of the EAS. The success of an EAS implementation largely depends on how effectively the users are adopting and utilizing the system, especially during the initial live going. Key determinants for employees to use the system are the **perceived**

usefulness and **perceived ease of use** of this system. A user wants to see the benefits of adopting the system. Experts pointed out that when employees struggle with a certain EAS and their perceived ease of use is not high, the system will not align with the needs of the users and therefore they will not successfully adopt the system. Expert 6 pointed out the importance of the perceived ease of use of the EAS system: *"The system can work efficiently, but when the users are not satisfied because it does not work pleasantly, the adoption of the system will not be optimal, and the implementation will not be a success."*

Expert 3 mentioned the importance of an almost perfect EAS: *"I think that it is very important to have a system that works very well. Employees will always look for flaws and issues and magnify them. It is important to prevent those as much as possible. If the system is almost perfect and the employees see the usefulness of it, then you will face less resistance."*

Expert 2 described that the perceived usefulness of a system is not always on individual level, but rather for the entire organization: *"You have to show the users of the EAS that there are benefits, maybe not always directly related to their own function or department but for the organization as a whole."* The perceived usefulness and perceived ease of use that the users experience with the EAS is categorized under the post implementation phase but is shaped and starts in the pre-implementation phase. In this phase, the users are (preferably) introduced to the system and their first opinion is created there. Therefore, it is important to have an overview of the consequences of the implementation of the EAS and try to make those consequences as good as possible. One way to enhance the user acceptance and therefore the adoption of the EAS is to make use of **early adopter incentives**. The engagement of key users early in the adoption process and recognizing their contribution is crucial to create enthusiasm for the new EAS and therefore enhance the adoption. Early adopters can serve as champions within the organization, and with that stimulate others to adopt and embrace the system. Expert 3 points out the importance of those early adopters, and he also acknowledges the type of early adopters you should definitely have in your implementation process: *"You certainly need early adopters in your implementation process, people who act as the driving forces. There are always people who resist. Therefore, it is important to identify these people timely and involve early adopters in your project."*

Another crucial element after the EAS is rolled out is the role of process optimization and continuous support. Optimization and support are vital to ensure that issues are addressed

instantly. All experts highlighted the importance of **setting up a support team or resource center** where users having problems with the system can contact somebody for troubleshooting. This is the place where minor problems can be solved timely before major problems are caused. Expert 2 mentioned: *"What is crucial after the implementation is good support. Users should know where they can go with their problems or questions, and you should have set up a good support team that can address questions and problems and help the users."* The importance of this resource center is highlighted by all the experts, expert 6 mentioned the importance of having someone in the support team (or somewhere else in the organization) who can adjust the system if needed: *"Crucial is that you have someone who is taking responsibility for the process and streamlines it. This person must show ownership and should be able and willing to adjust the processes and system if necessary."* Making the necessary changes to the system after the implementation is called **process refinement**. Processes, systems, and people are unpredictable and therefore it is unavoidable that the systems need adjustments based on the feedback provided by users. The EAS should constantly be aligned with the needs of the organization and therefore regular reviewing and refinement of the system is needed. Expert 1 is working for an ERP implementation partner and support company and highlights the difference between companies investing in development of the system and process refinement and companies that do not invest: *"Clients who are continuously refining their processes and developing the system get more out of it. After the implementation it is important to refine the processes and do not be satisfied with the initial implementation."* As described earlier, it is important that users feel comfortable with the system and use it effectively. Therefore, it is useful to **provide ongoing training** to the users of the system to become more familiar with it, and to stay up to date with new updates or features. Expert 3 highlights the unpredictability of an implementation and the need for ongoing training: *"We found out that the system was not working optimally and beside that, updates were implemented. Therefore, ongoing training is needed (also after the implementation) to adopt the system within the organization."*

The last part is about continuous improvement. Experts mentioned the benefits of fostering a culture of continuous improvement to optimize the implementation of the EAS. **Data-driven decision making** can be used to monitor system performance and identify areas for improvement. Data should be gathered on system efficiency and effectivity, so organizations can make data-drive adjustments to optimize their processes and the EAS. Expert 4 highlights

the importance of having strong measurement tools to measure the performance of the new system: *"In an implementation process that I managed, we could measure how often opportunities were adjusted in the system. This was important to measure the spillover effects of the implementation, with this information we could adjust the processes."* Expert 2 did also mention the importance of evolving the EAS with the changing needs of the organization. The system must be viewed as a dynamic system and not so much as a static tool for ensuring continuous effectiveness. **Ongoing system improvement** is needed to align the EAS with these changing needs of the organization. Expert 4 did also mention the need for ongoing system improvement and the benefits of having an IT person in house: *"In the first year of the implementation EAS often require a lot of adjustments. When the users start working with it, often small adjustments are needed. It can be problematic if you are reliant on an external IT company for those adjustments."* Expert 1 also highlighted the importance of improving the system after implementation: *"In the final phase, the most important factors are giving and receiving feedback and adjusting the system to it. Constantly developing the system to internal and external needs is crucial to keep the system successful."*

In the literature review there was made a table (Table 10) to describe the social, organizational and behavioral factors influencing a successful EAS adoption. Following the expert interviews, a new table of influencing factors was created and is presented in Table 11 in Appendix E.

The insights derived from the expert interviews confirm several factors identified in the literature review, particularly regarding the importance of leadership support, communication, and training. However, the expert interviews also provide additional practical insights and highlight areas that differ from previous research. The big difference between the model constructed from the literature review and the model derived from the expert interview is the structure of the model. Table 10 (literature review) is basically a table with influencing factors on EAS adoptions, while Table 11 (expert interviews) is more a guideline with influencing factors that should be considered when implementing an EAS in different phases.

Several key factors identified in the literature are reinforced by the expert interviews. Both sources emphasize the critical role of leadership and communication, particularly the alignment of strategic management decisions with the EAS implementation process. This aligns leadership with the concept of "Organizational Culture and Strategic Orientation" from the literature. Similarly, both sources agree on the significance of training, though experts

emphasize tailored training programs during implementation to ensure effective user engagement. While the literature focuses on "Incentives and Rewards" as a general organizational factor, the experts highlighted the importance of giving incentives to early adopters to use the system, but also take the consequences of the EAS implementation in account (what are the perceived benefits and disadvantages). Both the literature and the experts confirm that perceived usefulness and perceived ease of use are critical for gaining employee acceptance and adoption of the EAS, thereby contributing to its overall success.

While many factors from the expert interviews align with the literature, several key distinctions emerge. The experts placed significant emphasis on employee involvement and engagement during the pre-implementation phase, particularly highlighting the importance of identifying internal stakeholders and securing employee buy-in. Process mapping and IT infrastructure readiness were identified by the experts as crucial elements for a successful EAS implementation, drawing from their experience managing large-scale implementations. While the literature emphasizes teamwork and communication, the role of cross-departmental communication is overlooked. Experts highlighted the importance of breaking down silos and ensure collaboration across departments to align goals and processes effectively. Additionally, experts advocated for using Agile methodologies and iterative development to remain flexible during the implementation. Through employing a phased implementation with regular feedback loops, issues can be identified and addressed early, minimizing potential disruptions of the process. Experts emphasized the critical importance of post-implementation activities. Key elements identified include process refinement, ongoing training, and continuous support for users. Additionally, the experts highlighted the significance of ongoing system improvement, driven by data-based decision-making and continuous user feedback. This approach ensures that the system remains aligned with the organization's evolving needs. Interestingly, this focus on post-implementation activities and continuous improvement is not extensively discussed in the existing literature.

In general, both models share a lot of overlapping factors focusing on strategic alignment, leadership and communication, training, perceived usefulness & perceived use, etc. However, the expert interviews put also emphasis on the importance of several other factors like the organizational structure, processes, and way of working and developing.

4.2 Company interviews

The second round of interviews was conducted within four organizations that have implemented a new EAS within the last 6 years. The aim was to interview one implementer and one user of the system from each company. Company A and Company B both provided an implementer and a user of the system. Company C was a special case (which will be further explained in the case descriptions), and therefore two users were interviewed. In Company D, one implementer of the system and two users of the system were interviewed. Within those nine interviews, the specific implementation processes for each company were explored and factors are identified which have positively or negatively influenced the implementation.

This subchapter is divided into different parts. In “5.2.1 Company descriptions” descriptions are made for all the four companies to describe their context, the effectiveness of their implementation and their level of Lean Six Sigma maturity. In section 5.2.2, 'Cross-Company Comparison,' a table is presented that outlines the specific implementations for each company, highlighting their scores on EAS implementation effectiveness, their level of Lean Six Sigma maturity, and the factors emphasized during their implementation process. Section 5.2.3, 'Comparative Analysis: Company vs. Expert Interviews,' highlights the key results from the company interviews, focusing on the most significant findings and comparing them to the insights from the expert interviews. The complete findings from the company interviews are provided in Appendix F.

4.2.1 Company descriptions

4.2.1.1 Company A

Company A is a production company operating in the Netherlands and Germany with five locations and three production sites. The director of the company was interviewed as implementer of the system. The other interview was conducted with the manager of one of the subsidiaries of the company.

Company A started the implementation of a new ERP system in 2022 across their various sites. The subsidiary in question moved to this new ERP system at the beginning of 2023. Company A wanted to centralize the subsidiaries and therefore introduced the ERP system to all their different sites. The ERP system is currently in the optimization phase, where several modules

and processes are adapted to better align the production needs of the different sites. The subsidiary is currently working on additional features to enhance the alignment of the ERP system to their specific needs. Challenges that Company A faced during the implementation period are the lack of customization for specific needs, insufficient user training and data migration problems. Both the implementer and user acknowledged that there was room for improvement in aligning the system with the company's processes, migrating the data, and training the employees in the new system. Overall, the system is working well at the moment and adjustments are made to optimize it. In term of Lean Six Sigma, the company is still at a low maturity level. The company has implemented some basic Lean principles as 5S, but only at one of the three production sites yet. Some employees have undergone a Lean Six Sigma training (mostly Yellow Belt), but the company lacks the knowledge to implement advanced Six Sigma techniques. Company A has the ambition to increase the Lean Six Sigma maturity of the organization by introducing more Lean Six Sigma projects.

4.2.1.2 Company B

Company B is an assembly company with three different industries in the Netherlands. The company operates out of multiple locations and focuses on logistics and assembly. One interview is conducted with the quality manager and implementer of the EAS, and one interview is conducted with a quality engineer and user of the system.

