UNIVERSITY OF LJUBLJANA
SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

USE OF LOW-CODE DEVELOPMENT PLATFORM FOR PROCESS IMPROVEMENT – CASE OF SELECTED COMPANY

Ljubljana, January 2025 PAVEL JOVANOV

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LIST OF ABBREVIATIONS

AI - Artificial Intelligence

API - Application Programming Interface

BI - Business Intelligence

BPM - Business Process Management

BPMS - Business Process Management System

CAGR - Compound Annual Growth Rate

CG - Corporate Governance

COTS - Commercial Off-The-Shelf

CX - Customer Experience

DPA - Digital Process Automation

ERP - Enterprise Resource Planning

ICT - Information and Communication Technology

iBPMS - Intelligent Business Process Management System

IT - Information Technology

KPI - Key Performance Indicator

LCDP - Low-code development platform

ML - Machine Learning

OCR - Optical Character Recognition

P2P - Peer-to-Peer

RPA - Robotic Process Automation

SaaS - Software as a Service

1 INTRODUCTION

A corporate information system typically combines multiple technologies, frameworks, and libraries. However, handling these dependencies can be expensive as the corporate system becomes larger and more complex. Additionally, the software industry is facing a shortage of skilled technical experts, making it increasingly difficult to find qualified developers for many applications in the market (Pinho, 2023).

As a result, corporations have a growing demand for simplified and expedited development processes for complex enterprise solutions. These solutions must be easily integrable, modifiable, and upgradable, enabling organizations to swiftly adapt to market dynamics, changes in legislation, and evolving customer requirements (Serengetitech, 2021).

Consequently, in recent years, there has been a significant rise in the prominence of low-code development platforms (LCDPs) as an approach. As the name suggests, LCDP allows for software development with minimal code writing (Pinho, 2023).

LCDP empowers individuals with limited coding skills to create and deploy digital solutions that cater to specific business requirements. By reducing technical barriers associated with coding, low-code enables practitioners or even end-users who have domain expertise to address their business challenges through digital solutions (Martinez & Pfister, 2023).

According to Gartner, the global low-code development technologies market is expected to reach a value of $26.9 billion in 2023, which represents a 19.6% increase from 2022. The adoption of low-code technologies is set to accelerate in the coming years, driven by an increase in business technologists and the implementation of enterprise-wide hyper automation and composable business initiatives. It is projected that the market will continue to grow at a compound annual growth rate (CAGR) of 29.6% and reach $92.09 billion by 2027 (Gartner, 2022).

While LCDP does offer a quick development approach it may come with several limitations like lack of customization, limitations in scalability, vendor lock-in (getting locked in a particular vendor environment) and security risks. The following can arise in the case of developing and releasing apps with no consideration for organizational IT security, called shadow IT (Martinez & Pfister, 2023).

Since business processes are essential for the day-to-day execution of business activities, in my master thesis I will be focusing on the use of a LCDP tool for improvement of a corporation's business process.

1.1 Problem statement

The challenge that most of the highly competitive companies and corporations face regarding their BPM are connected with poor understanding and management of processes in their value chain or lack of business intelligence and underdeveloped business agility to be able to adapt to changes (Vukšić et al., 2013).

The changed challenge includes the organization's necessity to rapidly adapt its processes in order to keep up with the evolving technological advancements. One approach to addressing these challenges is by tightly integrating the activities in a process's life-cycle, such as connecting the modeling, implementation, and analysis phases through the data generated and utilized during process execution (Dumas, La Rosa, Mendling, & Reijers, 2018).

For that being the case, a question of whether LCDP can be a sufficient tool for managing a chosen corporation's business process. A tool which is capable of handling business processes on a daily basis in a way which satisfies company's objectives and optimizes the business processes. At the same time, it should be customizable enough so that it can meet company's future requests, as an answer to the changing business environment.

Therefore, the purpose of this master thesis is to find out what are the business requirements of Corporation X for BPM improvement and assess whether LCDP is an appropriate choice for fulfilling these requirements.

In case of not being an appropriate choice, to present what the constraints of LCDP are and suggest alternatives for solving the company's need for process improvement.

1.2 Research context

The goals of this study are:

- to examine the functioning of LCDPs;

- to examine a business process of Company X and company's business opportunity to use LCDP for BPM purposes;

- to analyze, on the basis of the company's requirements, the suitability of using the LCDP tool for business process (BP) improvement.

The main research question is to what extent the LCDP can meet corporation's business requirements for business process improvement. The research sub-questions are; what are the LCDP BPM solution requirements in relation to the company's business needs, whether the characteristics of the company have a strong influence on the choice of LCDP BPM solution and whether it makes sense to introduce a LCDP BPM solution in a corporation.

The research method used in this thesis is a case study, which allows the theoretical findings to be compared with a concrete example and findings to be summarized. The purpose of this case study is mainly to relate the general characteristics of LCDP BPM solution, especially for corporations, to the specific case of a large company, and to determine whether LCDP as a BPM solution is suitable for this type of company.

The reason I have chosen a large company operating in the healthcare market as a case study is that there has been too little research in the past on how large companies are taking advantage of the opportunities offered by LCDP to build information systems for BPM improvement. The second reason is that this is a business case that I am working on myself in the company and I have a good insight into the company's operations and requirements.

1.3 Outline

This thesis is structured as follows. Chapter 2 introduces LCDPs for BPM. It includes the definitions of LCDP and BPM, an analysis of the advantages and the disadvantages of using LCDP as a BPM solution, and a discussion of current LCDP trends. The chapter also outlines different methods for deploying a BPM solution (own development, using a developed platform, employing LCDP). Furthermore, it reviews major LCDP vendors Appian, IBM and Ultimus and concludes by addressing the challenges associated with deploying LCDP solutions for BPM.

Chapter 3 examines the corporate finance digital solutions market, providing an analysis of the market and detailing the types of digital solutions available. Chapter 4 focuses on presenting the technological characteristics of corporations, the use of ICT for BPM and the adoption of LCDP in large enterprises.

In Chapter 5 I focus on the case study and BPM technology improvement needs in Company X. This chapter begins by outlining the research methodology and provides a description of Company X. Additionally, it examines the company’s current approach to BPM, details the company's specific characteristics relevant to the studied process, describes the actual situation in the company, the identified requirements for business process improvement and the expected benefits of such improvements.

Chapter 6 assesses the suitability of LCDP for BPM as a business solution and offer suggestions to the company for the use of BPM business solutions. In Chapter 7 all the results, their implications and limitations are discussed. Lastly, I conclude the study in Chapter 8.

2 LOW-CODE-DEVELOPMENT PLATFORMS FOR BPM

2.1 Definition of LCDP

Rather than just writing code, though some coding may be necessary, an LCDP offers a development environment for creating application software, typically using a graphical

user interface. Applications created on a low-coded platform could be fully functional or call for more coding in certain circumstances. Platforms for low-code development can shorten the time required for traditional development, allowing commercial applications to be delivered more quickly (Wikipedia, 2023).

When talking about the occurrence of LCDP we have to start with the reason for the appearance of those platforms. In today's digital age, there's a big shortage of skilled software developers. Experts predict that there will be a much higher demand for IT professionals than there are people available to fill those roles (Waszkowski 2019; Torres 2018). To make things even more difficult, it's costly and challenging to train and hire new software developers in our fast-changing world (Pane & Myers 2006).

Therefore, the goal of LCDP is to tackle this problem by making software development more accessible to people who are experts in their own fields and by making the process of creating and using software faster. LCDP aims to close the divide between what a system needs and what developers can do in a certain time, which is often a major reason why it takes a long time to create complex business applications (Pane & Myers 2006).

