

**Leveraging capabilities for digitally supported process improvement  
a framework for combining Lean and ERP**

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**LEVERAGING CAPABILITIES FOR DIGITALLY SUPPORTED PROCESS  
IMPROVEMENT:  
A framework for combining Lean & ERP**

**ABSTRACT**

**Purpose**

ERP and Lean are both widely used approaches to business process improvement. However, research is limited on their interactions when implemented in combination, leveraging the advantages of both. The purpose of this paper is to propose a generic framework for implementing ERP and Lean in combination to develop digitally supported business process improvement capability and improved competitiveness.

**Methodology**

Principles and elements for the framework were derived from the extant literature and subsequently applied as input for solution incubation using design science research in a five-year case study. Study results and learnings enabled solution refinement and the development of a generic framework for digital supported process improvement capabilities.

**Findings**

The paper presents a case study narrative and propose a framework for digitally supported business process improvement capability based on Lean and enabled digitally by ERP. The framework delivers tangible productivity and quality improvements deployed, and an increase of continuous improvement capability.

**Originality**

This paper provides a novel generic framework and a set of guidelines for implementing Lean and ERP in SMEs and/or service companies to improve their business process excellence. The paper contributes to the scientific literature by providing insights on how SMEs and service operations can integrate Lean and ERP methods, digitalize and streamline processes in the organization, and build continuous improvement capabilities.

**KEY WORDS:**

ERP, Lean, Business Process Improvement, Digitalization

## 1. Introduction

Over the last few decades, businesses across industries have implemented either ERP (enterprise resource planning) or related IT (information technology) systems and/or Lean management approaches to enable continuous improvement of productivity, product quality and customer satisfaction (Nadarajah and Kadir, 2016), and achieve business process excellence and competitive advantage (Ghobakhloo and Fathi, 2019; Maguire, 2016; Powell, 2013). Lean has been used and defined in numerous ways (Arlbjørn & Freytag, 2013). In addition, Lean foundation has five principles: identifying value, mapping value streams, creating flow, establishing pull, and continuous improvement (Womack and Jones, 2003). Such foundation is supported by organizational settings for pursuing a long-term philosophy of continuous improvement through people and partners, processes, and continuous improvement activities (Liker, 2004).

ERP systems (Davenport, 1998) digitalize the information flow across functions and offer a range of functionalities supporting daily business processes by offering an infrastructure for process improvement (Masini and Wassenhove, 2009). Thus, the value of ERP resides not in the technological assets, but in the ability to develop repeatable patterns of value-creating actions using these assets (Masini & Wassenhove, 2009). Recent empirical studies have demonstrated that companies able to combine and integrate Lean and ERP as complementary initiatives are more likely to achieve operations and service excellence than businesses with independent initiatives (Erkayman, 2019; Ghobakhloo and Fathi, 2019; Chiarini and Vagnoni, 2017, Iris and Cebeci, 2014; Powell *et al.*, 2013; Powell *et al.*, 2012).

However, the existing literature concerned with combining Lean and ERP has mainly addressed manufacturing industry challenges of building continuous improvement capabilities. Many service companies in the digital economy, currently use IT (Kobus *et al.*, 2018) / or ERP to support their operations and business processes, but lack management to fully develop their continuous improvement capacity (Gupta *et al.*, 2016) and several studies confirm the importance of improving service operations to remain competitive (Vashishth *et al.*, 2019). This fact calls for more research on the benefits from integrating Lean initiatives on top of ERP implementation for improving service speed, quality etc., while remaining flexible. (E.V. *et al.*, 2019; Obwegeser *et al.*, 2019). Consequently, we argue that process improvement capability can be raised by combining ERP and Lean, as Lean provides a systematic improvement approach and ERP can provide digital support for process improvement.

The purpose of the paper is therefore: to propose and evaluate a generic framework for developing digitally supported business process improvement capability by combining ERP and Lean implementation.

The study design comprises a review of the existing research on Lean and ERP implementation, a synthesis of principles for a new framework, and empirical testing and evaluation of the integrated framework in service operations (cf. Figure 1).

[Figure 1 about here]

## 2. Review of Lean and ERP implementation methods for business process improvement

Decades of research has shown organisations can address shortcomings of overall performance and sustain competitive advantage by implementing business process improvement (Nadarajah and Kadir, 2016). Business process improvement aims at

simplifying, stabilizing, standardizing, and automating business processes continuously to eliminate waste and improve value for business clients and stakeholders (Rytter, 2012). Business process improvement implies documentation and streamlining of processes and measurement of performance, which can result in higher levels of process maturity and transcend the processes to focus on customer needs (Nadarajah & Kadir, 2016). Development of business process improvement capability is distinguished from process improvement by its emphasis on moving from isolated improvement activities to organizationally driven approaches which consistently encourage, support, and exploit such activities for improved performance over time where improvement efforts also are incorporated into the organizational culture (Bessant and Francis, 1999; Hansen & Møller, 2016). Process improvement capability often encompass use of Lean principles, methods, tools, and organizational settings which are supported by process and performance visibility provided by ERP or equivalent IT solutions. Consistent and persistent deployment of Lean and/or ERP can significantly improve the effectiveness and efficiency of business processes (Matthews et al., 2017) by providing tangible results and development of improvement capabilities (Hansen, 2015).

### **2.1 Combining ERP and Lean**

Powell and Strandhagen (2011) claim that the benefits associated with Lean and ERP systems are almost identical (reduced cost, increased productivity), but also that set business targets are more easily achieved by combining and synchronizing the two implementation efforts. Only one integrated framework for ERP-based Lean implementation process (Powell *et al.*, 2012) was found. The framework provides clear guidance for how to combine ERP and Lean via initial development of a strategic vision, followed by training, ERP software selection, and Lean tools introduction. The framework is designed for companies which choose to implement a new ERP solution in combination with later Lean efforts reflecting the case for many businesses a decade or two ago. However today, many companies have run ERP systems for several years and instead struggle to improve process and client value on top of their IT infrastructure by using Lean tools.

Surprisingly, the discussion about ERPs ability to enable Lean in a service context is almost absent in the extant literature. Service operations are often leaning on manufacturing operations as the role model of digitalization and efficiency (Gupta *et al.*, 2016) and benefiting from adopting approaches as Lean and ERP. To some extent, service operations has even larger potential for automation and digitalization than manufacturing (Bortolotti and Romano, 2012). This means ERP should be used as an automation and digitization tool enabling Lean and thereby avoid multiple IT solutions in service to minimize the need to integrate and support several systems.

### **2.2 Methods for ERP implementation**

The term implementation is in the world of ERP often used to describe a well-defined project covering the steps from choosing a system and its configuration to training its users and to *go-live* (Powell *et al.*, 2012). Several researchers have developed process models simulating ERP implementation. Vilpola (2008) discussed a model based on previous studies of ERP implementation. Berchet and Habchi's (2005), Pellerin and Hadaya's (2008), Rajagopal's (2002) present several-stage models, and Wallace and Kremzar's (2002) *ERP Proven Path* methodology for ERP implementation. These models represent a linear implementation process with emphasis of continuous improvement at the end, the exception is Harwood (2003) presenting a high level generic ERP implementation model better suited to continuous

process improvement.