Company B started with the implementation of a Quality Management System (QMS) in 2023 to achieve higher quality controls and standardize work processes. The quality manager was the key implementer and led the project with external consultants and key users of the system. According to both participants of the interviews, the implementation process is still ongoing but has already shown significant benefits for the organization. The visibility and accessibility of documentation of key processes is improved and inefficiencies are reduced. Automation of manual tasks has ensured that employees can work more efficiently. Company B did also encounter issues where some users struggled to adapt to the new system and data migration and automation of forms caused challenges. According to the implementer and user, the system is still in an optimization phase, where processes and the system could be improved. In general, the system is already enhancing the efficiency and effectiveness of the organization and there is optimism that once the system is fully integrated, it will enhance the results of the company. Company B is in an early stage and a low level at Lean Six Sigma maturity. They

started with adopting some basic Lean principles in workflow management and waste reduction areas. The focus is primarily on basic Lean tools as 5S and Kanban. Several employees have followed Lean trainings (Green Belt), but not with specific applications within the organization. According to the employees, Six Sigma tools are not being applied because of the nature of their processes, statistical methods are not easy to implement within their processes. The organization aims to implement more Lean principles within their daily operations, particularly to prepare for their IATF certification.

4.2.1.3 Company C

Company C is a production company within the chemical industry. The company was acquired by an Asian company in 2018, which has several subsidiaries. One interview was conducted with the Continuous Improvement Engineer and the other one was conducted with the Manager Analytical Laboratory.

In line with the acquisition of the company in 2018, they had to switch to the ERP system that all the subsidiaries of the Asian company are using. The goal of the company was to move al their subsidiaries to the same system to centralize the data and better control their processes. The transition was a huge operation, led by consultants from PwC, a project manager from the Netherlands, key users and business owners from the Netherlands and a team of employees from Asia. A FIT-GAP analysis was conducted to use the Asian templates and look for minimal adjustments to fit the processes of Company C. The goal was to integrate the standards of the Asian corporate with the needs of Company C. The implementation was a well prepared and structured process, however challenges did arise due to the limited flexibility of the new ERP system. Company C managed to adapt their processes to the corporate ERP system, from which it can be concluded that (from Asian side) the implementation process was successful. However, employees in the Netherlands are experiencing some technical issues and do not feel that the new ERP system has offered them improvements. Company C initiated a strategy based on Lean Six Sigma principles several years ago, but several reasons have caused this to never really take off. The organization applies some basic Lean principles regarding standardization and waste reduction. Within the organization there are multiple employees trained in Lean Six Sigma (Green Belt to Black Belt), but these capacities are not fully used at the moment. The company is at a low Lean Six Sigma maturity level but is aiming to further

integrate Lean Six Sigma principles to enhance the continuous improvement culture in the organization.

4.2.1.4 Company D

Company D is a manufacturing company within the Netherlands. The company has multiple locations and five plants across the Netherlands, Germany and Indonesia. The first interview was conducted with the investor of the company. The Sales & Planning coordinator and the Planner of the company were also interviewed.

Company D decided in 2018 to transition to a new ERP system for several causes, under which limited possibilities with their current system and future growth ambitions. Their aim was to find an ERP system that suits their organization and specific processes, which enables them with new opportunities. The implementation process was well managed and structured and was led by one project manager (the investor) and external project managers, supported by the key users of the system. Company D faced a delay in the live going of the system due to some internal complexities. In general, the implementation process is considered largely very successful. The implementation process was well structured and streamlined and caused the organization multiple benefits, under which process efficiency, streamlining processes, data integration and better data visibility. After the live going, the system needed minor adjustments, but overall, the implementation process went very smoothly. Company D is not really investing in Lean Six Sigma at organizational level. The company has some foundational Lean principles integrated within their processes, trained several employees (Green to Black Belts) and is using statistical methods within quality processes. Some departments are using more advanced methods (based on Six Sigma), but overall, the organization is still on a low Lean Six Sigma maturity level.

4.2.2 Cross company comparison

In this section, a cross-company comparison will be presented. The four companies are summarized in a table where the effectiveness of their EAS implementation and their Lean Six Sigma maturity level is displayed. Additionally, the key influencing factors identified from the company interviews are displayed.

In Table 4 all the factors identified through the company interviews are listed, even as the EAS implementation effectiveness, and the Lean Six Sigma maturity for each company. The EAS implementation effectiveness and Lean Six Sigma maturity were measured through analyzing the data derived from the interviews. In the cels underneath, all the relevant factors are listed among a certain implementation phase. The cells are marked with “++”, “+” or left blank. When the interviews pointed out that the company has put a lot of emphasis on a certain topic, then the cell is marked “++”. When the cell is marked with “+”, then the company has put some emphasis on this topic, according to the interview. And when the cell is left blank, then the company has put no emphasis on this topic according to the interview. The table below (Table 4) provided an overview for each organization, where the level of emphasis put on specific factors during the different implementation phases is shown.

Table 4: Cross company comparison

	Company			
	A	B	C	D
EAS implementation Effectiveness	Fair	Good	Fair	Excellent
Lean Six Sigma Maturity level	Low	Medium-low	Medium-low	Low
Pre-implementation phase				
Strategic alignment management	++	++	++	++
Visible & actively involved leaders	+	++	+	++
Leaders securing resources		++	++	+
Horizontal communication		+		+
Early employees' involvement				+
Employee buy-in		++		++
Process mapping and alignment		++	++	+
Standardization with flexibility		+		++
During implementation phase				
Continuous communication & regular updates		++	+	+
Training programs	+	+	+	+
People and resource availability		+	++	
Automation streamline workflows	+	++		
Flexibility in workflow designs		+		++
User feedback loops		+	+	+
Post-implementation / Current situation				
Perceived usefulness		++		++
Perceived ease of use		+		++
Flexibility in process adaptation				++
Continuous feedback and system refinement	+	++		
Support team / Resource center	+	+	++	

4.2.3 Comparative analysis: Company vs. Expert Interviews

This section discusses the insights gathered from the company interviews, with a specific focus on the differences compared to the expert interview results. The complete findings from the company interviews can be found in Appendix F. While both sets of interviews highlight common factors such as leadership, communication, and employee engagement, key differences emerged that offer new insights into the adoption phases of EAS. This section explores these differences, particularly focusing on factors that were not emphasized by the experts but were significant in the company interviews. The model developed from the company interviews is presented below in Figure 3. A distinction is made between the perspective of the implementers and the users of the EAS.

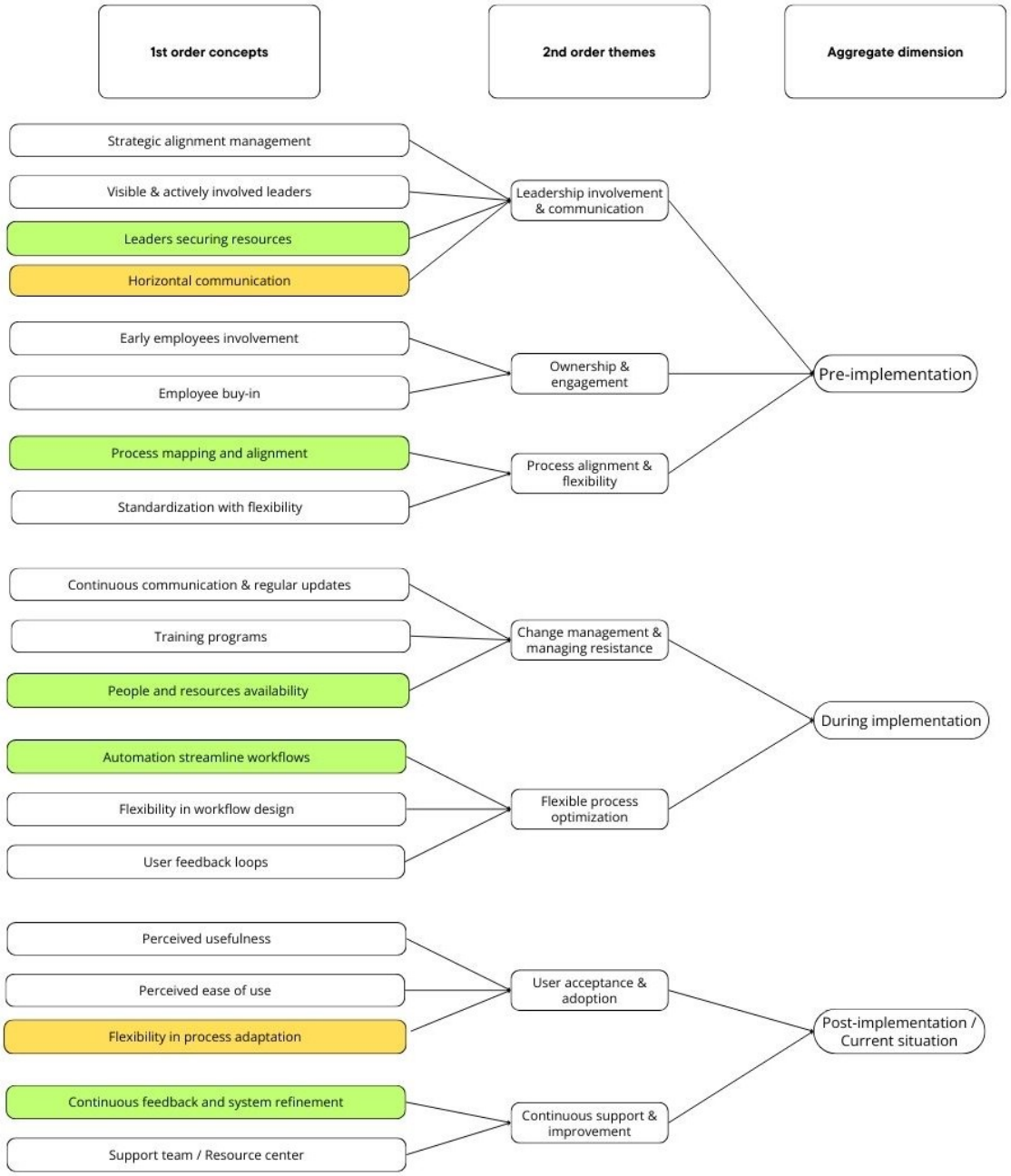

Figure 3: Model company interviews. Factors mentioned by the implementers are highlighted in green, those mentioned by the users only are marked in yellow, and factors mentioned by both are marked in white.