LCDPs introduce a fresh approach to building software applications with limited manual coding, employing visual programming, a user-friendly graphical interface, and model-driven design. In line with the principles of End User Software Programming (Pane and Myers 2006), LCDPs extend the opportunity for software development to individuals with diverse expertise (Di Sipio et al. 2020). It combines diverse techniques including visual modeling, swift app development, model-driven design, cloud computing, and automatic code generation (Sahay et al. 2020; Di Sipio et al. 2020).

Low-code development tools make it easier to create apps that are ready for use without needing to write as much code, thanks to automatic code generation. Moreover, Low-Code platforms offer greater adaptability and speed, allowing for faster development, quicker responses to market demands, reduced bug fixing, simplified deployment, and easier maintenance (Sahay et al. 2020; Di Sipio et al. 2020).

Additionally, these platforms are employed to create efficient, database-powered mobile and web applications for a range of uses and consequently, low-code development is quickly gaining widespread acceptance. For instance, Forrester predicts that the LCDP market is on track to reach a value of $21 billion by 2022. Furthermore, a Gartner report forecasts that by 2024, over 65% of large companies will be using LCDPs to some degree (Wong et al. 2019).

As of 2022, there are over 400 LCDPs available, with nearly all major companies like Google (2020) and Salesforce (2022) offering their versions (Ugur, 2021).

However, LCDP comes with its own set of distinctive challenges (Sahay et al. 2020). Opting for the wrong LCD application or platform could lead to a loss of time and resources.

LCDP draws inspiration from the model-driven software approach, which emphasizes abstract representations of knowledge and activities as the driving force behind development, rather than solely focusing on algorithmic computation (Sahay et al. 2020).

Among the most well-known low-code platforms are Appian (2022), Google App Maker (2020), Microsoft Powerapps (2022), and Salesforce Lightning (2022).

A standard LCDP application can be constructed using one of two methods (Sahay et al. 2020):

The "UI to Data Design" approach, in which developers first create the user interface and then establish connections to the required data sources.

The "Data to UI" approach, where the process begins with designing the data model and is followed by the creation of user interfaces.
In both approaches, application logic is implemented, and third-party services and APIs are integrated as needed.

One of the key driving factors behind LCDP is the aim to construct applications, receive feedback from users, and swiftly implement those suggested modifications (Waszkowski 2019).

2.2 Definition of BPM

The labor of today's organizations is complex, requiring a workforce of people, artificial intelligence (AI), robots, and smart technologies, as well as a multitude of jobs and vast volumes of information. It can be challenging, if not impossible, to achieve and replicate favorable results without well-organized business process management (BPM) methods to handle processes, data, and people (Appian, 2023).

This is the reason why businesses employ BPM, a people-driven discipline, to manage, develop, and improve processes. The continuous improvement of business outcomes is the main goal of BPM.

BPM helps to improve performance, key performance indicators (KPIs), and overall outcomes by focusing on complete processes as opposed to individual activities. This method lowers expenses, improves employee happiness, and reduces mistakes (Appian, 2023).

Having said that, BPM is a management discipline and a collection of supporting technologies that:

- concentrates on how the business executes work to deliver value to employees and stakeholders across various functional areas,
- strives for an organization-wide perspective of value delivery, and
- sees the company from a process-centric perspective (BABOK, 2015).

An organization's work processes may be improved by the implementation of a BPM effort, which adds value.

BPM controls the creation, modification, cancellation, and governance of both automated and human processes. Process-centric organizations consider BPM as a continuous endeavor and an essential component of the organization's continuing administration and operation. (BABOK, 2015).

All processes, no matter how efficient at first, eventually become ineffective unless they are constantly improved and adjusted. As a result, BPM may be thought of as an uninterrupted cycle (see Figure 1) that includes the subsequent stages:

1. Process Identification: A business challenge is formulated at the start of this phase. Next, pertinent processes are found, described, and linked. A redesigned process architecture that provides a broad overview of the organization's processes and their interrelationships is the end result. This stage and the selection of performance metrics, which are frequently crucial for process analysis, might occasionally overlap.

2. Process Discovery (As-Is Process Modeling): This entails using as-is process models to record relevant processes in their existing condition. It offers a glimpse of the current state of affairs.

3. Process Analysis: During this stage, problems with the existing procedures are located, recorded, and, if feasible, measured in terms of performance metrics. An organized list of concerns with a priority system based on effect and expected effort to resolve is the outcome.

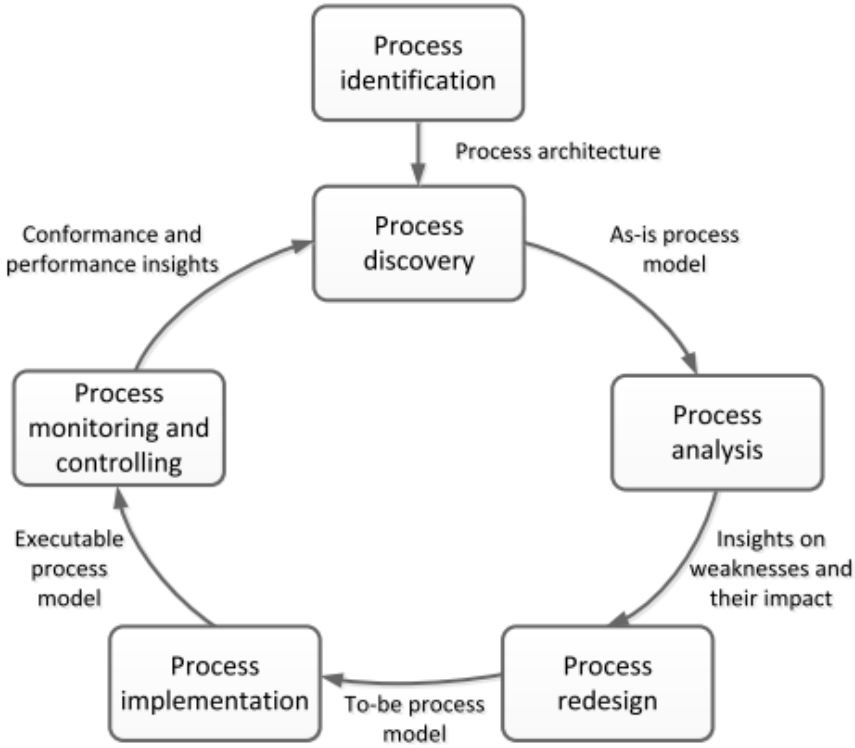
4. Process Redesign (Process Improvement): The purpose is to find modifications that solve problems from the previous stage and help the company reach its performance targets. Selected performance metrics are used to evaluate and contrast different change choices. Process analysis and redesign go hand in hand: after analyzing new change alternatives, a redesigned process is shown by a to-be process model.

5. Process Implementation: This stage entails getting ready for and carrying out the modifications needed to go from the existing (as-is) process to the newly designed (to-be) process. It includes process automation (creating and implementing IT technologies to support the new process) and organizational change management (modifying participants' working ways). Process automation is the main topic of the book, namely the technique of creating an executable process model from the to-be process model and implementing it in a BPM system (BPMS).

6. Process Monitoring and Controlling: Following the redesign of the process, information is gathered and examined to evaluate the process's performance in relation to predetermined benchmarks and goals. Corrective measures are implemented once any faults, bottlenecks, or departures from the intended behavior are found and addressed. This

cycle of continual monitoring and managing is triggered by new concerns, which necessitates repeating the entire process (Dumas, La Rosa, Mendling, & Reijers, 2018).