### **2.3 Methods for Lean adaptation and transformation**

Womack and Jones (2003) proposed five principles for implementing Lean in 1996. Most implementation frameworks are derived from the context of production: Hobbs (2004) describes a step-by-step process for the implementation of Lean manufacturing for reflecting the five Lean principles and Bicheno and Holweg (2009) present a hierarchical Lean transformation framework. Additionally, some approaches less orientated towards manufacturing suggest improvement to happen in loops. As Malmbrandt and Ahlstrom (2013) investigating use of Lean service principles and methods or Kumar *et al.* (2012) suggesting use of a DMAIC framework to implement a Lean Pull Replenishment approach. Also, Nightingale and Mize (2002) propose a model of three cycles that portrays the overall steps necessary to initiate, sustain, and refine an enterprise transformation based on Lean practices.

## **3. Key principles for digitally supported continuous improvement capability implementation**

### **3.1 Overview of Lean and ERP implementations' steps**

Table I shows the steps proposed in Lean and ERP implementation frameworks. The colors represent the framework steps (blue=combined, white=ERP, grey=Lean). The highlighted steps in yellow are the ones used in both ERP and Lean frameworks.

The overlapping steps from ERP and Lean are continuous improvement, ongoing training, process definition, performance goals, strategic vision and initial training. While the continuous improvement associated with implementing ERP and Lean tools are undetailed, it is necessary to analyze additional available continuous improvement project frameworks and steps.

Operational inefficiencies can be eliminated continuously on a project-by-project basis by taking each project through the DMAIC phases (Lokkerbol *et al.*, 2012). Kumer *et al.* (2012) use DMAIC when executing the Lean improvement initiatives and achieved customer service excellence. Sunder M (2016) suggest DMAIC usage when adapting Lean and Six Sigma tools in financial service companies.

[Table I about here]

### **3.2 Principles for an implementation framework**

Based on the analysis and comparison of the relevant frameworks for isolated and integrated implementation of Lean and ERP systems presented above, a synthesis of principles was proposed for constructing the framework to reach business process improvement capability. The framework itself is developed by using design science research in a five-year case study based on the principles below:

- 1) *The preparation phase* is important in a framework, as most of the existing contributions highlight the need for developing a transformation program with a realistic pace for implementation activities. The preparation also includes assessing ERP and Lean maturity and getting stakeholders committed to the journey through project scoping and setting targets, as well as organizing the project.
- 2) *A method for managing and executing improvement projects* should preferably be based on DMAIC or a similar continuous improvement approach which can be applied on a project-by-project basis. Such a sequence of standardized steps has to be applicable to a broad set of improvement cycles and should be tailored to the individual company

needs and resources (Lokkerbol *et al.*, 2012). A project will usually be broken into the following steps:

- *Define the current situation and performance gap.* (Lokkerbol *et al.*, 2012; Sunder M, 2016; etc.).
  - *Identify improvement options* (Harrison *et al.*, 1997) *and analyze* the possible solutions (Kumar *et al.*, 2012).
  - *Plan implementation* tasks for the particular project (Kumar *et al.*, 2012; etc).
  - *Implement solutions* (Nightingale and Mize, 2002; etc).
  - *Measure and monitor performance improvements* (Nightingale and Mize, 2002).
  - *Control and adjust* (Lokkerbol *et al.*, 2012; Nadarajah and Kadir, 2016; etc.).
- 3) *Emphasis on cycles of continuous process improvement* must be included in the steps above with the DMAIC framework.
- 4) *Performance metrics and procedures* should be part of the framework. It is seen in several of the existing recommended frameworks such as Bessant and Francis (1999) with their capability/maturity framework or Delgado *et al.* (2014) that a set of business and process performance metrics based on productivity-costs, quality, time, and customer satisfaction.

There are two ways ERP can be helpful in continuous improvement projects. Firstly, ERP can maintain and automate standardized work while ensuring that work is done in exact sequence and format (Ghobakhloo and Hong, 2014). Secondly, ERP systems deliver process and performance data to Lean improvement projects and enable so-called “data-driven decision-making cultures” in companies (Halgeri *et al.*, 2011; Nauhria *et al.*, 2009), combining immediate improvement and development of improvement capability (Hansen, 2015).

#### **4. Methodology to test the principles for developing a framework**

The method of the study was based on Design Science Research (DSR; Van Aken *et al.*, 2016) and inspired by Action Research (Coughlan and Coughlan, 2009) and its longitudinal, participative case study research methods. The aim of DSR is to discover predictive knowledge in a company setting by developing practical knowledge grounded in a participatory worldview (Reason and Bradbury, 2007). DSR intends to move beyond the theory-building versus theory-testing distinction and instead move the focus from theoretical explanation to actual problem solving (Holmström *et al.*, 2009). Therefore, we conducted DSR through phases inspired by Chaudhuri *et al.* (2020). First, solution incubation was carried out to understand problems and to develop the first solution design, which is detailed enough to be implemented but may be incomplete. Principles and elements for the framework were derived from the extant literature and subsequently applied as input for solution incubation. Second, solution refinement was carried out to refine the initial solution design through iterations to verify what works, thus including design improvements, implementation, and evaluation. The solution refinement led to the development of a digitally supported continuous improvement framework. Third, we evaluated the developed artefact from a theoretical point of view to contribute to the broader application of the paper findings thus proceeding beyond problem solving.

The roles of the researchers conducting the study and the intervention in the company was inspired by discussions on how to ensure validity in action research. One researcher held a managerial role in the company while also being the primary data collector. This dual role meant the researcher managed the project and the study simultaneously; a dual position that

requires clear research roles and structure (Coughlan and Coghlan, 2009). While one researcher was embedded in the case study to gain access to the data, the other two compensated by taking an active challenging role to minimize the natural biases from going native in the study. A protocol was developed and was continuously updated, specifying data needed for the ongoing collection, and over time key informants were let to review the case evidence gathered to strengthen the validity and reliability of the research (Voss *et al.*, 2002; Yin, 2009).

#### **4.1 Case selection and data collection**

The selected case company was an IT company responsible for local sales, implementation, and support of a software solution. A researcher was involved, who was also a manager in the case company. Such a manager ensured close collaboration and unique engagement with the case company that Myers (2013) argues is crucial for access to data and ensuring implementation. The case made it possible for the researchers to do in depth and longitudinal research into how a service business build capabilities for digitally supported continuous improvement and achieve operational benefits over time. The case can be considered *reveatory* in its attempt to uncover how Lean and ERP are implemented and creates benefits in combination (Yin, 2009; Voss *et al.*, 2002). The scoping of the intervention started in 2015 based on the results of a customer satisfaction survey, which showed a need for more effective processes in the company. The company thus had a clear incentive to participate in the research project to develop its competitive edge.

Rich methods of data collection were used in order to investigate the intervention (Coughlan and Coghlan, 2009), including:

- Videos and digital pictures from 14 improvement sessions 204 GB
- Documents, drawings, posters produced during the improvement sessions
- Summaries of 270 meetings e.g., weekly meetings and quarterly partner meetings
- Notes from 62 interviews with employees
- 46 A3 forms used for process improvement projects
- Reflection notes after relevant events and observations
- Performance data for five years period from the ERP system.

Case evidence is archived.

The collected data was used to write a case narrative divided into five parts:

- Background of the case company before improvement initiatives;
- Setting the Strategy, creating awareness for Lean and building Kaizen capabilities 2015;
- Implementing a Lean process for ERP Implementation 2016
- Improving customer support/service processes and performance 2017
- Understanding and improving the customer journey while using ERP 2018
- Epilogue and outcome 2019

The experiences and findings were used for developing the framework for ERP-Lean implementation during the collaborative process. Post intervention, the case narrative was analyzed and the findings were highlighted and used to update the framework.