Both the expert and company interviews emphasized the critical role of leadership involvement, communication, and employee buy-in during the pre-implementation phase. However, the company interviews provided further detail not as prominent in the expert findings. For instance, while experts focused on top-down leadership support, companies underscored the need for leaders to be **visibly active, secure necessary resources, and facilitate horizontal communication.** In Company B, both the implementer and user stressed

the importance of leaders actively engaging with departments to align objectives and secure resources. As the implementer stated: *"The need for a new system became evident from the quality management department and senior management. The rest of the organization is small enough that a few meetings were enough to communicate this with each other."* Conversely, Company A reported communication gaps during the pre-implementation phase. Although leaders were involved in securing resources, the lack of horizontal communication presented challenges. A user from Company A remarked: *"During the process, there were some gaps in the communication, this could have gone better by informing us and updating us earlier in the process."* Another difference from the company interviews was the **involvement of employees early in the process**. While only briefly mentioned by experts, this factor is crucial for generating **employee buy-in**. In Company D, the involvement of employees in the system selection process was crucial for securing early buy-in. One of the users from Company D stated: *"We were involved from the start of the selection process. By being part of the decision-making process we were able to understand the system better and immediately see the benefits of investing in it."* Lastly, while experts emphasized **process standardization**, the company interviews shed light on the **balance between standardization and flexibility**. In Company C, the FIT-GAP analysis helped align local processes with the corporate ERP system, although flexibility challenges arose due to system constraints. As one user noted: *"We had to adjust our way of working due to the way SAP forces specific processes and methods, which led to limited flexibility within our own processes."*

Both expert and company interviews highlighted the importance of **change management and training** during the implementation phase. However, the company interviews provided additional insights into how organizations manage resistance and optimize processes. In Company B, **continuous communication and regular updates** were pivotal for managing change and aligning departmental goals. The implementer described the communication structure used to ensure everyone was informed: *"Weekly, we have a quality meeting where we discuss the points that have occurred last week. A report is made of this meeting and shared with everybody. This ensures a communication structure where everyone is informed and involved in the process."* Similarly, the companies revealed challenges in **allocating sufficient resources and personnel** during the implementation. In Company D, employees struggled to balance the implementation with their regular tasks. The implementer noted: *"People had to*

work on the project in addition to their regular tasks, and it was repeatedly sidelined because operational tasks took precedence." Another significant theme that emerged from the company interviews, but was less emphasized in the expert interviews, was **flexible process optimization**. Company B leveraged automation to streamline workflows and reduce manual tasks, significantly improving operational efficiency. A user from Company B highlighted the benefits of this automation: *"Automation behind it is amazing. A report is generated immediately, and it streamlines decision-making processes."* Meanwhile, Company D placed a strong emphasis on maintaining **flexibility in workflow design**, allowing the system to be tailored to the organization's unique needs. A user from Company D stated: *"We wanted a system that offered standardization but also allowed customization in specific areas essential to our operations. This flexibility gave us the ability to act quickly while maintaining process integrity."*

The post-implementation phase revealed some of the starkest differences between the expert and company interviews. While both groups acknowledged the importance of **user acceptance** and **ongoing system refinement**, the company interviews placed far more emphasis on **flexibility in process adaptation**. Company D, in particular, highlighted the need to maintain flexible even after the system was up and running. A user explained: *"Even after the system was up and running, we quickly realized that flexibility in adapting processes was still important. The way we worked needed to evolve over time, and our ability to adjust quickly was key to meeting our needs."* Additionally, the **importance of continuous feedback and system refinement** was strongly emphasized by all companies. Company A continually gathered user feedback to identify areas for improvement, ensuring the system remained aligned with operational needs. The implementer of Company A noted: *"Even after the live going, we are continuously looking for process improvements that enhance the system."*

The findings from both the expert and company interviews led to the development of Table 5 outlining factors that influence a successful EAS adoption.

Table 5: Influencing factors EAS adoption according expert & company interviews

Implementation phase	Category	Factor
Pre-implementation	**Leadership involvement & Communication**	Strategic alignment management
		Expectations of consequences of EAS
		Leaders support: visible and actively involved & securing resources
		Horizontal communication
	Employee involvement and engagement	Early internal stakeholder involvement
		Employee buy-in
	Process alignment: standardization & flexibility	Process mapping and alignment
		IT infrastructure readiness
		Standardization with flexibility
During implementation	**Change management & Support**	Managing resistance
		Cross-departmental coordination
		Continuous communication & regular updates
		Training programs
		People and resources availability
	Flexible process optimization: Agile and iterative development	Phased implementation
		User feedback loops
		Streamline workflows
		Flexibility in workflow design
Current situation / post implementation	**User acceptance & adoption**	Perceived usefulness
		Ease of use
		Early adopter incentive
		Flexibility in process adaption
	Continuous support & Process optimization	Process refinement
		Ongoing training

		Support team / resource center
	Continuous improvement	Data-driven decision making
		Ongoing system improvement

5. Discussion

This study explored the key social factors contributing to the successful adoption of EAS in companies implementing Lean Six Sigma. Key findings, structured around three different implementation phases: pre-implementation, during implementation, and post-implementation/current situation, were discovered through expert and company interviews. This section discusses the findings and compares them to existing literature, providing a new perspective on the role of social factors in EAS implementations. Therefore, the following research question is answered by presenting a new model with influencing factors, along with an explanation of how these factors can be leveraged to successfully manage an EAS adoption process: “What are the key social factors, and how are they contributing to the successful adoption of EAS in companies implementing Lean Six Sigma?”. In this section both the theoretical and practical implications are presented, as well as the limitations and further research.

5.1 Theoretical implications

This study presents a fresh perspective on the role of social factors in EAS implementations within Lean Six Sigma contexts. While several findings align with existing literature, this study contributes new insights, particularly on how these factors can be leveraged throughout different phases of implementation. The insights gathered reveal critical aspects that influence EAS adoption success, providing a foundation for future research on managing these factors strategically.

The first key finding is the significant role of leadership involvement and communication during the pre-implementation phase. Visible and actively involved leaders are crucial for EAS adoption within an organization, aligning with Taqi et al. (2023), who argue that active leadership helps mitigate resistance and fosters a shared sense of purpose. Additionally, this research highlighted that leaders must ensure that sufficient resources are allocated to

support the organization and their employees during the implementation. Another critical factor mentioned by the participants is the alignment of the organization's strategy with the selection of a new EAS. Company D for example demonstrated a strong correlation between the strategic objectives and the choice for the new EAS, contributing to the success of their implementation. The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) emphasize that clear communication is essential to promote perceived usefulness and ease of use of new technologies among employees (Venkatesh & Davis, 2000). This study underscores the critical role of transparent communication about both the positive and negative aspects of EAS implementation to reduce uncertainty and enhance employee buy-in. However, it introduces a nuanced perspective by emphasizing the importance of horizontal communication, ensuring that employees are actively involved and informed throughout the process. This study proposes that early and sustained leadership involvement, emphasizing horizontal communication, not only mitigates resistance but also contributes to long-term success.

> *Proposition 1: Early and sustained leadership involvement, with transparent and horizontal communication, is essential for mitigating resistance and ensuring successful, long-term EAS adoption.*

This leads to the next critical point: early employee involvement and engagement. The experts emphasized the importance of stakeholder mapping and creating early internal stakeholder involvement. This was confirmed by the company interviews and closely linked to achieving employee-buy in. The interviews further underscored that early involvement of employees in the selection process fosters a sense of ownership and strengthens employee buy-in for the system. This aligns with the findings of Shibly et al. (2022), who stated that employee engagement is crucial in technology acceptance. Recent studies on Lean methodologies emphasized that involving employees early in the process contributes to a smoother implementation by leveraging their knowledge of the current processes and systems (Bueno et al., 2023). The implementer from Company D identified this as one of the key benefits of early employee involvement, reinforcing the importance of their participation from the outset. The findings of this study suggest that, in addition to leveraging employees' knowledge, early involvement in the selection and design phase instills a sense of ownership that facilitates a smoother transition and increases the likelihood of successful adoption. This insight expands

upon existing literature by highlighting that early involvement not only aids in technology acceptance but also supports a more efficient and cohesive implementation process.

> *Proposition 2: Early involvement of employees in the selection and design phases of EAS implementation fosters ownership, enhances user acceptance, and contributes to a smoother transition, ultimately improving overall EAS adoption.*

The final aspect of the pre-implementation phase is process alignment, specifically balancing standardization with flexibility. Experts in this study emphasized the importance of standardizing and documenting processes before EAS implementation, especially through Lean methods such as process mapping. This aligns with Tortorella et al. (2018), who argue that standardization and process mapping are essential to successful Lean and Industry 4.0 implementations, ensuring that the EAS aligns with organizational workflows. However, this study adds a new perspective by highlighting the need to audit IT infrastructure readiness as part of the pre-implementation phase. Experts emphasized that assessing the compatibility of existing IT infrastructure is critical to avoid misalignment and integration issues during EAS adoption. This additional step ensures that the technical foundation can support the new system, a factor often overlooked in process alignment literature. The interviews further underscored the need to balance standardized processes with flexibility. Several companies stressed the importance of adaptable workflows to meet specific operational needs, suggesting that flexibility is essential for system longevity and responsiveness. This study, therefore, proposes a dual approach of process standardization combined with adaptable frameworks, enhancing both system integration and operational flexibility.

> *Proposition 3: Effective EAS implementation requires a dual approach of standardized process alignment and flexible workflows, along with thorough IT infrastructure audits to ensure technical readiness and adaptability to specific organizational needs.*

The literature frequently highlights that resistance to change is a common challenge during the implementation phase of EAS. Research by Markus et al. (2000) suggests that such resistance often arises from poor communication and misaligned expectations, leading to employee concerns and fear of the unknown. Existing frameworks, such as the Technology Acceptance Model (TAM), emphasize the importance of perceived ease of use and perceived usefulness to foster user acceptance of new technologies (Bagozzi & Warshaw, 1992). While

the literature identifies the factors contributing to resistance, it lacks a focus on practical strategies to address these challenges effectively.