Figure 1: BPM lifecycle



Source: Dumas, La Rosa, Mendling, & Reijers (2018)

Historically, the BPMS has been the technology closely linked to the BPM discipline. The purpose of this software platform is to support the definition, implementation, and oversight of business processes (Grigory & Casati, 2004).

As A Van der Aalst et al. 2016. explained, Workflow Management (WFM) solutions may be thought of as a step up from the notion of BPM. WFM focuses mostly on business process automation, whereas BPM covers a wider range, including operations management, process analysis, and general work organization.

BPM aims to improve business processes on the one hand, sometimes without the use of new technology. For example, management might generate suggestions for cost reduction and service level improvement by modelling and simulating a company process.

However, BPM is often associated with software that is meant to monitor, control, and support operational processes (van der Aalst et al., 2016).

Because of this link, a new class of technology called BPM systems has emerged. These systems are capable of integrating with a wide range of other systems, including legacy systems, and of adapting to developing ones like mobile devices and cloud networks.

It is amazing how well BPM systems have replaced WFM systems, their predecessors (van der Aalst et al., 2016).

A BPMS has historically been seen as both highly desirable and frequently critical for enterprises hoping to use BPM successfully. The implementation of a BPMS which synchronizes the many phases of a business process, inevitably causes the implementing company to become more process-oriented (Reijers, 2021).

A BPMS differs from an Enterprise Resource Planning (ERP) system. ERP systems include integrated applications for gathering, storing, managing, and analyzing data from various business operations, even though both are engaged in carrying out business processes. Conversely, a BPMS's unique feature is the way it is configured using an executable process model that is processed by an internal workflow engine. Because of this special feature, a BPMS may support multiple flows for different kinds of operations. Nevertheless, workflow engines may also be integrated into contemporary ERP systems, integrating the advantages of both software platforms (Reijers, 2021).

Although the BPMS's full potential has not yet been reached, using it should give a business the following benefits (Grigory & Casati, 2004):

1. It lowers the organization's total workload by automating process coordination.

2. It makes it easier for the many IT systems used by the company to support work to be integrated in a flexible way.

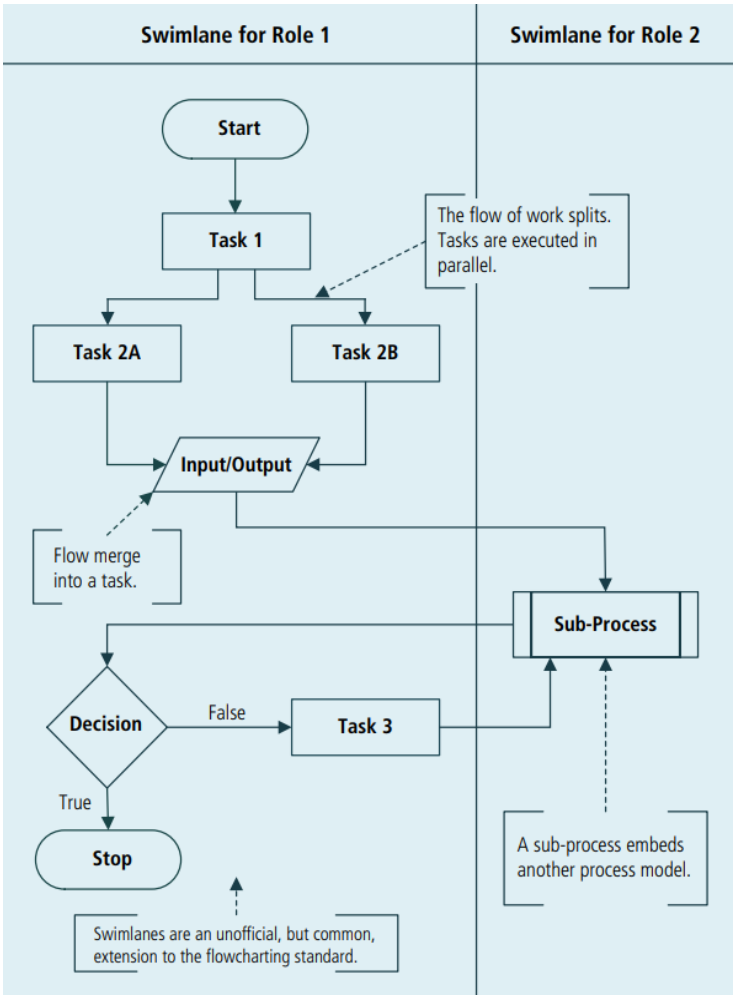
3. It improves process traceability and transparency.

4. It simplifies the application of organizational guidelines and procedures.

For the purpose of modeling business processes, Business Process Model and Notation (BPMN) is a standardized language that guarantees accessibility for both business users and technical developers. This language is flexible enough to support several kinds of modeling, including both collaborative (public) and internal (private) procedures. It is possible to use BPMN as an efficient input for process automation systems (BABOK, 2015).

One of BPMN's most important features is its ability to employ swimlanes and pools to distinguish between the actions of various process participants (see Figure 2). In situations where the workflow crosses a swimlane, accountability for that task flows to another job in the organization (BABOK, 2015).

Figure 2: Swimlane diagram



Source: BABOK (2015)

2.3 Advantages and disadvantages of using LCDP as a BPM business solution

The low-code platform functions as a toolkit intended for those with and without programming experience, enabling the rapid development and implementation of commercial applications requiring little or no coding. This platform is notable for how well it installs, configures, trains, and implements changes (Waszkowski, 2019).

Low-code solutions are becoming more and more popular, which is a significant development in the creation of critical business applications. As of right now, this strategy is acknowledged as the fastest and maybe most economical way to build software. The usage of low-code solutions becomes essential in the dynamic business environment where quick adaptation to rivals, suppliers, and the constantly shifting needs of contemporary customers is essential (Waszkowski, 2019).

Nevertheless, there are a number of disadvantages when using LCDP as a BPM solution. The performance of low-code applications is nearly invariably inferior to that of software written in an actual programming language (TechTarget, 2022).

Low-code frequently has the drawback of assuming a certain application structure. The majority of low-code tools are made for particular kinds of applications, such as matching and processing, summarizing and reporting, or choosing and reporting. To suit these established models, the low-code developer must add details. This speeds up development and simplifies some activities, but it also limits the functionality of the application (TechTarget, 2022).

Advantages of using LCDP as a BPM solution:

- Enhanced efficiency and effectiveness in app development: Development times for low-code apps are shortened since they require less manual coding. This enhanced effectiveness makes functioning apps available on schedule (Käss & Strahringer, 2023a).
- Democratization of development: By utilizing pre-defined components and templates, low-code apps simplify the process of creating applications for business users. By streamlining the development process, this method enables a stronger emphasis on innovation and satisfying user needs (Käss & Strahringer, 2023a).
- Cost-efficiency: Because low-code apps take less resources to build, they require fewer man hours and do not require hiring developers with expertise, which results in cost savings (Martinez & Pfister, 2023).
- Simplified maintenance: Because low-code applications have less code than traditional approaches, they produce fewer lines of code, which simplifies and expedites maintenance tasks (Martinez & Pfister, 2023).
- Less requirement instability: Low-code development minimizes development cycles brought on by inconsistent requirements, prevents resource waste on pointless features, and permits the early prototype production essential for requirements validation (Martinez & Pfister, 2023).
- Enhanced business professional involvement: Low-code enables a higher level of participation in the development process from those directly involved in operations. This facilitates the translation of requirements into application features because those directly involved in the process have a better grasp of the demands of the company (Martinez & Pfister, 2023).
- Reduced required knowledge for application development: Web development is a constantly changing sector that requires new abilities. Lack of necessary abilities is a problem that many businesses face. It gets expensive to hire highly competent engineers, especially when working with out-of-date systems and apps. Leveraging pre-existing expertise, low-code development provides an innovative answer to this skills gap (Käss & Strahringer, 2019).
- Easily work across many devices: You can write an application once and use it on several devices using low-code development. Its platform independence and simple one-click deployment mean that you just have to build new features or upgrades once for all instances of the application. The result is a continuously top-notch user experience regardless of the device—desktop, mobile, or tablet (MRC, 2019).