#### **4.2 Measuring process improvement capability to evaluate the created framework**

The success of a process improvement effort hinges on the ability of the company to evaluate the impact of the implemented changes (Harrison *et al.*, 1997). This requires process performance is measured and reported for the purpose of continuous improvement

(Nadarajah and Kadir, 2016). Measurements make continuous improvement possible at each stage of implementation when underperformance is detected (Sun *et al.*, 2015).

Two dimensions were measured, in order to test the developed framework and to justify its use in the company. First, a set of business and process performance metrics were chosen, and second, improvement capability maturity was assessed.

Companies have a range of KPIs and performance measurement systems to evaluate tangible improvements created, and to providing updated numbers for key metrics to decision makers, who can compare the results to targets set and decide on actions (Tan, 2004). Typical metrics include productivity, quality, time, and customer satisfaction (Delgado *et al.*, 2014). We used four KPI categories for this study, which were applied in the company already as shown in the findings.

Regarding the improvement capability with respect to process orientation and culture, we applied the widely disseminated Bessant and Francis (1999) model since it provides a detailed outline of the different maturity levels previously operationalized in the context of Lean (Hansen and Møller, 2016). The model places attention on the development of continuous business process improvement infrastructure (Matthews *et al.*, 2017).

## **5. Constructing and testing the framework through the business case**

The headquarters of the case company were founded in Estonia in 2002 offering an ERP solution as Software as a Service (SaaS). The company was one of the first software providers globally to introduce a SaaS (cloud-based) ERP service to corporate customers. Initially the focus was the local Estonian market, The company in Lithuania was established in 2008.

The case company (Lithuanian branch) had implemented its own ERP system, but it did not support execution and monitoring of the core business processes. Only the finance module and some CRM features were introduced in the end of 2013. However, the company faced a number of organizational challenges typical of a fast-growing SME and it became increasingly difficult to control the service quality.

The initiative of business process improvement started in 2014 with a decision of combining Lean with better usage of ERP and via engaging an external Lean consultant.

### **5.1 Setting the Strategy, creating awareness, and building continuous improvement capabilities**

Employees were formally introduced to Lean in beginning of 2015. In the summer of 2015, two workshops supported by an external Lean consultant were conducted with the purpose of setting a strategic vision and committing the staff accomplishing the following tasks:

- Specific objectives and targets were set for customer satisfaction, growth of turnover and operational excellence.
- A policy deployment X-matrix tool was applied to identify short-term actions that could contribute to reaching the objectives.
- The core business processes for Sales, Implementation and Support were mapped and analyzed
- Customer value and needs were identified
- Main KPIs were clarified and visualized.

These actions coincided with the recommendations of the preparation stage of the Lean ERP framework developed by the researchers framework (figure 3).

The workshops became steps towards further business improvement and instilled a break



in daily operations, where employees often felt they lacked time to make improvements. At first, the workshops contributed to a broader and shared understanding of customer value and the importance of meeting customer needs. Regarding objectives, the exercise created a set of very tangible metrics for the key business processes, including KPIs. After the workshop, it was decided to implement visual management, resulting in a publicly displayed dashboard, tracking business improvement efforts.

Additional improvement sessions were run with the same external consultant in the autumn subsequently followed by a trial period, to proceed with visual management. Weekly Friday meetings with a clear structure were organized to identify current performance and improvement opportunities. Kaizen meetings were also strengthened by integrating previous idea-generation processes and converting templates into A3 forms.

### ***5.2 Implementing a Lean process for ERP Implementation***

The company increased its revenue with 34.83 % in 2014 and 31.37 % in 2015. The year 2016 began with numerous unforeseen new software implementation projects for the clients. Consequently, there was a need to upgrade the core implementation process, as deficiencies of that process had rework and performance implications for post customer support processes. An improvement session was carried out in March 2016 to tackle this challenge. It started with the whole team gathered, introducing and repeating information about Lean tools and playing some Lean games. The ERP implementation process was scrutinized using tools as Fishbone diagrams, 5WHYs, PDCA, A3 forms etc. Subsequently, a follow-up session was held to identify ways of improving the main process, using the external facilitator. The two workshops yielded: a detailed map of the current end-to-end process of ERP implementation for the client. This created a shared understanding of the end-to-end process among everyone who was involved daily.

In response, the team decided to use the ERP project management module internally for implementing projects and a set of procedures was created. Finally, KPIs were developed to monitor progress of the new ERP implementation process: duration, revenue from new project implementation works, actual vs. planned dates for activities and re-work per project.

The implementation of the designed EPR improvement process was done using PDCA principles and running several improvement cycles. This years experience is summarized in figure 3.

### ***5.3 Improving customer support/service processes and performance***

In March 2017, the team and external consultant initiated a new improvement project choosing the customer support process as scope for an improvement workshop as number of requests received per customer was 9.74 times fewer in Estonia vs Lithuania at the time. The workshop started with a team-building exercise, and the support process was analyzed and the steps described in figure 3 were executed. The improvement project session produced the following results:

- A shared understanding of which customer requests create value
- A detailed map of the end-to-end customer support and its handovers and flaws
- A vision for a future Lean and digital customer-oriented support process characterized by clear customer specifications, simplicity and automation
- KPIs were set for monitoring customer support performance, the ERP system was adjusted to register and classify all future customer requests.

During the rest of 2017, further adjustments and improvements of the process were made.

At the annual employee conversations, the staff expressed their satisfaction with the integration of Lean methods and improved ERP usage within work routines and with the many ongoing improvement projects running.

#### **5.4 Understanding and improving the customer journey while using ERP**

Ambitions to make the company processes and work culture more competitive continued in 2018. It was decided to organize one more set of improvement sessions with the theme “Improving the customer journey through the support process.” The first part of the sessions was therefore spent repeating the same messages and teaching Lean curriculum from the previous workshops. Again, these included interactive game elements and constituted team building. The second part of the sessions included training in methods for conducting customer studies and observing work processes. The workshops included *go-to-gemba* visits to 5 customers with teams of two observing processes and interviewing staff. The main goal was to watch the customers daily work with ERP and understand why and when they needed support.

Employees returned excited about what they had observed and even changed their perception of customers behavior. Another series of customer visits were organized. After these visits, a half-day session was run drawing up support team and customer behavior. In other words, the steps from the framework in figure 3 were repeated. First, the team was trained and united. Then, better understanding of the current support process was created by visiting customers, issues of value stream were identified, activities for improvement were planned, new routines were agreed upon and standardized in ERP to enhance the support process, and KPIs were reviewed and configured in ERP.

At the end of year 2018, the Lean initiative had shifted its initial focus on project-based improvements to a focus on continuous improvement of the company processes and delivery of superior value to clients.

#### **5.5 Epilogue and findings**

After five years, the results were clear. The company morning stand-ups were daily routine, and every Friday, important KPI's were reviewed and decisions made at a structured meeting. A3 improvement projects were common day-to-day activities.

Process-improvement of sub-process of integration projects was done independently in 2019, without an external consultant. The sales process was also implemented in ERP from pipeline to signed contract information using the CRM module.