This study contributes by offering actionable solutions to manage resistance throughout the EAS implementation process. Findings from expert and company interviews indicate that continuous communication, tailored training programs, and adequate resource allocation are essential for reducing employee uncertainty and fostering acceptance. Regular updates, feedback loops, and open communication were found to be effective in aligning expectations and minimizing resistance. For instance, Companies B and C implemented continuous communication mechanisms to keep employees informed about the progress, helping to manage expectations and build support for the new system.

Furthermore, this research underscores the value of tailored training programs, which not only improve employees' confidence and competence with the new system but also enhance perceived ease of use and perceived usefulness. This aligns with Shibly et al. (2022), who confirmed that on- and off-the-job training significantly influences technology adoption. Additionally, Company D highlighted the need for resource availability, noting that employees were often overwhelmed by their regular tasks alongside implementation demands. Thus, adequate allocation of personnel and time resources is essential to ensure a smoother, less disruptive implementation process. This study adds to the literature by not only identifying resistance factors but also presenting practical approaches to mitigate them, specifically through structured communication, targeted training, and resource allocation.

> *Proposition 4: Managing resistance to EAS implementation requires a proactive approach involving continuous communication, tailored training, and sufficient resource allocation, as these strategies reduce uncertainty, improve user acceptance, and facilitate a smoother transition.*

The interviews emphasized the benefits of using Agile and iterative development during EAS implementations. Agile methodologies like Scrum facilitate a phased implementation, helping to minimize disruptions and allow for continuous refinement and improvement. Literature on Industry 4.0 technologies and Lean Six Sigma confirm the benefits of applying iterative processes to ensure a smooth transition during EAS implementations (Bueno et al., 2023). Shibly et al. (2022) and Taqi et al. (2023) emphasize the importance of gathering user feedback during the implementation phase to reduce resistance and enhance user acceptance of the

EAS. However, the interviews in this study add new insights. They highlight that, in addition to improving user acceptance, feedback loops ensure that processes are well-organized, and that the system remains aligned with the organization's operational needs.

> *Proposition 5: Integrating Agile methodologies and continuous feedback mechanisms during EAS implementation aligns the system with organizational needs and enhances user acceptance.*

The post-implementation phase is recognized in the literature as a critical stage for embedding a new EAS within an organization, optimizing functionality, and enhancing user acceptance and system usage. According to the Technology Acceptance Model (TAM), perceived usefulness and ease of use are particularly important in this phase, as they directly impact technology adoption. Shibly et al. (2022) further underscores this, highlighting that employees' initial experiences with the system can significantly shape their long-term engagement. Additionally, research indicates that employees are more motivated to adopt a new system when it brings tangible improvements to their daily tasks. To support continuous user acceptance, many studies stress the need for ongoing system and process support. Shibly et al. (2022) notes that regular training is essential for keeping users up-to-date, particularly in dynamic and evolving work environments. Company C in this study echoed the need for ongoing technical support post-implementation. This study contributes further by emphasizing the importance of post-implementation support structures. Findings suggest that establishing a dedicated support team or resource center is essential to provide technical assistance and maintain user engagement. Regular training sessions tailored to evolving user needs ensure that employees remain competent and motivated, reducing the risk of system underuse over time.

> *Proposition 6: Effective post-implementation support requires both ongoing training and a dedicated support team to sustain user acceptance, enhance user engagement, and prevent system underuse.*

In addition to support, process and system refinement emerged as a crucial area for ongoing improvement. Tortorella et al. (2018) argue that process optimization should continue beyond the system's go-live phase, with feedback loops helping to ensure that processes stay aligned with organizational goals and evolving needs. This study adds to these insights by showing that continuous feedback loops and data-driven decision-making are instrumental for EAS

performance. Interviews revealed that regularly measuring user input and monitoring system performance supports data-driven decisions, allowing for targeted improvements in the EAS. Agile methodologies implemented by companies in this study facilitated iterative refinements to workflows, enhancing system flexibility and addressing operational challenges as they arose.

> *Proposition 7: Continuous process and system refinement, supported by feedback loops and data-driven decision-making, is essential for maintaining a successful EAS adoption.*

To conclude, this study provides significant contributions to the existing literature on EAS adoption by emphasizing the importance of a phased approach and the strategic role of social factors throughout the implementation process. While prior research has predominantly focused on identifying individual factors that support EAS adoption, this study advances the understanding of how these factors can be practically leveraged across different phases—pre-implementation, during implementation, and post-implementation. This phased model, with a focus on iterative feedback loops and continuous communication structures, offers a flexible and adaptable framework that recognizes EAS adoption as an ongoing process, rather than a single, event. A unique contribution of this study is the emphasis on post-implementation activities, such as dedicated support teams and tailored, ongoing training, alongside continuous process and system refinement. These factors are seldom discussed in previous literature, and their inclusion here highlights their essential role in sustaining user engagement and optimizing system functionality over time. Additionally, Lean Six Sigma methodologies, such as process mapping and iterative development, were found to facilitate successful EAS implementations by providing a structured approach to standardizing workflows while allowing necessary flexibility. Lean Six Sigma principles not only support process alignment and system integration but also contribute to creating a socially inclusive environment where employee engagement and continuous improvement are prioritized.

The findings of this study have led to the development of a conceptual framework of influencing factors, grounded in insights from expert interviews and company case studies. This framework illustrates the propositions and their interrelationships, as depicted in Figure 4. The practical implications section will discuss how organizations can utilize this model to manage a successful implementation.

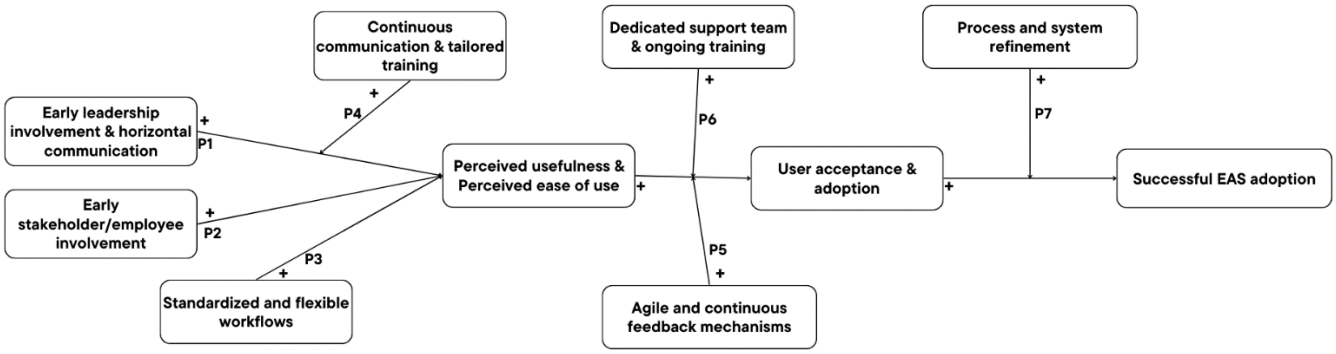

Figure 4: conceptual framework of propositions

5.2 Practical implications

This study proposes a practical guideline for implementing EAS, in combination with the use of Lean Six Sigma methodologies. The guideline is based on the insights from expert experiences in EAS implementations, and on the insights derived from interviews conducted within companies that have implemented an EAS within the past six years. The guideline is structured around the three main phases and is presented in the table below.

Table 6: Practical guideline EAS implementation

	Pre-implementation	**During implementation**	**Current situation / post implementation**
Leadership	Provide horizontal communication & clarify expectations of the EAS	Managing resistance through continuous communication	Set up a dedicated support team / resource center
	Active participation from leaders in implementation process	Provided tailored training programs	Provide ongoing training
	Align strategy organization with implementation of EAS		

Employee involvement and engagement	Identify and engage employees early in the process		Create early adopters
			Ensure high perceived usefulness & perceived ease of use
Process alignment	Use process mapping for standardized and flexible processes	Use Agile approach with a phased implementation process & feedback loops	Refine processes
	Ensure IT infrastructure readiness	Streamline workflows	Use data for ongoing system improvement

The implementation process is split up into the three different phases. Furthermore, there is made a distinction between three main themes. Those themes are leadership, employee involvement and engagement, and process alignment.

During the pre-implementation phase, it is crucial for leaders to establish horizontal communication across all departments and levels of the organization to ensure that everyone is updated and included within the decision-making process. Furthermore, it is important to map out the consequences that the EAS implementation will bring, both positively and negatively. The implementation should align with the broader strategic goals of the organization, meaning that the selected EAS should contribute to these strategic goals. Identifying internal stakeholders early in the process is key, particularly key users who will be directly affected by the new system. Those internal stakeholders/employees should be involved and engaged in the process to create ownership and reduce resistance among the employees. Process mapping can be employed to outline organizational workflows, standardize processes where possible, while maintaining flexibility for process adaptation. Finally, the IT infrastructure of the organization has to be reviewed to ensure it can support the new EAS effectively.

When the preparation phase is completed and the actual implementation begins, the role of leadership becomes even more critical. Managing resistance is a challenge faced in every change management project, and during the EAS implementation, this can be addressed through a continuous communication framework. Regular updates should be organized to address concerns, communicate progress and mitigate uncertainty. Leadership should also design and deliver training sessions tailored to different user groups to ensure that employees are prepared to work with the new system and feel comfortable using it. Process design remains important during this phase. Recommended is to apply an Agile approach, utilizing a phased implementation process with regular user feedback loops. Agile methods can be applied to break the implementation into manageable phases, minimizing disruptions and allowing for early feedback gathering. This iterative approach ensures that the organization is able to constantly review and refine the processes, making necessary adjustments to reduce risks associated with the implementation. With this approach it is important to eliminate inefficiencies and streamline the workflows within the new EAS.

Leadership plays an even more crucial role when the system goes live. In this first period, issues and questions of employees are unavoidable. Setting up a support team or resource center is therefore crucial. This team should consist of experts who can provide the users with quick and adequate responses and adjust when necessary. Additionally, offering continuous training opportunities to keep users informed about new features and best practices can optimize the system's effectiveness within the organization. This will also ensure that employees feel more comfortable and confident in using the system, fostering a higher perceived usefulness and perceived ease of use among the employees. It is essential to ensure that both perceived usefulness and ease of use remain high in employees' minds, as these factors are key to achieving a high adoption rate. Regularly assessing their perceived ease of use and perceived usefulness, and adjusting where necessary, ensures that the EAS is easy to use and offers value to the employees of the organization. This adoption rate can also be improved by identifying influential employees within the company and position them as early adopters. These early users can help build excitement and generate broader support for the system among the workforces. The final focus is on process refinement. When the EAS is implemented, it is essential to constantly evaluate and refine the processes to align the system capabilities with the evolving needs, therefore the often-mentioned flexibility in this study is essential.