- Low code can stop shadow IT: Applications are needed five times more frequently than an IT department's ability to supply them, according to Gartner. Users frequently resort to third-party solutions when they don't receive what they need right away, leading to what is known as "shadow IT." (MRC, 2019). Using legally sanctioned LCDPs is a good strategy for an IT department to avoid involvement in shadow IT. With the help of these platforms, business users may develop their own solutions without worrying the IT department, and IT can continue to regulate user access and data (Käss & Strahringer, 2019).

Disadvantages of using LCDP as a BPM solution:

- Customization and flexibility issues: Low-code platforms have more limits than designing bespoke software, which has less. Certain low-code solutions may not provide businesses with the exact capabilities they need because of certain restrictions on the user interface and flow. Platforms vary in terms of customization options as well, from restricted options to access to the core code (Käss & Strahringer, 2023b).
- Too complex development for citizen developers: Despite their ease of use, some aspects of LCDPs might still be too complex for non-professional developers and would require skilled LCDP developers (Käss & Strahringer, 2023b).
- Lack of governance: Governance issues are primarily because LCDPs empower a broader range of users, including those with limited technical expertise, to develop applications. This democratization of development can lead to challenges in maintaining control, ensuring compliance and securing the application's data (Käss & Strahringer, 2019).
- Lack of regulatory approval: In certain industries, the lack of regulatory approval for LCDP-developed applications can be a significant barrier, as strict regulations are in place to protect sensitive data. One of the interviewed experts from the research Practitioners' Perceptions on the Adoption of LCDPs stated: "For me, especially in Germany, especially in the public sector, the issue is regulatory. That is a big inhibitor" (Käss & Strahringer, 2023a).
- Vendor lock-in: One of the main concerns with LCDPs is the worry of being dependent on a single provider. However, depending on the vendor selected, this scenario can change. Certain manufacturers provide code that is generally standardized and clean, which makes it easier to maintain apps running on their platform. On the other hand, some suppliers write intricate code that makes maintaining apps on platforms other than their own almost impossible. Some suppliers even limit your freedom to change applications after you stop using their product (AlphaSoftware, 2023).
- Limited portability: portability refers to the ease with which software can be transferred from one environment to another. This includes moving applications across different operating systems, hardware platforms or cloud environments. LCDPs often create applications that are tightly coupled with the platform's specific environment and infrastructure which can make it challenging for an organization to migrate applications to a different environment (Käss, Strahringer, 2023b).

- Using low-code development tools to mitigate shadow IT risks: IT department heads occasionally come across cases of unapproved use of low-code development tools by people or departments. This wastes resources and puts organization's security at danger. It's critical to watch out for warning indications, such as requests for strange software from the help desk, in order to solve this problem. (AlphaSoftware, 2023).
- Scalability as low-code drawback: Scalability refers to an application's ability to be used on bigger projects, systems, or organizations (Käss & Strahringer, 2023b).
- Increased license costs: Although the cost of developing an app may be minimal at first, as more users download and use it, the costs increase (Martinez & Pfister, 2023).

It is clear from the benefits and drawbacks listed above that the main benefits of low-code are cost effectiveness, quicker development, and user-friendly interfaces.

In addition to reducing the amount of human coding, the guided low-code method facilitates smooth data integration, provides space for experimentation and discovery of novel ideas, and acts as a single point for configuration and application maintenance.

On the other hand, a major disadvantage of LCDPs is that they provide consumers very little customization possibilities for their apps. This occurs because you are limited to using the features that the low-code platform offers since low-code is not as powerful as traditional programming. If the user is not an experienced developer, it may be difficult to achieve certain needs in more complicated scenarios. Furthermore, because low-code systems can be costly per user, some firms are reluctant to fully utilize them and may experience scaling concerns. Vendor lock-in, another issue, is the risk of being restricted to a single provider.

Furthermore, as demand for business solutions is growing rapidly, this creates a risk of shadow IT. Meaning that low-code platforms let business users build solutions without heavy IT involvement for maintaining data control. However, unauthorized low-code use may pose resource and security risks. In this case, monitoring for signs like requests made by employees for installation, use or access to software that the IT department is not aware of or has not previously been approved is crucial.

2.4 LCDP trend

LCDPs have grown significantly in the last several years, attracting both commercial and academic interest. The market research company Forrester first coined the phrase "low-code" in 2014 (Richardson, 2014).

LCDPs were defined as platforms that enable the rapid development of commercial applications with little to no human coding and a little upfront setup, training, and deployment cost. This research recognized BPM as one of the LCDP categories, along with software for CRM, corporate resource planning, and other productivity-boosting programs (Di Ruscio, 2022).

The term "low-code" has undergone changes over time, and Forrester provided a more thorough explanation in 2017. LCDPs are defined as products or cloud services for application development in this revised definition. These platforms are available to clients for little or no initial cost in terms of money and training time, and they make use of declarative, visual methodologies rather than traditional programming. As the platforms yield higher economic value, the associated costs also climb (Forrester, 2017).

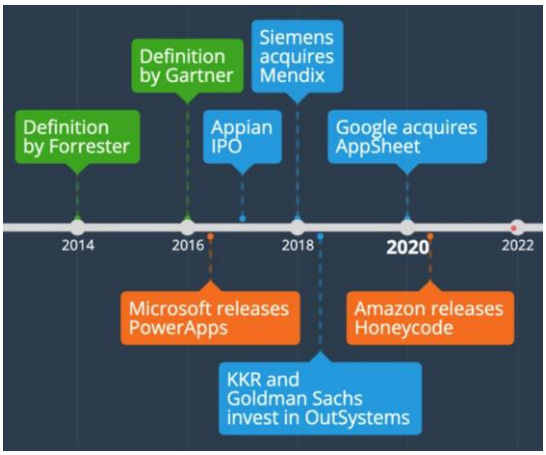
In May 2017, Appian began its initial public offering (IPO), and by 2018, its market worth had nearly attained $2 billion. OutSystems raised $360 million in funding in July 2018. In August 2018, Siemens said that it will buy Mendix for $730 million. In 2017, Forrester estimated that the global market for LCDPs was worth $3.8 billion (Forrester, 2018).

Additionally, Forrester regularly surveys developers about their use of LCDPs. Low-code platforms were used by 23% of developers in 2018; another 22% intended to use them in the next year (Forrester, 2019).

By 2019, 37% of developers were using or planning to use low-code products, indicating a rise in their use (Forrester, 2020).

By 2021, LCDPs are included into cloud-based services by major cloud providers. When Microsoft released its Power Apps LCDP in November 2016, it set the standard. In January 2020, Google became part of the trend by purchasing LCDP vendor AppSheet, making it their go-to low-code option. With the release of Honeycode, a low-code platform for creating web and mobile applications, in June 2020, Amazon made a splash (see Figure 3) (Di Ruscio, 2022).