A summary of metrics of the five-year period is presented in figure 2. Cost-based productivity - revenue vs. no of employees - grew year-by-year from 6% to 20%. The customer recommendation rate was seen in the customer survey that was carried out in three of the five years. We can see the tendency of coefficient improvement as well from 7 to 7.4 and 8 during the years. The number of questions drops quite significantly through the five years from 56.62 to 32.75 tickets per customer. The percentage of tickets solved in one day also increased. The time it took to implement a project also decreased between 2017 and 2019. For easier overview, decreasing numbers are converted to inversely proportional numbers.

Referring to the Bessant and Francis (1999) model, the process improvement capabilities of the team had reached level 3.5. The company was regularly running systematic problem-solving cycles without support of the external consultants. Experimentation and innovation had become the norm, and implemented performance metrics enabled ongoing cost reductions, quality improvements, and time savings.

[Figure 2 about here]

## 6. Learnings from the case and proposed framework

The case demonstrates how applying the combined ERP and Lean approach enabled the intervention to produce positive results in terms of productivity, quality, and customer orientation. It also produced business process improvement capability in the SME service company. The business transformation effort was implemented through a synthesis of existing Lean and ERP frameworks and the applied DSR / action research methodology. Based on the case journey and results, we have summarized our findings in the form of a digitally supported business process improvement framework, presented in figure 3.

[Figure 3 about here]

### 6.1 Setting the strategy and preparing for ERP and Lean capabilities

The proposed framework suggests, (Powell *et al.*, 2012; Pellerin and Hadaya, 2008; Nightingale and Mize, 2002), the preparation stage as crucial for the results of the intervention. In this stage, the company must start by clarifying the starting situation: Are ERP and Lean implemented from scratch; is one of the approaches already present; or does the company already have some degree of maturity with respect to both approaches? (In Figure 3 – Identify Lean and ERP maturity).

An ERP solution existed at the case company, and the intervention was concerned with enhancing the existing system via Lean methods to enable process improvement and customer value. Most of the initial training thus covered Lean principles and tools. However, the starting point might be different and thus require another focus for other companies.

A subsequent key step is to ensure the initial business strategy and competitive priorities are aligned with Lean and ERP actions in the long and short term - second step in Figure 3. It is particularly important that the role of core processes in creating customer value is made obvious, and managers and employees are aware of it - third step in Figure 3. For the case company, a significant effort was made to create such awareness by applying the X-matrix tool (Barnabè and Giorgino, 2017), which likely supported further initiatives and results.

The next step in the preparation stage - fourth step in Figure 3 - is to consider how to organize the upcoming ERP or Lean triggered business -s transformation. The chosen approach might depend on the given company size and resources. The case company was an SME, and it was clear that the CEO would play a key role, not just as a sponsor of the initiatives, but also as an *agent of change* and a dedicated improvement project leader in collaboration with key employees. The importance of a committed sponsor as well as strong *agents of change* being able to deal with technical and cultural/political challenges have been highlighted in previous research (Schniederjans and Yadav, 2013; Kumar *et al.*, 2012).

Specific needs for training should be identified, planned, and executed for relevant stakeholder groups at an early stage to facilitate the professional and cultural transformation - fifth step in Figure 3. Employees and managers leading the implementation should receive intensive training in relevant ERP/Lean curriculum and skills, while other stakeholders should acquire further awareness and understanding (Nightingale and Mize, 2002; Vilpola, 2008). Existing research stresses the value of experiential learning methods or on-the-job training as a way to acquire skills and competencies in the areas of Lean or EPR (Wallace and Kremzar 2002; Bicheno and Holweg, 2009). Since the case company was an SME, it was decided early on to make training part of the planned improvement projects, offering the opportunity of

training Lean and ERP tools as part of problem solving.

Finally, KPIs and improvement objectives should be discussed and set at the preparation stage - sixth step in Figure 3 - in order to be able to track whether the initiative delivers the expected business benefits. Initially, the case company only had financial measures in place, and thus a need for developing service quality and process performance measures arose. A simple set of KPIs was developed and tracked via manual data recording. At a later stage the performance reporting was automated via ERP (Bortolotti & Romano, 2012).

## **6.2 Managing improvement projects**

With respect to the improvement project management and execution phase of the above framework, our case enables to convey some interesting observations and recommendations. One of the features of the case was the company business transformation which happened in a set or pattern of *Improve-Monitor* cycles. For every cycle, the improvement was first done as a Kaizen event (Aken *et al.*, 2010), where a systematic set of standardized improvement steps were made. The implementation of a new work process and digital solutions was followed by a subsequent *monitoring* period, where new routines were established, only small adjustments were made to ensure improved operations. The realized approach was likely due to the size of the company, where there was no full-time agent of change dedicated to driving Kaizen events. In addition, employees were in need for a stable daily work and more familiarity with the new processes before they would have mental surplus to investigate new improvement options.

We have identified some critical aspects, which yield good results for every step in the improve and monitor cycle:

- *Unite and train the team.* Aken *et al.* (2010) address the need for uniting improvement teams and the importance of ongoing training is documented by existing research – both in terms of ERP (Pellerin and Hadaya, 2008; Berchet and Habchi, 2005 and etc.) and Lean (Nightingale and Mize, 2002; Malmbrandt and Åhlström 2013, and etc.). The case indicates a combined team-building and training effort, enabled the team to identify improvement options and subsequent implementation speed.
- *Understand/map current process, value stream issues.* The current situation and inefficiencies of the selected process should be mapped, documented and analyzed as one of the first improvement project steps as mentioned by Obwegeser *et al.* (2019). Estimating baseline performance and identification of root causes are also typical steps in understanding the current state of process (Lokkerbol *et al.*, 2012; Kumar *et al.*, 2012; Nadarajah and Kadir, 2016; Sunder M, 2016). In the case company, each improvement cycle included these activities to understand the current value stream issues and challenges.
- *Identify solutions and analyze impact.* Generating or proposing ideas for solutions that can improve current operations and performance is essential after initial analysis Harrison *et al.* (1997). Typically, a deep understanding of the current state must be combined with creative thinking and stretch targets set to foster innovation and systematic problem solving. Evaluation of costs and benefits should be done as a final step before implementation (Nightingale and Mize, 2002; Kumar *et al.*, 2012). The case company illustrates how the team retreated from daily operations and performed creative and systematic problem-solving, the pain and gain charts were used for prioritization and selection of implementation.
- *Plan and organize implementation.* Part of this step includes making a more or less detailed plan for timely implementation of actions. Delegation of time and resources,

and assignment of roles and responsibilities for people (Obwegeser *et al.*, 2019; Kumar *et al.*, 2012; Harrison *et al.*, 1997; Nightingale and Mize, 2002). The case company developed a clear plan for implementation activities with a timeline and designation of team members to tasks for every improvement project.

- *Solve problems and enforce new routines.* The actual implementation is the most important part of the transformation process, as confirmed by Obwegeser *et al.* (2019) and Lokkerbol *et al.* (2012). The implementation team should execute actions and proactively and persistently deal with obstacles for further process redesign and improvement of performance. An implementation team was attached to every project for the case company, and they developed instructions that could solidify new processes and routines, particularly during the first two improvement cycles. Maintaining discipline with respect to executing work routines was essential to succeed.
- *Standardize and automate with ERP.* Implementing or materializing new standard work routines into the ERP system, plays an important role in improvement projects (Ghobakhloo and Hong, 2014). The automation part was done without additional challenges in the case company, while IT experience and knowledge allowed for the team to implement automation of the processes.
- *Establish new KPIs in ERP.* For every improvement project, it is critical that KPIs are established in order to be able to monitor the performance of new processes. We recommend to start out simple and record and calculate KPIs manually or through Excel. After the trial phase, data and performance reporting can be implemented into to ERP. Several studies have highlighted need for KPIs/metrics as well as for various incentives for organizations to maintain improvement results and Kaizen practices (Done *et al.*, 2011; Pritchard, 2013).
- *Monitor performance and adjust if needed.* After the improvement project steps are completed, the relax phase is recommended based on the case company's experience. The KPIs should be followed on the regular weekly meetings and benchmarked with the goals set. If adjustments are needed based on the KPIs or employee feedback about the new routines, small adjustments should be made as stressed by Obwegeser *et al.* (2019).