Leveraging data-driven decision-making processes can be instrumental in analyzing system performance and user feedback, helping to identify areas for improvement and ensuring that the EAS continues to meet the organization's goals.

These practical steps provide a framework for organizations to effectively implement an EAS while ensuring its long-term functionality and usefulness. Leadership, employee engagement, and process alignment serve as the central themes that guide the entire implementation process.

5.3 Limitations and future research

This study provides several contributions to both the literature on EAS implementations in Lean Six Sigma environments and practical implications for companies implementing these systems. However, there are also limitations of this study and future research avenues to address.

The mixed research method used in this study necessitated making choices in selecting experts and companies to interview. As a result, only a limited number of companies was interviewed, and this small sample size restricts the generalizability of this research. Another limitation is the small sample size within the case studies, with a maximum of three individuals interviewed per company, making it challenging to draw broad conclusions about the specific implementation processes. This was a known limitation of this qualitative research, which was chosen to gain deeper insights into EAS implementations. The focus on companies using Lean Six Sigma methodologies is a key specialization of this study but can also be considered a limitation. While this context was crucial for understanding the impact of continuous improvement methodologies, it may limit the framework's applicability for organizations not employing Lean Six Sigma. The companies interviewed for this study operate within the production industry, which may pose challenges for generalizing the findings and applying the model to industries outside of manufacturing. The last limitation is the cross-sectional design of this study. Although the implementation process is divided into distinct phases, data was collected from interviews conducted at a single point in time, making it difficult to capture the full range of dynamics. Moreover, since EAS implementations are ongoing and evolve over time, and the companies interviewed implemented their systems at different stages, this variability makes it difficult to draw straight comparisons.

Future research can address the limitations of this study and expand and build on the findings this research. A future study can focus on increasing the sample size of interviewed companies and explore organizations from various industries to enhance the generalizability of the findings. Another suggestion is to conduct an in-depth case study focusing on one or two companies implementing an EAS, with a larger sample of participants within each case. Interviewing more employees would provide richer data and allow for stronger, more robust conclusions. To further validate the findings of this study, future research could apply this model within a company that is aiming to implement a new EAS. The proposed practical guide could be used alongside the technical aspects of implementation, helping to manage the process and offering an opportunity to test the model, and therefore validate the findings of this study. Finally, future studies could adopt a mixed-method approach, combining qualitative and quantitative research. Using quantitative methods, such as surveys, would allow for broader validation and generalization of the findings, ultimately strengthening the framework and increasing its applicability across different contexts.

6. Conclusion

This study aimed to explore the key social factors influencing the successful adoption of EAS within companies using Lean Six Sigma methodologies. Through integrating a literature review, expert interviews and case studies of companies that have implemented a new EAS within the past six years, this study proposed a new model with influencing factors across different time phases in the implementation process. This new model contributes to the existing literature, while offering a practical guide to manage an EAS implementation for organizations at the same time. The findings reveal several elements that are crucial throughout the implementation processes such as leadership involvement, the use of horizontal and vertical communication, employee involvement and engagement, and the importance of process alignment. While previous studies have focused on identifying social factors influencing the implementation process, this research provides a phased model that underscores how these social factors can be applied to manage a successful EAS adoption. The emphasis on ongoing support and iterative developments introduces a new perspective in the literature, highlighting that a successful EAS implementation is not a one-time effort but an evolving process of continuous adaptation and optimization. This study does not only bride the existing gap in the

literature, but also offers a practical framework for organizations trying to manage a successful EAS adoption. These findings can be further applied in future research aiming for generalization and validation.

7. References

Abrams, L. S. (2010). Sampling 'Hard to Reach' Populations in Qualitative Research:The Case of Incarcerated Youth. *Qualitative Social Work*, *9*(4), 536-550. https://doi.org/10.1177/1473325010367821

Adeoye-Olatunde, O. A., & Olenik, N. L. (2021). Research and scholarly methods: Semi-structured interviews. *Jaccp: Journal of the American College of Clinical Pharmacy*, *4*(10), 1358-1367. https://doi.org/10.1002/jac5.1441

Ahmad, M. M., & Pinedo Cuenca, R. (2013). Critical success factors for ERP implementation in SMEs. *Robotics and Computer-Integrated Manufacturing*, *29*(3), 104-111. https://doi.org/https://doi.org/10.1016/j.rcim.2012.04.019

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In J. Kuhl & J. Beckmann (Eds.), *Action Control: From Cognition to Behavior* (pp. 11-39). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-69746-3_2

Al-Gahtani, S. S., Hubona, G. S., & Wang, J. (2007). Information technology (IT) in Saudi Arabia: Culture and the acceptance and use of IT. *Information & Management*, *44*(8), 681-691. https://doi.org/https://doi.org/10.1016/j.im.2007.09.002

Al-Gahtani, S. S., & King, M. (1999). Attitudes, satisfaction and usage: Factors contributing to each in the acceptance of information technology. *Behaviour & Information Technology*, *18*(4), 277-297. https://doi.org/10.1080/014492999119020

Al-Mashari, M., Al-Mudimigh, A., & Zairi, M. (2003). Enterprise resource planning: A taxonomy of critical factors. *European Journal of Operational Research*, *146*(2), 352-364. https://doi.org/10.1016/s0377-2217(02)00554-4

Bagozzi, R. P., & Warshaw, P. R. (1992). An Examination of the Etiology of the Attitude-Behavior Relation for Goal-Directed Behaviors. *Multivariate Behavioral Research*, *27*(4), 601-634. https://doi.org/10.1207/s15327906mbr2704_6

Barker, H., & Ishizu, M. (2012). Inheritance and continuity in small family businesses during the early industrial revolution. *Business History*, *54*(2), 227-244. https://doi.org/10.1080/00076791.2011.631117

Bourgeault, I., de Vries, R., & Dingwall, R. (2010). *The SAGE Handbook of Qualitative Methods in Health Research*. Sage. http://digital.casalini.it/9781446248461

Bueno, A., Goyannes Gusmão Caiado, R., Guedes de Oliveira, T. L., Scavarda, L. F., Filho, M. G., & Tortorella, G. L. (2023). Lean 4.0 implementation framework: Proposition using a multi-

method research approach. *International Journal of Production Economics*, *264*. https://doi.org/10.1016/j.ijpe.2023.108988

Cañas, H., Mula, J., Díaz-Madroñero, M., & Campuzano-Bolarín, F. (2021). Implementing Industry 4.0 principles. *Computers & Industrial Engineering*, *158*. https://doi.org/10.1016/j.cie.2021.107379

Capestro, M., Rizzo, C., Kliestik, T., Peluso, A. M., & Pino, G. (2024). Enabling digital technologies adoption in industrial districts: The key role of trust and knowledge sharing. *Technological Forecasting and Social Change*, *198*, 123003. https://doi.org/https://doi.org/10.1016/j.techfore.2023.123003

Chang, M.-K., Cheung, W., Cheng, C.-H., & Yeung, J. H. Y. (2008). Understanding ERP system adoption from the user's perspective. *International Journal of Production Economics*, *113*(2), 928-942. https://doi.org/10.1016/j.ijpe.2007.08.011

Chowdhury, T., & Murzi, H. (2020). *The Evolution of Teamwork in engineering workplace from First Industry Revolution to Industry 4.0: A Literature Review*. https://doi.org/10.18260/1-2--35318

Cifone, F. D., Hoberg, K., Holweg, M., & Staudacher, A. P. (2021). 'Lean 4.0': How can digital technologies support lean practices? *International Journal of Production Economics*, *241*. https://doi.org/10.1016/j.ijpe.2021.108258

Claessens, B. J. C., Van Eerde, W., Rutte, C. G., & Roe, R. A. (2004). Planning behavior and perceived control of time at work. *Journal of Organizational Behavior*, *25*(8), 937-950. https://doi.org/https://doi.org/10.1002/job.292

Clohessy, T., & Acton, T. (2019). Investigating the influence of organizational factors on blockchain adoption. *Industrial Management & Data Systems*, *119*(7), 1457-1491. https://doi.org/10.1108/IMDS-08-2018-0365

Coleman, D. C. (1956). Industrial Growth and Industrial Revolutions. *Economica*, *23*(89), 1-22. https://doi.org/10.2307/2551266

Dalenogare, L. S., Benitez, G. B., Ayala, N. F., & Frank, A. G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, *204*, 383-394. https://doi.org/10.1016/j.ijpe.2018.08.019

Dalkey, N., & Helmer, O. (1963). An Experimental Application of the DELPHI Method to the Use of Experts. *Management Science*, *9*(3), 458-467. https://doi.org/10.1287/mnsc.9.3.458

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319-340. https://doi.org/10.2307/249008

Emerson, R. W. (2015). Convenience Sampling, Random Sampling, and Snowball Sampling: How Does Sampling Affect the Validity of Research? *Journal of Visual Impairment & Blindness*, *109*(2), 164-168. https://doi.org/10.1177/0145482x1510900215

Flick, U. (2013). *The SAGE Handbook of Qualitative Data Analysis*. SAGE Publications Ltd. http://digital.casalini.it/9781446296691

Flick, U. (2017). *The SAGE Handbook of Qualitative Data Collection*. SAGE Publications Ltd. http://digital.casalini.it/9781526416063

Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, *210*, 15-26. https://doi.org/10.1016/j.ijpe.2019.01.004

Frank, A. G., Thürer, M., Godinho Filho, M., & Marodin, G. A. (2024). Beyond Industry 4.0 – integrating Lean, digital technologies and people. *International Journal of Operations & Production Management*, *44*(6), 1109-1126. https://doi.org/10.1108/ijopm-01-2024-0069

Fuller, R. M., Vician, C., & Brown, S. A. (2006). E-Learning and Individual Characteristics: The Role of Computer Anxiety and Communication Apprehension. *Journal of Computer Information Systems*, *46*(4), 103-115. https://doi.org/10.1080/08874417.2006.11645917

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research:Notes on the Gioia Methodology. *Organizational Research Methods*, *16*(1), 15-31. https://doi.org/10.1177/1094428112452151