Figure 3: Major events in low-code history



Source: Di Ruscio et al., (2022)

AgilePoint, Appian Corporation, Caspio Inc., Fujitsu RunMyProcess, LANSA, Magic Software Enterprises Ltd., MatsSoft Limited, Mendix Technology, Microsoft Corporation, Netcall, Oracle Corporation, OutSystems Inc., Pegasystems Inc., QuickBase Inc., ServiceNow Inc., WaveMaker, Zoho, Alphabet Inc. (parent company of Google Inc.), and TrackVia are some of the well-known companies in the LCDP market today.

These firms provide a range of LCDP solutions and play a major part in driving the market's growth and innovation (Low-Code Development Platform Global Market Report, 2023).

Furthermore, it is anticipated that by 2024, the combined market for low-code application platforms and hyper automation technologies—such as business process automation, robotic process automation, and citizen automation and development platforms will be close to $32 billion (Gartner, 2022).

We can observe an increasing trend towards low-code, but what is the reason for the recent spike in interest in low-code development?

This instance can be explained in a few ways:

One of the main reasons for the rise in demand for low-code development is the lack of qualified developers. The demand and supply of qualified software experts are significantly out of sync due to the extensive usage of software in many aspects of human existence (Breaux & Moritz, 2021).

Because highly talented coders are drawn to more financially lucrative and intellectually difficult tasks, this gap is always widening. As a result, there's an increasing need for business apps that are both more sophisticated than basic spreadsheets and inexpensive to create and update by hand (Di Ruscio et al., 2022).

Furthermore, as many LCDPs are cloud-based and don't require users to install specific software, they frequently don't require any initial setup. This lowers the bar to entry significantly for new users. They may quickly evaluate various platforms, create and distribute free small-scale apps, and do all of this in the comfortable setting of their web browser (Di Ruscio et al., 2022).

A contributing factor is also the notable expansion of the digital native labor force in the past four decades, which is distinguished by enhanced computer proficiency. Many nations now include basic computer programming as a required element of their curriculum. Digital natives now consist of domain experts, including accountants, doctors, and construction engineers (Di Ruscio et al., 2022).

Unlike in the past, when domain experts needed extensive training to become proficient with tools released forty years ago, modern domain experts need much less training to use LCDPs for implementing customized applications because they have a great deal of experience working with computers and important software (Di Ruscio et al., 2022).

Moreover, one noteworthy aspect of contemporary LCDPs is their cloud-based deployment capabilities. Apart from generating code, these platforms have the ability to implement software systems on cloud-based infrastructures that are scalable and offer

web-based interfaces for worldwide access. Because of this feature, releasing apps and updates takes much less time and effort, which makes LCDPs a desirable option for quick application development and delivery (Di Ruscio et al., 2022).

Finally, but just as importantly, reading books written by technology specialists was a major part of learning about application development in the past. But the emergence of the internet—particularly of video-sharing websites like YouTube—has changed the nature of education (Di Ruscio et al., 2022).

This change makes it possible to produce and communicate current training materials that are suited to a variety of audiences. With the capacity to create and share training materials like walkthroughs and screencasts, citizen developers can now create and facilitate more dynamic and participatory learning environments (Di Ruscio et al., 2022).

2.5 LCDP vendors for BPM

There are several vendors in the LCDP sector. I based my decision for which LCDP platforms to compare, on a graphical competitive positioning of four types of technology providers analysis tool developed by Gartner, called Magic Quadrant. Using Gartner's Magic Quadrant (see Figure 4) can be seen as a first step to understanding the technology providers the company might consider for their investment choice, in markets where growth is high and vendor differentiation is clear (Gartner, 2023a).

The Magic Quadrant categorizes companies based on their ability to execute and the completeness of their vision:

- Leaders in the magic quadrant effectively implement their existing vision and are well prepared for future developments.
- Visionaries have a clear sense of the market trends or a plan to alter market dynamics, but their execution is still a work in progress.
- Niche Players excel in a specific segment or struggle with focus and fail to outdo competitors in innovation or performance.
- Challengers perform strongly in the present or lead a significant market segment, but they lack insight into future market directions (see Figure 4) (Gartner, 2023a).

IBM BPM (iBPMS) is considered a leader in Gartner's Magic Quadrant because of its cloud infrastructure, low-code tool for creating a workflow solution very quickly, comprehensive automation capabilities and powerful integration. Its platform excels in combining process, task and decision automation, as well as at facilitating rapid development and deployment of intelligent applications.

The unified platform, built on a common data model with a consistent, web-based design, supports dynamic workflow automation and collaboration across multiple roles. This positioning emphasizes IBM's ability to deliver BPM solutions for enterprises, aligned with market demands and evolving technological trends (IBM, 2019).

Appian is recognized as a leader in the Gartner's Magic Quadrant (see Figure 5) due to its low-code design that excels in rapid development of enterprise corporations and process automation. The platform's user-friendly interface allows both technical and non-technical users to build and deploy applications quickly.

Figure 4: Gartner's Magic Quadrant

Source: Gartner (2023a)

Figure 5: Appian and IBM as Magic Quadrant Leaders

Source: IBM (2019)

Appian’s AI process automation features, data fabric to unify data across systems, and integration with various enterprise systems, contribute to its leadership position. Its ability to deliver end-to-end process automation, strong security and compliance features, demonstrates a clear strategic vision for the support of different business needs (Appian, 2023).

However, a niche player can also support an organization's needs better than a market leader, depending on how the vendor’s characteristics align with the organization's specific goals (Gartner, 2024).

For that reason and due to the fact that I have already worked with Ultimus BPM on smaller projects, the third studied LCDP vendor is Ultimus BPM. Ultimus could be positioned as a niche player, as this quadrant includes vendors that focus on a specific market or have a limited ability to execute compared to leaders. Ultimus is pioneering in integrating blockchain technology with its process automation suite and by that opens new possibilities in industries that require transparent and secure transactions. The company is targeting mostly financial services and government sectors, which align well with its strengths in handling complex regulated activities (Ultimus, 2023).

To evaluate each of the specified LCDP providers in order to compare them, I choose to use the SWOT (Strengths, Weaknesses, Opportunities, Threats) analytical technique, as this approach gives a clear picture of the differences and similarities between the vendors.

2.5.1 Appian

The complete BPM lifecycle is covered by Appian's all-inclusive low-code BPM solution, which includes workflow execution, performance measurement, process design and modeling, process execution, and ongoing process optimization. It provides a simple and effective method for BPM tasks for both technical and non-technical users. The following are the main functions and services that Appian provides to its users:

1. Model and design processes:
- With an emphasis on opportunities for improvement, Appian helps with process design and modelling (see Figure 6).
- Using visual interfaces, multidisciplinary teams comprising IT, citizen developers, and business users may create process models more quickly and efficiently.
- It offers a low-code platform for process design.

2. Execute process workflows:

- Appian prioritizes speed, security, and integration while executing processes.
- BPM apps with native DevOps support may be developed and launched rapidly.
- Without extra work, the platform guarantees a flawless experience across platforms, including mobile ones.

3. Measure and analyze process performance:

- Appian places a strong emphasis on process performance analysis and measurement, along with continuous improvement.
- The usefulness of process mining software is emphasized for fact-based and data-driven examination of operational system log files.
- Analytics and real-time management tools are available to track and alter in-flight procedures as needed.