## 7. Discussion

### **7.1 The framework provides a generic approach for developing continuous improvement capability by combining Lean and ERP.**

The purpose of this study was to develop a comprehensive generic framework using ERP and Lean to improve processes, enable digitally supported continuous improvement capability, and competitive advantage.

While Powel *et al.* in 2012 presented a framework for combining Lean and ERP, their framework was designed for companies starting from scratch. The framework provided in this study is generic and can be modified and applied to situations where companies already have ERP or some Lean capabilities. This is a relevant contribution seeing as both ERP use and Lean are widespread in most industries. The framework is also generic in the sense the time-laps given in the framework are not strictly defined. Repetition of improvement projects develop the continuous improvement capability (cf. Nightingale and Mize, 2002), but the length of each cycle can be carefully evaluated by the company depending on the context and resources available.

In the course of the five years the framework was developed and tested, other studies

focused on combining ERP and Lean were published. Janssens *et al.* (2020) present a process for ERP implementation through a collection of coherent and detailed activities or processes, independent of phases, and viewed over the entire project. Ghobakhloo and Fathi (2019) propose an overall strategic roadmap for increasing productivity by integrating a firm's IT resources and capabilities to support manufacturing digitization and leanness. Kobus *et al.* (2017) discuss the implementation of Lean IT in waves of 3-4 months in four implementation phases. Obwegeser *et al.* (2019) present an IT infrastructure service operations improvement model with steps, guidelines, and a toolbox.

While these more recent studies offer insights and practical knowledge about domains of ERP implementation (Janssens *et al.*, 2020), Lean and IT implementation in combination (Sartal and Vázquez, 2017; ErKayman, 2018), IT for digitalization and Lean (Ghobakhloo and Fathi, 2019; Kobus *et al.*, 2017) and Lean in IT organizations (Obwegeser *et al.*, 2019), they do not address the development of continuous improvement capability. The framework offered in this paper provides an approach for developing digitally supported continuous improvement capability, documented through a standardized maturity model (Bessant and Francis, 1999).

The company case illustrates the particular set of challenges faced by a IT service company that is technology-focused rather than customer oriented, as also explained by Kundu and Bairi (2014). Through five workshops run in the course of the first year, a deliberate effort was made from the outset to create awareness around the importance of understanding customer needs and delivering value, which is fundamental for any (ERP) or Lean transition to succeed (Womack and Jones 2003; Bortolotti and Romano, 2012). Employees had to learn to adapt their *ERP programming* approach to problem solving with the Lean mindset concerned with the improvement of processes and customer value and apply both in combination as part of their ongoing work.

This ability for continuous improvement was furthermore demonstrated since the company continued to grow by 12% turnover in the year 2020 even during the challenging pandemic situation.

Future research should investigate the extent to which these findings apply to a wider range of contexts as for companies with more extensive experience using Lean and ERP. Furthermore, the study shows future research could investigate the time lags and their impact on implementation effect and to what extent sustainable implementation could be accelerated.

## **7.2 Perspectives on the role of ERP and Lean in digitalization of companies**

Many companies are under pressure to perform better in spite of decreasing resources and seek digitalization as a strategy to move forward. The benefits of digitalization thus require continuous improvements capability and the ability to use data in the real time (Trstenjak and Cosic, 2019). This paper demonstrates how the combination of Lean and ERP can be a successful way of achieving the benefits of digitalization as processes are improved and wasteful activities in day-to-day operations are eliminated (ErKayman, 2018; Kobus *et al.*, 2018; Kobus *et al.*, 2017). SMEs could benefit from exploiting the possibilities in an ERP system instead of implementing multiple IT tools while digitalizing their processes. This, however, might not be possible for larger companies, which would need ERP integration in combination with additional specialized IT solutions. Future research could investigate how the combination of Lean, ERP, and other digital components impact the capacity for building continuous improvement capability and competitive advantage.

## **7.3 Reflections on developing the framework with a case company**

The study used conclusions from existing scholarship to develop principles for implementing

a combined ERP and Lean approach, and then proceeded to test and develop the framework inside the case company. The nature of the chosen methodology allowed for the conclusions from the case study to be embedded into the framework. The presentation of the framework also benefits from the contextualization in the case description, which allows the reader to get practical insights about the use of the framework. Furthermore, the methodology acknowledges that the development of Lean - in combination with ERP - as an emergent system requires a system view that integrates people, processes and tools, as well as the evolving culture (Liker and Morgan, 2011). In this way, the timeframe of the study made it possible to assess the development of digitally enabled improvement capabilities in practice.

However, the methodology limited the developed framework to findings from a single case and the practical knowledge that arose in the case, which might have inhibited findings that could have been uncovered through a deductive study where a proposed framework was tested in multiple companies. One example of a topic that was not covered in the framework is project governance. In this case company, project governance could be done ad hoc as top management had a dedicated focus on implementing ERP and Lean through the framework and due to the small size of the company. In medium-sized or large corporations, project governance may already be established as a system. This study, however, lacks any recommendations as to what governance implementation requires which can be researched in the future.

## **8. Conclusions**

Many organizations have adopted a version of Lean and of ERP, but struggle leveraging continuous improvement capability and continuing the journey of digitalization to support operational excellence (Trstenjak and Cosic, 2019). This paper provides a novel generic framework that can address this need: an implementation guide for how to develop and measure business process improvement capability based on Lean and enabled digitally by ERP and thereby improve productivity, quality, and competitive advantage.

The paper contributes to the literature by providing insights on how SMEs and service operations can integrate Lean and ERP to build the digital infrastructure for business process improvement capabilities, and by providing deep insights into how these capabilities enable organizational growth and profitability. The practical contribution of the generic framework is applicable for organizations in all industries and enterprise sizes if properly incorporated with existing practices. The provided case study furthermore contributes with practical knowledge and examples on how to mature improvement capability (Bessant & Francis, 1999).

The main limitation of the study is the investigated case maturity with ERP and Lean might not be generalizable. Therefore, further research should investigate how findings apply to a wider range of contexts- e.g., companies of different sizes and industries, with more extensive experience using Lean and ERP.