Hahn, G. J., Hill, W. J., Hoerl, R. W., & Zinkgraf, S. A. (1999). The Impact of Six Sigma Improvement—A Glimpse into the Future of Statistics. *The American Statistician*, *53*(3), 208-215. https://doi.org/10.1080/00031305.1999.10474462

Hameed, M. A., Counsell, S., & Swift, S. (2012). A meta-analysis of relationships between organizational characteristics and IT innovation adoption in organizations. *Information & Management*, *49*(5), 218-232. https://doi.org/https://doi.org/10.1016/j.im.2012.05.002

Hong, K.-K., & Kim, Y.-G. (2002). The critical success factors for ERP implementation: an organizational fit perspective. *Information & Management*, *40*(1), 25-40. https://doi.org/10.1016/s0378-7206(01)00134-3

Hoppit, J. (2011). The Nation, the State, and the First Industrial Revolution. *Journal of British Studies*, *50*(2), 307-331. http://www.jstor.org.ezproxy2.utwente.nl/stable/23265314

Hwang, B.-G., Ngo, J., & Teo, J. Z. K. (2022). Challenges and Strategies for the Adoption of Smart Technologies in the Construction Industry: The Case of Singapore. *Journal of Management in Engineering*, *38*(1), 05021014. https://doi.org/doi:10.1061/(ASCE)ME.1943-5479.0000986

Ibrahim, A., & Kumar, G. (2024). Selection of Industry 4.0 technologies for Lean Six Sigma integration using fuzzy DEMATEL approach. *International Journal of Lean Six Sigma*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/IJLSS-05-2023-0090

Jeschke, S., Brecher, C., Meisen, T., Özdemir, D., & Eschert, T. (2017). Industrial Internet of Things and Cyber Manufacturing Systems. In S. Jeschke, C. Brecher, H. Song, & D. B. Rawat (Eds.), *Industrial Internet of Things: Cybermanufacturing Systems* (pp. 3-19). Springer International Publishing. https://doi.org/10.1007/978-3-319-42559-7_1

Klenke, K. (2016). References. In *Qualitative Research in the Study of Leadership* (pp. 355-392). Emerald Group Publishing Limited. https://doi.org/10.1108/978-1-78560-651-920152019

Mabert, V. A., Soni, A., & Venkataramanan, M. A. (2001). Enterprise resource planning: Measuring value. *Production and Inventory Management Journal*, *42*(3/4), 46-51. http://ut.on.worldcat.org/atoztitles/link?sid=ProQ:&issn=08978336&volume=42&issue=3%2F4&title=Production+and+Inventory+Management+Journal&spage=46&date=2001-07-01&atitle=Enterprise+resource+planning%3A+Measuring+value&au=Mabert%2C+Vincent+A%3BSoni%2C+Ashok%3BVenkataramanan%2C+M+A&id=doi:

Mandal, P., & Gunasekaran, A. (2002). Application of SAP R/3 in on-line inventory control. *International Journal of Production Economics*, *75*(1-2), 47-55. https://doi.org/10.1016/s0925-5273(01)00180-3

Marcon, É., Soliman, M., Gerstlberger, W., & Frank, A. G. (2022). Sociotechnical factors and Industry 4.0: an integrative perspective for the adoption of smart manufacturing technologies. *Journal of Manufacturing Technology Management*, *33*(2), 259-286. https://doi.org/10.1108/JMTM-01-2021-0017

Markus, M. L., Axline, S., Petrie, D., & Tanis, S. C. (2000). Learning from adopters' experiences with ERP: problems encountered and success achieved. *Journal of Information Technology*, *15*(4), 245-265. https://doi.org/10.1080/02683960010008944

Moore, G. C., & Benbasat, I. (1991). Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research*, *2*(3), 192-222. https://doi.org/10.1287/isre.2.3.192

Mowery, D. C. (2008). Plus ca change: Industrial R&D in the "third industrial revolution". *Industrial and Corporate Change*, *18*(1), 1-50. https://doi.org/10.1093/icc/dtn049

Nair, J., Chellasamy, A., & Singh, B. N. B. (2019). Readiness factors for information technology adoption in SMEs: testing an exploratory model in an Indian context. *Journal of Asia Business Studies*, *13*(4), 694-718. https://doi.org/10.1108/JABS-09-2018-0254

Oster, E., & Thornton, R. (2012). Determinants of Technology Adoption: Peer Effects in Menstrual Cup Take-Up. *Journal of the European Economic Association*, *10*(6), 1263-1293. https://doi.org/10.1111/j.1542-4774.2012.01090.x

Piazolo, F., & Felderer, M. (2016). Multidimensional Views on Enterprise Information Systems. *Springer International*(1). https://doi.org/10.1007/978-3-319-27043-2

Robinson, O. C. (2014). Sampling in Interview-Based Qualitative Research: A Theoretical and Practical Guide. *Qualitative Research in Psychology*, *11*(1), 25-41. https://doi.org/10.1080/14780887.2013.801543

Roe, R. A. (2008). Time in Applied Psychology. *European Psychologist*, *13*(1), 37-52. https://doi.org/10.1027/1016-9040.13.1.37

Rogers, E. (1995). *Diffusion of innovations* (Vol. 1). The Free Press.

Sætre, A. S., & Ven, A. V. d. (2021). Generating Theory by Abduction. *Academy of Management Review*, *46*(4), 684-701. https://doi.org/10.5465/amr.2019.0233

Schultze, U., & Avital, M. (2011). Designing interviews to generate rich data for information systems research. *Information and Organization*, *21*(1), 1-16. https://doi.org/https://doi.org/10.1016/j.infoandorg.2010.11.001

Shibly, H. R., Abdullah, A. B. M., & Murad, M. W. (2022). *ERP Adoption in Organizations*. https://doi.org/10.1007/978-3-031-11934-7

Subba Rao, S. (2000). Enterprise resource planning: business needs and technologies. *Industrial Management & Data Systems*, *100*(2), 81-88. https://doi.org/10.1108/02635570010286078

Tao, F., Qi, Q., Liu, A., & Kusiak, A. (2018). Data-driven smart manufacturing. *Journal of Manufacturing Systems*, *48*, 157-169. https://doi.org/https://doi.org/10.1016/j.jmsy.2018.01.006

Tao, F., Qi, Q., Wang, L., & Nee, A. Y. C. (2019). Digital Twins and Cyber–Physical Systems toward Smart Manufacturing and Industry 4.0: Correlation and Comparison. *Engineering*, *5*(4), 653-661. https://doi.org/10.1016/j.eng.2019.01.014

Taqi, H. M. M., Nur, S. M. S. A., Salman, S., Ahmed, T., Sarker, S., Ali, S. M., & Sankaranarayanan, B. (2023). Behavioural factors for Industry 4.0 adoption: implications for knowledge-based supply chains. *Operations Management Research*, *16*(3), 1122-1139. https://doi.org/10.1007/s12063-022-00338-9

Tinmaz, H. (2020). History of Industrial Revolutions: From Homo Sapiens Hunters to Bitcoin Hunters. In R. d. Rosa Righi, A. M. Alberti, & M. Singh (Eds.), *Blockchain Technology for Industry 4.0: Secure, Decentralized, Distributed and Trusted Industry Environment* (pp. 1-26). Springer Singapore. https://doi.org/10.1007/978-981-15-1137-0_1

Tortorella, G. L., Cawley Vergara, A. M., Garza-Reyes, J. A., & Sawhney, R. (2020). Organizational learning paths based upon industry 4.0 adoption: An empirical study with Brazilian manufacturers. *International Journal of Production Economics*, *219*, 284-294. https://doi.org/https://doi.org/10.1016/j.ijpe.2019.06.023

Tortorella, G. L., de Castro Fettermann, D., Frank, A., & Marodin, G. (2018). Lean manufacturing implementation: leadership styles and contextual variables. *International Journal of Operations & Production Management*, *38*(5), 1205-1227. https://doi.org/10.1108/ijopm-08-2016-0453

Tulasi, D., Lukito, R., Wahyu, D., & Ellitan, L. (2019). The Role of Leadership in Industrial Revolution 4.0 1. 2394-9333.

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, *46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Wood, T., & Caldas, M. P. (2001). Reductionism and complex thinking during ERP implementations. *Business Process Management Journal*, *7*(5), 387-393. https://doi.org/10.1108/14637150110406777

Xu, L. D. (2011). Enterprise Systems: State-of-the-Art and Future Trends. *IEEE Transactions on Industrial Informatics*, *7*(4), 630-640. https://doi.org/10.1109/TII.2011.2167156

Zhang, Y., Ren, S., Liu, Y., & Si, S. (2017). A big data analytics architecture for cleaner manufacturing and maintenance processes of complex products. *Journal of Cleaner Production*, *142*, 626-641. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.07.123

Appendices

Appendix A: Semi-structured expert interview guide

Thank you for participating in this interview. I would like to briefly explain what the research is about and what your participation entails.

This research is being conducted as part of my Master's in Business Administration at the University of Twente. Commissioned by the organization Symbol, this research focuses on the social factors and how they can contribute to the successful adoption of an Enterprise Application System/ERP system. The following research question has been formulated:

What are the key social factors, and how are they contributing to the successful adoption of EAS in companies implementing Lean Six Sigma?

The goal of this interview is to uncover the main success factors and examine how they can contribute to a successful adoption. Before we start the interview, I would like to go over a few details with you:

- Your participation is entirely voluntary. You can stop the interview at any time.
- Your answers will be treated confidentially and will not be attributed to you as an individual.
- The interview will last about 60 minutes.
- The conversation will be recorded for analysis.

If you have no further questions, I would like to ask for your verbal consent to begin the interview.

The interview consists of several parts. First, I want to identify what constitutes a successful adoption/implementation and how this can be measured. We will then move on to social factors that can influence an EAS adoption, followed by organizational factors, and finally behavioral or other relevant factors. The interview will conclude with a discussion on Lean Six Sigma.