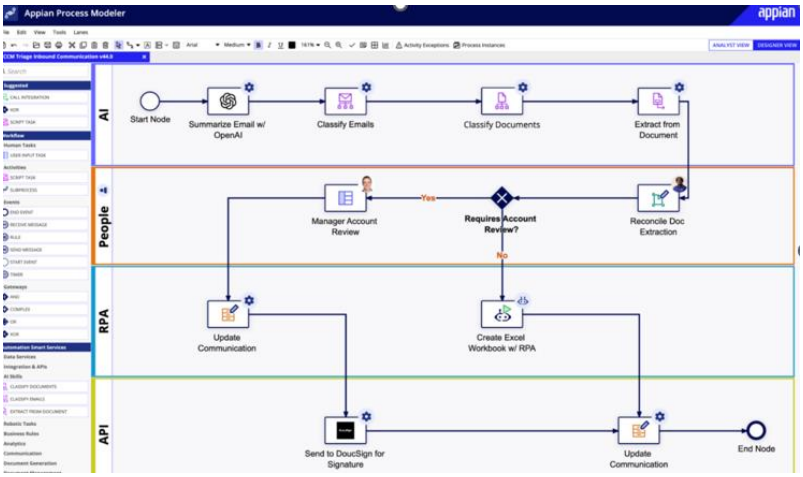
4. Enhance and optimize processes:

- One important factor is continuous improvement, and Appian encourages ongoing procedures to improve and optimize operations.
- By using predictive analytics, proactively identifying bottlenecks, adapting to changing circumstances, and dynamically reporting on company operations, the platform assists businesses (Appian, 2023).

Though Appian is best known for its low-code process automation and application development technologies, a substantial and growing part of the company's business is now Appian's Intelligent Document Processing (IDP). A suite of capabilities which are designed to automate the capture, extraction and interpretation of data from unstructured documents. IDP uses Optical Character Recognition (OCR) to recognize and extract text from images, PDFs and scanned documents. It also includes the ability to handle multi-language text and to recognize handwriting (Deep Analysis, 2024).

The platform can extract data from different document types, including tables and forms and can handle complex scenarios like multi-page tables and tables with merged cells. Additionally, the AI and ML components classify documents based on their content. Over time, by learning from each processed document, the accuracy of data extraction is improved (Deep Analysis, 2024).

Figure 6: Appian Process Modeler



Source: Appian, 2023

Table 1: SWOT Analysis for Appian BPM

STRENGTHS +	**WEAKNESSES -**
Emphasizes low-code development, which enables users to create robust business applications quickly and efficiently. Therefore, the platform is accessible to users with different levels of technical knowledge (Deep Analysis, 2024).	Implementing this comprehensive solution can be costly, especially for small to medium sized companies, due to the wide range of features and the need for proper training of employees (Deep Analysis, 2024).
Appian includes a wide range of tools like BPM, RPA, case management, business rules and AI/ML modules. This allows companies to manage several processes within a single platform (Deep Analysis, 2024).	Despite the low-code nature, Appian's users might require additional training to fully leverage the platform's capabilities (Deep Analysis, 2024).
Appian is globally present and is therefore able to support diverse clients across different industries globally (Deep Analysis, 2024).	The complexity of integrating Appian with existing systems of an organization can be a challenge for organizations using outdated software (Deep Analysis, 2024).
Appian has a wide range of no-code integration points to SAP, Oracle, Salesforce, Dropbox, etc., together with a range of APIs and connectors to most database types (Deep Analysis, 2024).	
Appian has a renewal rate of around 99%, which indicates high satisfaction and strong customer loyalty (Deep Analysis, 2024).	
OPPORTUNITIES +	**THREATS -**
To expand to relatively untapped markets such as supply chain management and energy, to offer solutions to these industries. (Deep Analysis, 2024).	The BPM market is highly competitive with different vendors offering similar solutions. In order to maintain its market position, Appian must continuously innovate (Deep Analysis, 2024).
To leverage its comprehensive BPM and RPA features in order to attract new customers, as more and more businesses seek process automation (Deep Analysis, 2024).	Economic fluctuations could affect Appian's budget for IT and process management solutions, with a downturn having a negative impact on the company's revenue growth (Deep Analysis, 2024).

(table continues)

(continued)

Table 1: SWOT Analysis for Appian BPM

OPPORTUNITIES +	**THREATS -**
To strengthen partnerships with major system integrators which can help Appian expand its implementation capabilities (Deep Analysis, 2024).	Technological advancements and changes in BPM methodology require constant updates and improvements to the platform. This requires additional resource investment by the company (Deep Analysis, 2024).

Source: Deep Analysis (2024)

2.5.2 IBM BPM

An all-inclusive platform for BPM is IBM Business Process Manager (see Figure 7). It gives users a strong toolbox for developing, testing, and putting into practice business processes and provides thorough monitoring for efficient administration (IBM, 2021).

The platform comes with specific tools for writers, administrators, and users, as well as a single BPM repository for centralized administration of business processes and related components. The solution, which comes in three versions, meets a range of demands and levels of BPM participation (IBM, 2021).

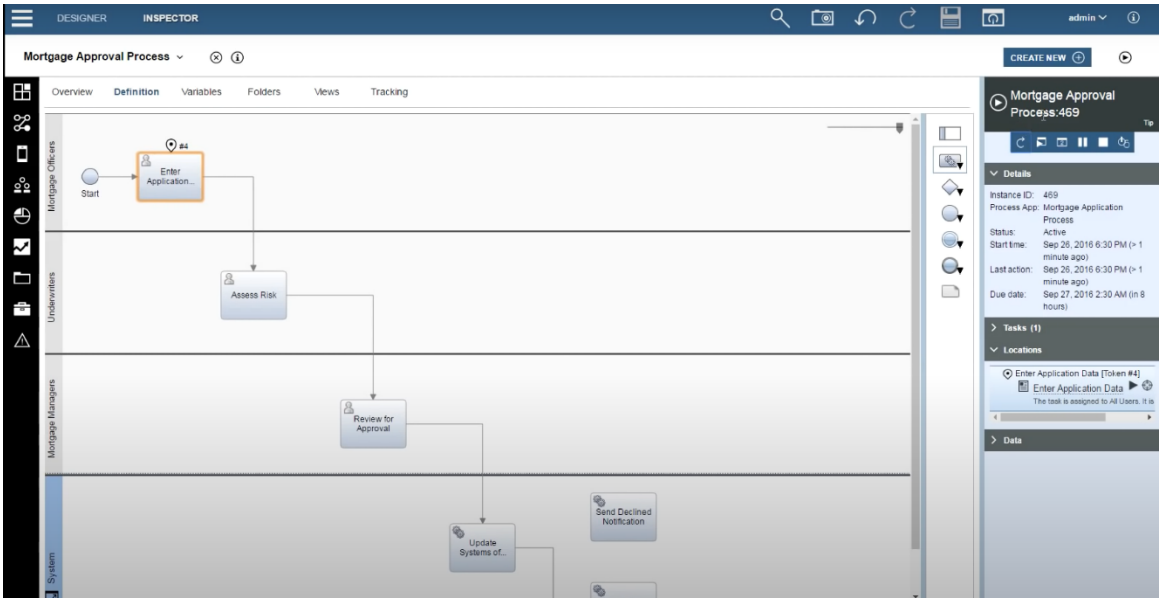
IBM BPM Express, the initial version, is marketed as an affordable, feature-rich, and easy-to-use solution for firms starting out in BPM. It is especially well-suited for medium-sized enterprises (IBM, 2021).

Full visibility, tooling, runtime support, and basic system interaction are just a few of the characteristics of the second edition of IBM BPM Standard, a reliable and scalable BPM solution.

It is meant for multi-project improvement initiatives, giving businesses the instruments they need to plan, carry out, keep an eye on, and enhance their business processes (IBM, 2021).

IBM BPM Advanced, the most sophisticated edition, is a feature-rich BPM system that offers enhanced integration and networking capabilities over and beyond the regular features. It provides transaction process management and enterprise integration. The platform is intended to provide a full suite of BPM capabilities to enterprises undergoing transition, while also streamlining task management and expanding support for high-volume automation (IBM, 2021).