## References

- Aken, E.M.V., Farris, J.A., Glover, W.J. and Letens, G. (2010), "A framework for designing, managing, and improving Kaizen event programs", *International Journal of Productivity & Performance Management*, Vol. 59, no. 7, pp. 641-667.
- Arbjørn, S.J. and Freytag, V.P. (2013), "Evidence of lean: a review of international peer-reviewed journal articles", *European Business Review*, Vol. 25, no. 2, pp. 174–205.
- Barnabè, F. and Giorgino, M.C. (2017), "Practicing Lean strategy: Hoshin Kanri and X-Matrix in a healthcare-centered simulation", *TQM Journal*, Vol. 29, no. 4, pp. 590-609.
- Berchet, C. and Habchi, G. (2005), "The implementation and deployment of an ERP system: An industrial case study", *Computers in Industry*, Vol. 56, no. 6, pp. 588-605.
- Bessant, J. and Francis, D. (1999), "Developing strategic continuous improvement capability", *International Journal of Operations & Production Management*, Vol. 19, no. 11, pp. 1106-1119.
- Bicheno, J. and Holweg, M. (2009), *The Lean Toolbox: The Essential Guide to Lean Transformation*, PICSIE Books, Buckingham.
- Bortolotti, T. and Romano, P. (2012), "'Lean first, then automate': a framework for process improvement in pure service companies. A case study", *Production Planning & Control*, Vol. 23, no. 7, pp. 513-522.
- Chaudhuri, A., Gerlich, H.A., Jayaram, J., Ghadge, A., Shack, J., Brix, B.H., Hoffbeck, L.H. and Ulriksen, N. (2020), "Selecting spare parts suitable for additive manufacturing: a design science approach", *Production Planning & Control*, , pp. 1-18.
- Chiarini, A. and Vagnoni, E. (2017), "Strategies for modern operations management: Answers from European manufacturing companies", *Benchmarking: An International Journal*, Vol. 24, no. 4, pp. 1065-1081.
- Coughlan, P. and Coughlan, D. (2009), "Action Research" in *Researching Operations Management*, ed. C. Karlsson, Taylor and Francis, Inc, New York, pp. 236-264.
- Davenport, T.H. (1998), "Putting the enterprise into the enterprise system", *Harvard business review*, Vol. 76, no. 4.
- Delgado, A., Weber, B., Ruiz, F., Garcia-Rodríguez de Guzmán, I. and Piattini, M. (2014), "An integrated approach based on execution measures for the continuous improvement of business processes realized by services", *Information and Software Technology*, Vol. 56, no. 2, pp. 134-162.
- Done, A., Voss, C. and Rytter, N.G. (2011), "Best practice interventions: Short-term impact and long-term outcomes", *Journal of Operations Management*, Vol. 29, no. 5, pp. 500-513.
- E.V., G., Antony, J. and Sunder M., V. (2019), "Application of Lean Six Sigma in IT support services – a case study", *TQM Journal*, Vol. 31, no. 3, pp. 417-435.

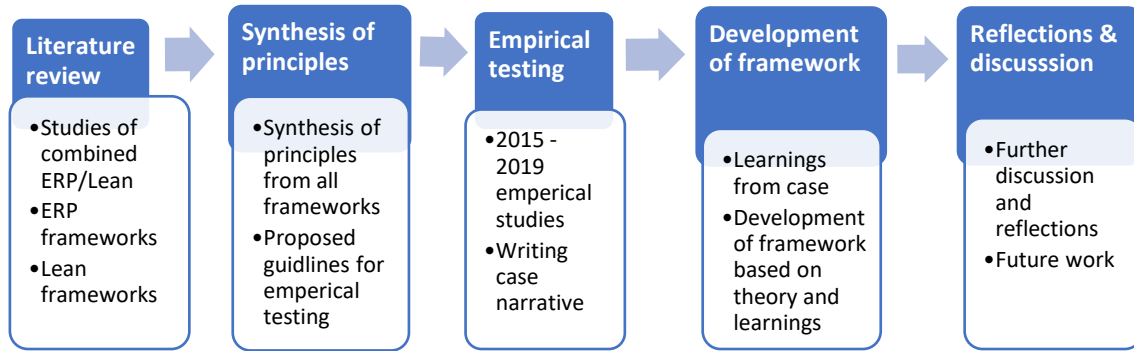


- Erkayman, B. (2019), "Transition to a JIT production system through ERP implementation: a case from the automotive industry", *International Journal of Production Research*, Vol. 57, no. 17, pp. 5467-5477.
- Ghobakhloo, M. and Fathi, M. (2019), "Corporate survival in Industry 4.0 era: the enabling role of lean-digitized manufacturing", *Journal of Manufacturing Technology Management*, Vol. 31, no. 1, pp. 1-30.
- Ghobakhloo, M. and Hong, T.S. (2014), "IT investments and business performance improvement: the mediating role of lean manufacturing implementation", *International Journal of Production Research*, Vol. 52, no. 18, pp. 5367-5384.
- Gupta, S., Sharma, M. and Sunder M., V. (2016), "Lean services: a systematic review", *International Journal of Productivity and Performance Management*, Vol. 65, no. 8, pp. 1025-1056.
- Halgeri, P., McHaney, R. and Pei, Z.J. (2011), "ERP Systems Supporting Lean Manufacturing in SMEs" in *Enterprise Information Systems: Concepts, Methodologies, Tools and Applications*, ed. Information Resources Management Association, IGI Global, Hershey, PA, USA, pp. 1121-1140.
- Hansen, D. (2015), "What's your next move?", *Quality Progress*, June, pp. 16–22.
- Hansen, D. and Møller, N. (2016), "Conceptualizing Dynamic Capabilities in Lean Production: What are They and How Do They Develop?", *Engineering Management Journal*, Vol. 28, no. 4, pp. 194-208.
- Harrison, D.S., Haug, R.T., Baker, G.H. and Moore, G.L. (1997), *Continuous improvement planning: Case study of basic process reengineering*, American Society of Civil Engineers.
- Harwood, S. (2003), *ERP: The Implementation Cycle*, Butterworth-Heinemann, Oxford.
- Hobbs, D.P. (2004), *Lean Manufacturing Implementation : A Complete Execution Manual for Any Size Manufacturer*, J. Ross Publishing, Boca Raton, Fla.
- Holmström, J., Ketokivi, M. and Hameri, A. P. (2009), "Bridging Practice and Theory: A Design Science Approach", *Decision Sciences*, Vol. 40, pp. 65-87.
- Iris, C. and Cebeci, U. (2014), "Analyzing relationship between ERP utilization and lean manufacturing maturity of Turkish SMEs", *Journal of Enterprise Information Management*, Vol. 27, no. 3, pp. 261-277.
- Janssens, G., van Moorst, L., Kusters, R. and Martin, H. (2020), "An expert-based taxonomy of ERP implementation activities", *Journal of Computer Information Systems*, Vol. 60, no. 2, pp. 175-183.
- Kobus, J., Westner, M. and Strahringer, S. (2017), "Change management lessons learned for Lean IT implementations", *International Journal of Information Systems and Project Management*, Vol. 5, pp. 47-60.
- Kobus, J., Westner, M., Strahringer, S. and Strode, D. (2018), "Enabling digitization by implementing Lean IT: lessons learned", *TQM Journal*, Vol. 30, no. 6, pp. 764-778.