Table 7: Semi-structured interview guide experts

Topics	
Introduction	Can you briefly introduce yourself? What is your role, your connection to EAS, your experience in this field and which systems have you worked with/implemented?
	How long have you worked at this company? What specific responsibilities did you have during the EAS implementation?
Measuring variables for EAS adoption	What, in your view, determines the successful adoption of EAS? What are the key performance indicators for measuring successful adoption?
	I have provided you with a list of variables to measure the level of EAS adoption. How important are these variables according to you? Can you think of other variables that are important for measuring EAS adoption?
Influencing factors in EAS adoption	What do you consider the most important factors that influence the successful implementation and adoption of EAS in companies?
	From the list of factors I have sent you, which do you consider most and least important for a successful EAS adoption?
	Can you provide examples of how these factors have influenced an adoption process? How are these factors linked to adoption?
	How do these factors influence the adoption process in different phases (pre-implementation, during implementation, and current situation)?
	How can these factors be used to improve EAS adoption?
	Are there any factors we have not discussed that you consider important?
Lean Six Sigma	Are you familiar with Lean and/or Six Sigma methodologies?
	How do these methods influence the EAS adoption process?

	Is there an interaction between Lean Six Sigma implementation and EAS? Do they influence each other mutually? How can Lean Six Sigma methods be used in the adoption of EAS? Can you give examples?
Conclusion	Is there anything you would like to add that we have not discussed? Do you have any recommendations to improve EAS adoption based on your experiences?

I would like to sincerely thank you for your time and effort.
What did you think of the interview? Do you have any tips or suggestions for improvement for next time?
Are you interested in the results of the research? I would be happy to share them with you.
If you have any questions or additional thoughts, please feel free to contact me via email or phone.

Appendix B: Semi-structured interview guide managers/implementers

Thank you for participating in this interview. I would like to briefly explain what the research is about and what your participation entails.
This research is being conducted as part of my Master's in Business Administration at the University of Twente. Commissioned by the organization Symbol, this research focuses on the social factors and how they can contribute to the successful adoption of an Enterprise Application System/ERP system. The following research question has been formulated:

> *What are the key social factors, and how are they contributing to the successful adoption of EAS in companies implementing Lean Six Sigma?*

In this interview, we want to explore your perspective as a manager or person responsible for implementation, learning more about your involvement in the implementation and adoption of the EAS within your organization. We aim to focus on the factors that you believe determine successful adoption and how these factors can be influenced. Before we begin, I would like to review a few details with you:

- Your participation is entirely voluntary. You can stop the interview at any time.

- Your answers will be treated confidentially and will not be attributed to you or your organization.
- The interview will last approximately 45 minutes.
- The conversation will be recorded for analysis.

If you have no further questions, I would like to ask for your verbal consent to start the interview.

The interview consists of several parts. First, we will discuss what, in your view, constitutes successful EAS adoption and how this is measured within your organization. Then, we will delve into the factors that can influence the adoption process, concluding with a discussion on the role of Lean Six Sigma.

Table 8: Semi-structured interview guide managers/implementers

Topics	
Introduction	Can you briefly introduce yourself? Can you tell me about your role, the EAS implementation, and your involvement in the implementation/transformation process?
Measuring variables for EAS adoption	What specific goals or outcomes did you aim to achieve with the EAS? What were the results? What were the key performance indicators to measure this?
	How do you feel the system was implemented in your organization? Can you give specific examples of how the EAS has improved or changed your daily operations?
Influencing factors in EAS adoption	To what extent did you consider social and organizational factors (in addition to technical factors) during the implementation? What do you consider the most important (social and organizational) factors that influenced the EAS implementation in your organization?
	Can you share examples of specific situations during your EAS implementation/adoption process where these factors played a role?

	How did you leverage these factors to influence adoption? Were there specific strategies you used? Is there anything you would do differently now?
	How do these factors influence the adoption process in different phases (pre-implementation, during implementation, and current situation)?
	I have developed a model based on initial interviews with EAS implementation experts. This model outlines factors that can contribute to successful EAS implementation. What are your thoughts on this? Are these factors recognizable to you? What is your opinion on them?
	Are there any factors you think we haven't discussed?
Lean Six Sigma	Which Lean Six Sigma methods do you use within the organization? How mature do you find your organization in terms of Lean Six Sigma (methods used, trained personnel, ongoing projects)? How have these methods contributed to a successful adoption? Is there a mutual interaction between Lean Six Sigma and EAS adoption? Can you provide examples?
Conclusion	Is there anything you would like to add that we haven't discussed? Do you have any recommendations to improve EAS adoption based on your experiences?

I would like to sincerely thank you for your time and effort.

What did you think of the interview? Do you have any tips or suggestions for improvement for next time?

Are you interested in the results of the research? I would be happy to share them with you.

If you have any questions or additional thoughts, please feel free to contact me via email or phone.

Appendix C: Semi-structured interview guide users/operational employees

Thank you for participating in this interview. I would like to briefly explain what the research is about and what your participation entails.

This research is being conducted as part of my Master's in Business Administration at the University of Twente. Commissioned by the organization Symbol, this research focuses on the social factors and how they can contribute to the successful adoption of an Enterprise Application System/ERP system. The following research question has been formulated:

> *What are the key social factors, and how are they contributing to the successful adoption of EAS in companies implementing Lean Six Sigma?*

In this interview, we want to explore your perspective as a user of the system, learning more about your involvement in the implementation and adoption of the EAS within your organization. We want to focus on how the system has affected your daily work, how you perceive the implementation, and what factors have influenced this process. Before we begin, I would like to review a few details with you:

- Your participation is entirely voluntary. You can stop the interview at any time.
- Your answers will be treated confidentially and will not be attributed to you or your organization.
- The interview will last approximately 45 minutes.
- The conversation will be recorded for analysis.

If you have no further questions, I would like to ask for your verbal consent to start the interview.

The interview consists of several parts. First, we will discuss what, in your view, constitutes successful EAS adoption and how this is measured within your organization. Then, we will delve into the factors that can influence the adoption process, concluding with a discussion on the role of Lean Six Sigma.

Table 9: Semi-structured interview guide operational employees/users

Topics	
Introduction	Can you briefly introduce yourself? Can you tell me about your role within the company and your involvement in the implementation and use of the EAS?

Measuring variables for EAS adoption	What specific goals or outcomes did your organization aim to achieve with the EAS? What were the results? What were the key performance indicators to measure this?
	How do you feel the system was implemented in your organization? Can you give specific examples of how the EAS has improved or changed your daily work?
Influencing factors in EAS adoption	To what extent were social and organizational factors (in addition to the technical setup) considered during the implementation in your organization? What do you consider to be the key (social and organizational) factors that influenced the implementation of the EAS in your organization?
	Can you share examples of specific situations during your EAS implementation/adoption process where these factors played a role?
	(How) did the organization try to use these factors to promote the implementation? What do you think could have been done differently? What was not given enough attention?
	How do these factors influence the adoption process of EAS in the different phases (pre-implementation, during implementation, and the current situation)?
	In my first round of interviews, I spoke with several experts on EAS implementations, from which I developed the following model. This model describes factors that contribute to a successful EAS implementation. What do you think of this model? Do you recognize these factors? What do you think of it?
	Are there factors we haven't discussed yet that you think are relevant?
Lean Six Sigma	What Lean Six Sigma methods are used within your organization? How mature do you think your organization is in terms of Lean Six Sigma (methods used, trained people,

	ongoing projects)? (How) have these methods contributed to successful adoption? Is there an interaction (does one influence the other, or do they affect each other)? Can you give examples?
Conclusion	Is there anything you would like to add that we haven't discussed yet? Do you have any recommendations to improve EAS adoption based on your experiences?

I would like to sincerely thank you for your time and effort.

What did you think of the interview? Do you have any tips or suggestions for improvement for next time?

Are you interested in the results of the research? I would be happy to share them with you.

If you have any questions or additional thoughts, please feel free to contact me via email or phone.

Appendix D: Influencing factors EAS adoption

Table 10: Social, organizational and behavioral factors influencing EAS adoption literature

Factor Category	Merged Factor
Social factors	Peer influence
	Image
	Social Network
Organizational Factors	Training and Expertise
	Managerial Support and Leadership
	Incentives and Rewards
	Organizational Culture and Strategic Orientation
	Teamwork and Communication
	Trust and Transparency

Behavioral Factors	Perceived Ease of Use
	Perceived Usefulness
	Personal innovativeness
	Prior experience
	Enjoyment with Innovation
	Motivation

Appendix E: Influencing factors EAS adoption expert interviews

Table 11: Influencing factors EAS adoption according expert interviews

Implementation phase	Category	Factor
Pre-implementation	**Leadership & Communication**	Strategic alignment management
		Expectations of consequences of EAS
		Leadership support
	Employee involvement and engagement	Internal stakeholder involvement
		Employee buy-in
	Process standardization	Process mapping and alignment
		IT infrastructure readiness
During implementation	**Change management & Support**	Managing resistance
		Cross-departmental coordination
		Continuous communication & regular updates
		Training programs
	Agile and iterative development	Phased implementation
		User feedback loops
Current situation / post implementation	**User acceptance & Motivation**	Perceived usefulness
		Ease of use
		Early adopter incentive
	Continuous support & Process optimization	Process refinement
		Ongoing training
		Support team / resource center

	Continuous improvement	Data-driven decision making
		Ongoing system improvement

Appendix F: Detailed results company interviews

Pre-implementation

Similar to the expert interviews, the results of the company interviews are subdivided into the three different implementation phases. Through the company interviews information is gathered on how these factors are applied within the specific implementation processes for the four companies. The model is constructed based on the Gioia methodology, similar as the model for the expert interviews. However, there is made a distinction between the perspective of the implementer of the system and the users of the system. The factors mentioned by the implementers are marked with a green cell, the factors mentioned by the only the users are marked with a yellow cell, and the factors mentioned by both are marked with a white cell.

In figure 3 the first phase of the EAS implementation process is made visible, the pre-implementation phase. The structure of this model is similar to the one constructed from the expert interviews, however there are a few small changes. The factors are built around three key themes: Leadership involvement & communication, Ownership & engagement, and Process alignment & flexibility.

The companies mentioned the importance of leadership involvement and communication during the implementation process, as leaders provide strategy and vision, resources, and support for the process. In Company B, both the implementer and user emphasized the importance of leaders securing resources during the implementation process and ensure that all departments are aligned with the organizational project goals. Leaders were actively involved in the project by decision-making and resource allocation. The implementer from Company B mentioned: *"The need for a new system became evident from the quality management department and senior management. The rest of the organization is small enough that a few meetings were enough to communicate this with each other."* This is also reflected in table 4, where it is visible that Company B placed a lot of emphasis on leadership involvement and strategic alignment. Resources were secured by the managers and cross-departmental coordination was secured.