Figure 7: IBM Business Process Manager (BPM): Building a Business Process



Source: IBM Business Process Manager, YouTube (2023)

Table 2: SWOT Analysis for IBM BPM

STRENGTHS +	**WEAKNESSES -**
IBM Business Process Manager on Cloud offers a full suite of BPM capabilities which allow for development, testing and execution of BPM projects (Carlson-Neumann, 2016).	For organizations which are not familiar with the IBM's ecosystem, the initial setup and understanding of the system can be complex, requiring additional training (Carlson-Neumann, 2016).
The cloud-based nature of the solution ensures that the environment is scalable and secure. It accommodates growth and protects sensitive information (Carlson-Neumann, 2016).	There is a dependency on the IBM BPM on Cloud team for certain operations, which can result in delayed processes if the support is not fast (Carlson-Neumann, 2016).
This IBM's solution unburdens users from having to install, configure and maintain the BPM product. This brings the focus on the management of business process applications (Carlson-Neumann, 2016).	
Provides collaboration between the IBM BPM on Cloud team and the users. Which is essential for a successful BPM implementation (Carlson-Neumann, 2016).	

(table continues)

(continued)

Table 2: SWOT Analysis for IBM BPM

STRENGTHS +	**WEAKNESSES -**
Offers various editions (Express, Standard, Advanced) for different organizational needs and scales, from entry-level to complex deployments (Carlson-Neumann, 2016).	
Provides tools for real-time monitoring and performance analytics which facilitates continuous process improvement (Carlson-Neumann, 2016).	
OPPORTUNITIES +	**THREATS -**
Opportunity to integrate IBM BPM with other IBM on Cloud services and tools will create a more comprehensive digital transformation environment (Carlson-Neumann, 2016).	Although the solution is scalable and designed to be secure, any security breaches or vulnerabilities could damage the reputation and trust in IBM's cloud services (Carlson-Neumann, 2016).
Opportunity to expand its user base, as currently more and more organizations are moving towards cloud solutions (Carlson-Neumann, 2016).	The competitive BPM market, with many other BPM solutions available, could be a possible threat to IBM BPM on Cloud's market share (Carlson-Neumann, 2016).
Opportunity to attract a wider range of businesses with specific needs by offering more flexible deployment models and more customization options. (Carlson-Neumann, 2016).	Technological changes could require continuous improvements and updates to the platform, as a challenge to keep up with the trend (Carlson-Neumann, 2016).

Source: Carlson-Neumann (2016)

2.5.3 Ultimus

Composed Process Solutions (CPS), Adaptive BPM Suite, and Advanced Task Service are the three essential parts of Ultimus BPM's DPA (see Figure 8) Suite, a powerful technology (Ultimus, 2024).

Using pre-built components, CPS facilitates the rapid construction and adjustment of processes and even supports the development of blockchain smart contracts. Using a distinct rules-based logic, the Adaptive BPM Suite emphasizes a "industrial" approach to process execution (providing tools for creating software that meets client demands without

starting from scratch). In addition to regulating system performance and providing an intuitive interface, the Advanced Task Service serves as a portal (Ultimus, 2024).

Table 3: SWOT Analysis for Ultimus BPM

STRENGTHS +	**WEAKNESSES -**
Ultimus has a global presence with offices across North America, Latin America, Europe, the Middle East and Asia. This wide distribution of sales allows the company to serve a variety of clients and to understand these markets' needs (Vignette, 2021).	While Ultimus offers low-code capabilities, for more complex automation projects it still relies on pro-code. This may require organizations to maintain a higher level of technical expertise, which can be seen as a barrier for businesses without a strong background in IT (Vignette, 2021).
The Ultimus Digital Process Automation Suite is an all-in-one system that combines low-code with pro-code environments. This versatility enables organizations to handle both simple and complex process automation projects efficiently (Vignette, 2021).	The comprehensive nature of Ultimus BPM might be overwhelming for smaller projects or organizations with limited process automation needs, leading to additional costs for initial setup and learning for such users (Vignette, 2021).
The core of Ultimus' BPM system is built around patented rules-based logic, which allows for a user and role-based structure for task allocation. This is a significant differentiator which provides flexibility and precision in the process management (Vignette, 2021).	
Ultimus provides a wide range of pre-configured assets and workflow components. This accelerates the design and deployment of custom workflows. It significantly reduces the time and effort required for process automation (Vignette, 2021).	
OPPORTUNITIES +	**THREATS -**
There is a significant potential for Ultimus to expand its presence in financial services and government sectors, as they require robust, compliant and efficient process automation solutions. These sectors are often involved in complex, regulated activities that align well with Ultimus' strengths (Vignette, 2021).	The growing popularity of low-code and no-code platforms presents a competitive threat to Ultimus as many organizations are turning towards these solutions because of their simplicity and reduced need for technical expertise (Vignette, 2021).

(table continues)

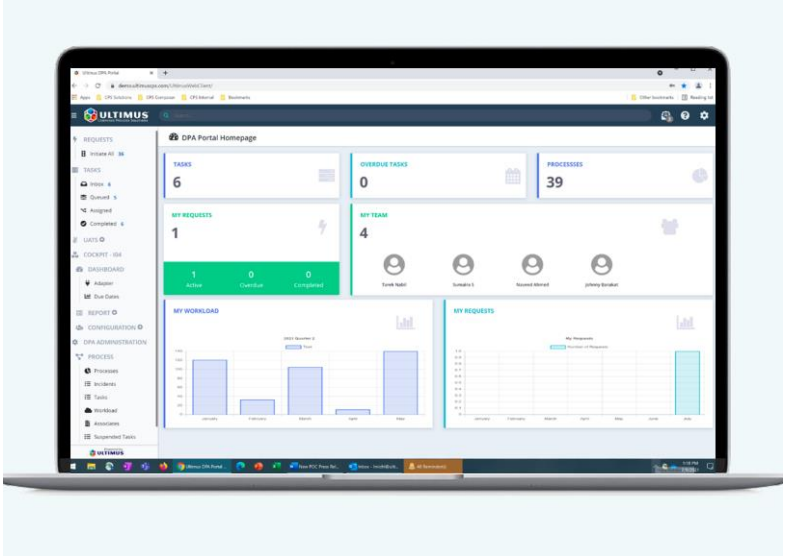
(continued)

Table 3: SWOT Analysis for Ultimus BPM

OPPORTUNITIES +	**THREATS -**
Ultimus is pioneering the integration of blockchain technology with its process automation suite, which enables the creation of quasi-smart contracts. This unique capability can open new possibilities in industries looking to utilize blockchain for transparent and secure transactions (Vignette, 2021).	The BPM market is becoming increasingly saturated with numerous vendors offering innovative solutions. Keeping space and differentiating offerings poses an ongoing challenge for Ultimus (Vignette, 2021).
Expanding its partner ecosystem can enhance Ultimus' market reach and implementation capabilities (Vignette, 2021).	

Source: Vignette (2021)

Figure 8: Ultimus DPA Portal Homepage



Source: Ultimus (2023)

2.6 The deployment of a BPM system

Software applications have naturally grown more adaptive to meet the unique needs of organizations as the number of software application creators and customers has expanded (Shahzad et al., 2017).

The software development process is often expensive in a traditional software development environment that follows protocols, standards, and team structures.

Businesses that disregard budgeted time and necessary funds put themselves at risk for software issues, which can raise losses and financial obligations (Shahzad et al., 2017).

It is well known that developing software takes a lot of time and resources, thus different resources must be carefully allocated to meet the needs of the development process. Many software models include estimates of costs and times, which encourages businesses to assess whether it is more economical to buy pre-existing software or create their own.