- Kumar, S., Choe, D. and Venkataramani, S. (2012), "Achieving customer service excellence using Lean Pull Replenishment", *International Journal of Productivity and Performance Management*, Vol. 62, no. 1, pp. 85-109.
- Kundu, G.K. and Bairi, J. (2014), "A scale for measuring the applicability of lean practices in IT support services", *Journal of Enterprise Information Management*, Vol. 27, no. 5, pp. 1-25.
- Liker, J.K. (2004), *The Toyota way*, McGraw-Hill, New York.
- Liker, J.K. and Morgan, J. (2011), "Lean Product Development as a System: A Case Study of Body and Stamping Development at Ford", *Engineering Management Journal*, Vol. 23, no. 1, pp. 16-28.
- Lokkerbol, J., Does, R., Jeroen, M. and Schoonhoven, M. (2012), "Improving processes in financial service organizations: where to begin?", *International Journal of Quality & Reliability Management*, Vol. 29, no. 9, pp. 981-999.
- Maguire, K. (2016), "Lean and IT---Working Together? An Exploratory Study of the Potential Conflicts Between Lean Thinking and the Use of Information Technology in Organisations Today" in *Understanding the Lean Enterprise: Strategies, Methodologies, and Principles for a More Responsive Organization*, eds. A. Chiarini, P. Found & N. Rich, Springer International Publishing, Cham, pp. 31-60.
- Malmbrandt, M. and Åhlström, P. (2013), "An instrument for assessing lean service adoption", *International Journal of Operations & Production Management*, Vol. 33, no. 9, pp. 1131-1165.
- Masini, A. and Van Wassenhove, L.N. (2009), "ERP Competence-Building Mechanisms: An Exploratory Investigation of Configurations of ERP Adopters in the European and U.S. Manufacturing Sectors", *M&SOM*, Vol. 11, no. 2, pp. 274-298.
- Matthews, R., MacCarthy B., Braziotis C. (2017) "Organisational learning in SMEs: a process improvement perspective", *International Journal of Operations & Production Management*, Vol. 37 Issue: 7, pp.970-1006.
- Myers, M.D. (2013), *Qualitative Research in Business and Management*, 2nd edn, SAGE Publications.
- Nadarajah, D. and Kadir, S.L.S. (2016), "Measuring Business Process Management using business process orientation and process improvement initiatives", *Business Process Management Journal*, Vol. 22, no. 6, pp. 1069-1078.
- Nauhria, Y., Wadhwa, S. and Pandey, S. (2009), "ERP Enabled Lean Six Sigma: A Holistic Approach for Competitive Manufacturing", *Global Journal of Flexible Systems Management*, Vol. 10, no. 3, pp. 35-43.
- Nightingale, D.J. and Mize, J.H. (2002), "Development of a Lean Enterprise Transformation Maturity Model", *Information Knowledge Systems Management*, Vol. 3, no. 1, pp. 15.
- Obwegeser, N., Nielsen, D.,T. and Spandet, N.,M. (2019), "Continual Process Improvement for ITIL Service Operations: A Lean Perspective", *Information Systems Management*, Vol. 36, no. 2, pp. 141-167.

- Pellerin, R. and Hadaya, P. (2008), "Proposing a New Framework and an Innovative Approach to Teaching Reengineering and ERP Implementation Concepts", *Journal of Information Systems Education*, Vol. 19, no. 1, pp. 65-73.
- Powell, D. (2013). ERP systems in lean production: New insights from a review of lean and ERP literature. *International Journal of Operations & Production Management*, 33(11), 1490-1510.
- Powell, D., Alfnes, E., Strandhagen, J.O. and Dreyer, H. (2012), "The concurrent application of lean production and ERP: Towards an ERP-based lean implementation process", *Computers in Industry*, Vol. 64, no. 3, pp. 324-335.
- Powell, D., Riezebos, J. and Strandhagen, J.O. (2013), "Lean production and ERP systems in small- and medium-sized enterprises: ERP support for pull production", *International Journal of Production Research*, Vol. 51, no. 2, pp. 395-409.
- Powell, D. and Strandhagen, J.O. (2011), "Lean production vs ERP systems: an ICT paradox?", *Operations Management (1755-1501)*, Vol. 37, no. 3, pp. 31-36.
- Pritchard, S. (2013), "Business Applications and Data Analytics make Companies Lean", *Computer Weekly*, pp. 22-24.
- Rajagopal, P. (2002), "An innovation—diffusion view of implementation of enterprise resource planning (ERP) systems and development of a research model", *Information & Management*, Vol. 40, no. 2, pp. 87-114.
- Reason, P. and Bradbury, H. (2007), *The SAGE Handbook of Action Research: Participative Inquiry and Practice*, SAGE Publications.
- Rytter, N.G. (2012), "Business Process Excellence – Theory vs. Business Reality?", *The European Business Review*, June, pp. 85-89.
- Sartal, A. and Vázquez, X.H. (2017), "Implementing Information Technologies and Operational Excellence: Planning, emergence and randomness in the survival of adaptive manufacturing systems", *Journal of Manufacturing Systems*, Vol. 45, pp. 1-16.
- Schniederjans, D. and Yadav, S. (2013), "Successful ERP implementation: an integrative model", *Business Process Management Journal*, Vol. 19, no. 2, pp. 364-398.
- Sun, H., Ni, W. and Lam, R. (2015), "A step-by-step performance assessment and improvement method for ERP implementation: Action case studies in Chinese companies", *Computers in Industry*, Vol. 68, pp. 40-52.
- Sunder M., V. (2016), "Lean six sigma project management – a stakeholder management perspective", *TQM Journal*, Vol. 28, no. 1, pp. 132-150.
- Tan, K.H., Platts, K. and Noble, J. (2004), "Building performance through in-process measurement: Toward an "indicative" scorecard for business excellence", *International Journal of Productivity and Performance Management*, Vol. 53, no. 3, pp. 233-244.
- Trstenjak, M. and Cosic, P. (2019), "Lean Philosophy in the Digitalization Process", *Annals of the Faculty of Engineering Hunedoara - International Journal of Engineering*, Vol. 17, no. 1, pp. 13-16.

- Van Aken, J., Chandrasekaran, A. and Halman, J. (2016), "Conducting and publishing design science research", *Journal of Operations Management*, Vol. 47-48, no. 1, pp. 1-8.
- Vashishth, A., Chakraborty, A. and Antony, J. (2019), "Lean Six Sigma in financial services industry: a systematic review and agenda for future research", *Total Quality Management and Business Excellence*, Vol. 30, no. 3, pp. 447-465.
- Vilpola, I.H. (2008), "A method for improving ERP implementation success by the principles and process of user-centred design", *Enterprise Information Systems*, Vol. 2, no. 1, pp. 47-76.
- Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management*, 22(2), 195-219.
- Wallace, T.F. and Kremzar, M.H. (2002), *ERP: Making It Happen: The Implementers' Guide to Success with Enterprise Resource Planning*, 3rd edn, Wiley & Sons, Hoboken, NJ.
- Womack, J.P. and Jones, D.T. (2003), *Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Revised and Updated*, 2nd edn, Free Press, New York.
- Yin, R. K. (2009). *Case study research: Design and methods*. SAGE Publications.