Company A highlighted gaps in the communication from the management of the organization. Leaders were involved in securing resources, but the communication was mostly top-down and not horizontal, which caused some problems. The user from Company A mentioned: *"And then we had to transition to the new ERP system. During the process there were some gaps in the communication, this could have gone better by informing us and updating us earlier in the process."*

The leaders from Company D were highly involved within the project. The leaders ensured that the system selection was aligned with the strategic goals of the organization, and they fostered an open communication across the organization where all opinions were taken into account. The users from Company D mentioned the importance of involved leaders: *"He was highly involved within the project. The system selection was aligned with the strategic goals and cross-departmental communication was ensured. He was leading by example."*

The second theme mentioned by the companies is ownership & engagement of the employees. Employees who are earlier involved in the process, are more likely to take ownership of the system and invest in it. In the implementation process for Company D the employees were involved in the earliest stage of the implementation process, the selection procedure. Users of the system were engaged in workshops regarding the system selection. This ensured that employees were involved immediately, causing employee buy-in within the system. The users from Company D mentioned the following: *"We were involved from the start of the selection process. By being part of the decision-making process, we were able to understand the system better and immediately see the benefits of investing in it."*

Company B also performed well in this phase creating an early employee buy-in through giving the users ownership of the system. The implementer of Company B provides insights on his approach: *"I make it very much their own process. Everyone has their own process and form, and work within it. Technically, they could find a workaround, but because they feel a sense of ownership, they are trying to solve it within the system."*

The last part of the pre-implementation phase is about process alignment and standardization on one side, but also the allowance for flexibility on the other side. Company C conducted a FIT-GAP analysis to identify where there is a mismatch between the new ERP system and the local processes. They have tried to fit the local processes to the corporate ERP system, but due

the limited flexibility of the system, challenges did still arise. User 2 from Company D highlights one of these challenges: *"We had to adjust our way of working and our business processes due to the way how SAP forces specific processes and methods, this has led to a limited flexibility within our own processes."* However, process mapping has helped Company C to visualize all the processes and identify where certain adjustments are needed. User 1 mentioned the benefits of the process mapping process: *"First, we mapped out our processes. Based on the process mapping, we conducted a GAP analysis to identify certain gaps and mismatches between our processes and the system. Based on this GAP analysis, we knew where certain adjustments were needed."*

Company B also started the project with process mapping. All the workflows were standardized and optimized before the implementation phase started, and this helped them avoid efficiencies within the process. The implementer sketched an image of this phase: *"Our external consultant started with setting up the workflows in collaboration with the process owners, after that we standardized all the processes. This helped to map out all the processes and look for improvements."*

During implementation

The during implementation phase is also examined through company interviews, with a distinction made between the perspective of the implementers and the users. Factors mentioned by the implementers are highlighted in green, those mentioned by the users only are marked in yellow, and factors mentioned by both are marked in white.

The first part of the model is constructed on the concepts of change management and managing resistance. Resistance among employees is common in change processes, this is something where companies must deal with. Companies that use continuous communication structures with regular updates, provide training programs, and make people and resources available during the implementation process are more likely to overcome this resistance and ensure a smooth change process.

Company B has placed a lot of emphasis on continuous communication and updates, as visible in Table 4. The project progress was shared across the different departments to ensure that everyone was informed and the organizational- and departmental goals were aligned. This

information flow ensured that expectations were managed and anxiety about new processes was mitigated. The implementer from Company B highlights their communication structure: *“Weekly we have a quality meeting where we discuss the points that have occurred last week with a decision made to it. A report is made of this meeting and is shared with everybody. This ensures a communication structure were everyone is informed and involved in the process.”*

The use of training programs is another crucial element in change management. Company A emphasized the importance of training sessions to prepare employees in the new system and help them to find their way to work with the system. However, gaps in training emerged as a challenge for certain employees who are not often exposed to working with the system. The user of Company A highlighted the training challenge that occurred: *“I think we did fall short in terms of training. When the implementer explains it one-on-one, he is a good teacher. But when he must explain it to the group, it is often not very clear. Even though I am an experienced user, I often do not fully understand it.”* Company C, in contrary, adopted a very comprehensive training approach. They have not only provided initial training, but also used mentorship from experienced staff. This method helped to build trust in the system and to reduce resistance among the employees. User 1 stated the following: *“What we did with training was to give people small portions and repeat it and expand, that really stuck with people. People were able to work independently quickly with a basic 1-point lesson. Some departments thought that one day of training was enough, but they struggled after it. So, mentoring those people helped a lot, and they started seeing value in it.”*

Company D emphasized the importance of allocating personnel during the implementation phase to work on the project. The implementer from Company D acknowledged that employees have struggled to devote the necessary attention to the ERP implementation due to their heavy workload and operational demands. He stated that more time should have been spent on working on the implementation to fully engage with the process. The implementer from Company D mentioned: *“Look, all these people have to work on the project in addition to their regular tasks. It's at the bottom of their priority list because, if a customer shipment has to go out, that's more urgent than the ERP project at that moment. So, the project was repeatedly sidelined. I gathered everyone in a room, they participated, I gave them homework, but a couple of weeks later, nothing had been done.*" The implementer emphasized the delay

they encountered during the implementation, noting that the process could have been more efficient if employees had more time to dedicate to it.

Another key theme during the implementation phase is flexible process optimization. This approach combines standardized and controlled processes, but also the allowance for flexibility in workflow design to streamline the processes and tailor the system to unique organizational or customer needs. Company B signifies the first part of this theme. This organization placed a lot of emphasis on automation and streamlined workflows, where manual tasks were reduced, and operational efficiency was achieved. The user from Company B highlights the benefits of this automation and streamlining of processes: *"We have a weekly quality meeting where we discuss the issues from the previous week, and then we make a decision based on those points, like sending something back. And then a report is generated immediately. This week, for example, we had this many rejected parts from this supplier, and here is the report: they're being sent back, scrapped, or whatever. The automation behind it is just amazing.*" The implementer from Company C mentioned the efficiency gains resulting from this improvement: *"We have freed up a lot of time for one of the quality engineers. Normally there were a lot of manual tasks, now he can just use LeanForms, fill in the field, take a picture and the rest happens automatically."*

Company D placed a lot of emphasis on balancing the standardization with flexibility. The selected ERP system offers a standardized framework, but also allowed for customization in specific areas. This system flexibility and adaptability ensures that the organizational- and employee needs are met without compromising the effectiveness of the system. The users from Company D highlighted the importance of this flexibility: *"We wanted a system that was not only focused on standardization, but also on customization in specific areas that were essential to us. We needed some flexibility to adapt to the business needs, especially because we are a smaller company that values flexibility. This flexibility gives us the ensures that we can act quickly while maintaining the integrity of our processes."*

Another key aspect of this phase is the use of user feedback loops. All the four companies mentioned the importance of these feedback rounds. Company A constantly gathered feedback from the users to enhance system improvement and respond to changing (organizational) needs. The user mentioned: *"By regularly engaging with end users we*

managed to make the process and the system more efficient and effective. This ensures that the system is also compatible with the operational processes."

Post-implementation / Current situation

For the post-implementation phase, the companies interviewed emphasized several key aspects that contributed to the ongoing success and improvement of the EAS systems. Again, a distinction is made between the perspective of the implementers and the users. These aspects are overarched in two themes: user acceptance and adoption and, continuous support and improvement.

A key theme in the post-implementation phase is ensuring that the system is not only accepted by the users, but that they are also capable of using it, and have the desire to work with it. Participants mentioned two key factors related to this capability and desire to work with the system: perceived usefulness and perceived ease of use. Users from both Company B and Company C emphasized that they had survived initial challenges within the system, and, over time, they recognized the benefits that the system brought with its ability to streamline processes, leading to improved acceptance for the system. User 1 from Company C highlighted how they have improved the perceived usefulness and ease of use: *"We placed a lot of emphasis on engaging users from different departments in feedback sessions. By integrating feedback to the system, we were able to address challenges and tailor the system* to the specific needs. This approach improved user acceptance, but also enhanced the effectiveness of the people working with the system." The implementer from Company B also mentioned the effect of enhancing the perceived usefulness: *"We were mostly focused on showing that the system could work for them, that it would not just be extra work or administrative pressure. This ensured the workers that the system could help them and that it is useful."* At Company A, initial resistance emerged, but once they realized that the system's capabilities simplified their daily operations, they began to use it more frequently.

As visible in Table 4, Company D placed a strong emphasis on flexibility in process adaptation. They mentioned that maintaining flexibility, while ensuring system consistency was a key factor in user satisfaction. The users from Company D mentioned the importance of staying flexible, even after the implementation phase: *"Even after the system was up and running, we have quickly realized that that flexibility in adapting processes was still important. The way we have*

worked needed to evolve over time, and our ability to quickly adjust processes and workflows within the system was key to meet our needs. Without that ongoing flexibility, it is impossible to remain effective." User 2 from Company B confirmed the importance of flexibility in process adaptation: *"Because SAP had some limitations in their processes regarding flexibility, we have to adjust our processes and workflows to meet the standards and way that SAP works."*

The last part of the post-implementation phase is based on the use of post-implementation support and continuous improvement. Users and implementers from Company A highlighted the importance of gathering feedback to continuously improve the system. Company A is constantly gathering input from their users to identify areas where the system could be optimized and to enhance workflows. The implementer from Company A mentioned: "We are constantly thinking about the best way to work. Sometimes we discover solutions for a challenge and then we fix it. Even after the live going, we are continuously looking for process improvements that enhance the system." User 1 from Company C underscores the importance of continuous feedback and system refinement using training and mentoring: *"We saw that after implementation some processes still do not work well, or people do not know how to perform certain tasks. Therefore, we continued training and mentoring even after live going."*

The companies emphasized that establishing a support team or resource center is essential during the post-implementation phase. Experienced employees can serve as support staff to assist less experienced users, allowing issues to be addressed and resolved internally and in a timely manner. User 1 from Company C highlighted the importance of setting up a resource center: *"During the live phase, the team of consultants and experts was available to answer questions or correct any issues. Afterwards, we continued to address issues and escalate them to the support team in Asia if necessary."* The implementer of Company C mentioned their approach on a support team: *"For example, we developed a rejection registration form. This way, when someone faces an issue, they can always come to us, and we work on improving it within the system. We've done this step by step, and users actively participate in refining their own forms."*