**Figure 1.** *The study design*

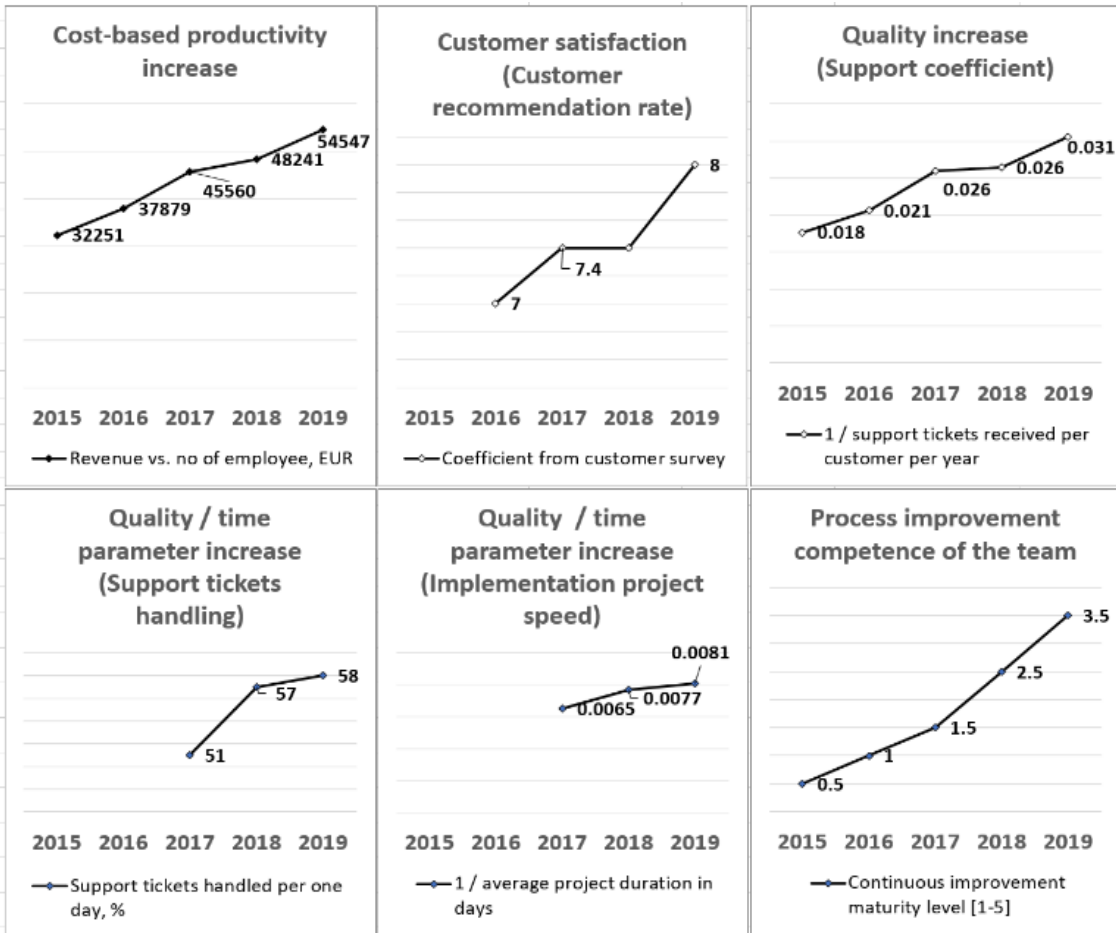
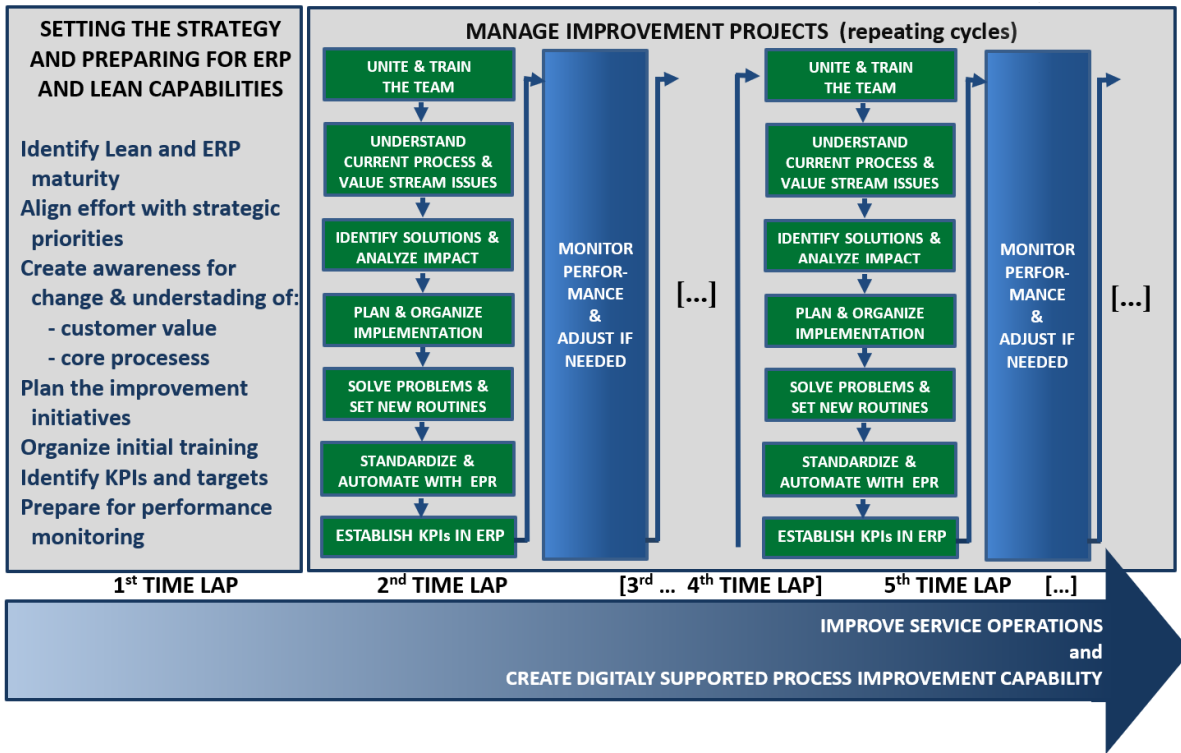


Figure 2. Graphical overview of the outcome



**Figure 3.** Developed framework for digitally supported business process improvement capability by combining implementation of ERP and Lean

	Powell <i>et al.</i> (2012)	Bortolotti and Romano (2012)	Vilpola (2008)	Pellerin and Hadaya (2008)	Berchet and Habchi (2005)	Wallace and Kremzar (2002)	Rajagopal (2002)	Kumar <i>et al.</i> (2012)	Malmbrandt and Ahlström (2013)	Bicheno and Holweg (2009)	Hobbs (2004)	Nightingale and Mize (2002)	Womack and Jones (2003)
Investment and cost–benefit analysis	■				■	■	■						
Define system requirements	■	■	■	■	■	■	■						
Software and vendor selection	■		■		■	■	■						
Business process reengineering (BPR)	■		■	■			■						
Data cleanup and conversion	■					■							
Software configuration	■	■	■	■		■							
Software installation	■		■			■							
Software customization	■	■	■			■	■						
System integration	■	■				■							
ERP system project Go-live	■	■	■	■	■	■							
Establish strategic goals and vision	■			■	■	■	■			■	■	■	■
Initial education	■		■			■				■		■	■
Define performance goals	■	■	■	■		■		■		■		■	■
Define processes	■	■	■	■	■	■	■	■	■	■	■	■	■
Ongoing training/learning	■	■	■	■	■	■			■			■	■
Continuous improvement	■	■		■	■	■		■	■	■	■	■	■
Organizational setup for change	■											■	■
Define and establish teams	■	■						■		■	■	■	■
Implement basic foundations of lean	■									■		■	
Understand customer needs		■						■	■	■	■		
Define products	■									■	■		■
Establish zero defect mentality	■								■	■			■
Vertical information systems	■									■		■	■
Identify flow and challenges in the flow	■	■						■	■	■	■	■	
Standardize work								■	■				
Lean accounting	■									■			■
Pull system	■							■	■	■	■		
Measure /control		■						■	■	■		■	

**Table I.** Steps from different Lean and ERP implementation frameworks