Despite the advantages and disadvantages of both strategies, choosing between construct and purchase is difficult and makes carefully weighing a number of considerations before making a choice necessary. Making the construct vs purchase decision is particularly tough, especially when it's being made for the first time (Shahzad et al., 2017).

When faced with this choice, Gomez says, organizations usually end up in one of three situations: either they buy a package solution and modify it to suit their needs, or they modify organizational needs to fit a purchased package, or they create a customized in-house software solution, each with their own set of advantages and disadvantages (Shahzad et al., 2017).

2.6.1 Own development

For basic company functions like accounting, payroll, sales tax, inventory, and customer relationship management (CRM), custom software development is not feasible when there are so many readily available solutions (Harvard, 2021).

However, writing custom code could become important if there isn't any software already out there that meets certain specifications and there's a good chance for improvements or better efficiency. Developing your own code is only worthwhile if there is a significant return on investment; otherwise, it is not recommended (Harvard, 2021).

A. Wilson has outlined the advantages and drawbacks of in-house and vendor-oriented development. According to Wilson, in-house development is preferable when there is a need to address a specific ad-hoc business process, the problem is unique and isolated, and the necessary staff for software development is available. In-house software development comes with certain benefits and drawbacks (Shahzad, 2017).

Employers may create and hire a customized workforce by developing BPM software internally. This method allows developers with specific technical knowledge to be assembled, giving the team a chance to be trained to understand the unique needs of the enterprise. As a result, the group may create software programs that satisfy and match the organization's requirements (Mettevo, 2023).

It gives the company the capacity to choose the development team according to certain goals. Because of this, the team may work directly with other departments to create specialized BPM software that meets specific needs. As a result, this cooperative strategy improves alignment and advances overall success (Mettevo, 2023).

It also provides fast application support, allowing developers to quickly fix any problems or errors. As a result, there is less downtime and faster reaction times. The team is able to prioritize important concerns and find solutions without the need for outside contractors or suppliers thanks to the prompt help (Mettevo, 2023).

However, the disadvantages of in-house development include the requirement for continuous employee involvement, reduced functionality, and difficulties with upgrades due to the necessity of a full iteration of development, which entails large time, financial, and human resource commitments (Harvard, 2021).

Writing your own code is a difficult and expensive task. Due to their high pay, hiring software engineers requires a significant financial outlay, with search companies often charging between 15% and 30% of the candidate's first year's income (Harvard, 2021).

Finding suitable people is still difficult despite this investment. In addition to sourcing, other costs include those for technical skill assessments, training, onboarding, conducting interviews, and offering a digital development and testing environment (Harvard, 2021).

Moreover, when the development team expands, the supervision of a DevOps executive becomes necessary due to the critical nature of efficiently managing code development duties. It is crucial to communicate business possibilities and demands clearly, and in order to prevent expensive delays, coding must come after a well-defined software plan (Harvard, 2023).

Another important factor to consider is continuing maintenance, as software is subject to security risks, user expectations that change over time, and the necessity for periodic rewriting resulting from aging programming languages. Because of all of these factors, the costs related to developing custom code continue over time (Harvard, 2023).

2.6.2 Using a developed BPM platform

According to A. Wilson, buying software from a vendor makes sense in situations when the program is used throughout the whole firm, the problem is broad, the software is vital, and there isn't a strong in-house software development group (Shahzad, 2017).

On the other hand, purchasing software from a vendor has pros and cons of its own. A pre-made solution, adaptable software, assistance, instruction, and enhanced functionality derived from user input are among the advantages. On the other hand, the disadvantages include depending on the vendor for updates and problem solving, as well as the vendor controlling the code and deciding what functions are available (Wiegers & Beatty, 2013).

Rather than building new systems from the ground up, some businesses choose to purchase packaged solutions, or commercial off-the-shelf (COTS) products, and alter them to meet their software needs—in this case the BPM software needs. Cloud solutions, also known as Software as a Service (SaaS), are becoming a more viable choice to meet those needs (Wiegers & Beatty, 2013).

Compared to building a custom solution, off-the-shelf solutions frequently attract with their meaningful promises: they provide advantages like cost predictability, the implementation of apparent best practices within a certain area, and a more affordable initial cost. Software as a Service (SaaS) products are rapidly increasing, indicating that there are answers for almost every problem (In-House vs. Outsourcing Software Development, 2023).

Choosing a pre-packaged solution might help startups and small to medium-sized businesses (SMEs) to access the market faster than their competitors. Nevertheless, before making a choice, it's important to understand the hidden expenses related to purchasing software (Mettevo, 2023).

Certain COTS items can be used right away without needing to be further customized. This might entail setting up system integrations, customizing the original product, or creating extensions to provide features not included in the COTS package. For the majority, however, to function well in the intended context, setup, integration, and extension are often necessary (Wiegers & Beatty, 2013).

In the continuation of this chapter, I will present the points which need to be considered when choosing to install a packaged solution vs creating a system from scratch.

Compared to custom (bespoke) development, COTS solutions provide the acquiring firm less flexibility to suit unique requirements. Therefore, differentiating between skills that are non-negotiable and those that may be modified to meet the requirements of the package is crucial (Wiegers & Beatty, 2013).

It is necessary to have a clear understanding of the business operations that the package must support in order to select the right packaged solution. Given this, determining the software requirements—at the very least, at a high level—is part of the selection process.

Users should be able to do their tasks with whichever package they choose, while different packaged solutions may accomplish this in different ways. Thus, the following tasks should be the main emphasis when choosing a packaged solution:

- Listing features according to the requirements of users and business procedures.
- Setting user requirements in order of priority and connecting them to business requirements
- Evaluating conformity with the business policies, industry norms and legislation.
- Evaluating how simple it is to adjust the package to reflect changes in rules.
- Analyzing how responsive the vendor is.
- Creating data structures based on employee needs and business standards, then comparing those data models with the vendor's model to identify any differences.
- Outlining the business reports that the COTS product must produce and making sure that it does so in the right forms (Wiegers & Beatty, 2013).

2.6.3 Using LCDP

LCDP for BPM simplify and enhance the process of designing and modeling desired processes. The workflow of this typically involves the following stages:

1. Design and model the desired processes.
2. Execute the process workflows.
3. Measure and analyze process performance.
4. Enhance and optimize processes (Appian, 2023).

1. Design and model the desired processes

The first stage involves many phases in designing and modeling the processes. The first phase involves mapping out future-state processes and identifying areas that require improvement. For effective process design, this phase involves using a low-code process automation platform (Appian, 2023).

After the initial phase, low-code development is utilized by multidisciplinary teams including business users, citizen developers, and IT to visually depict processes. These models can also be saved for later use in other projects (Appian, 2023).

After this is done, business rules need to be put into place. This implies that key procedures and policies, such as approval chains with business rules and spending request levels, must be created and replicated (Appian, 2023).

Adapting to changes is one of the most crucial aspects. By employing BPM to monitor, assess, and respond to evolving circumstances, such as changes in business events and laws, companies can maintain their sensitivity to evolving business environments (Appian, 2023).

2. Execute the process workflows

After the process model design is finished and automation is incorporated, meeting the needs of business and IT users for speed, security, and integration is necessary to move the project into production (Appian, 2023).

BPM software that supports DevOps facilitates speed by enabling the quick development and deployment of workflow applications as soon as design is complete. This guarantees flawless experiences across a range of devices with no extra work or expense (Appian, 2023).

Enterprise-grade BPM solutions have strong security guarantees that are supported by governance capabilities and certifications, preserving compliance across business domains.

Building applications on a platform with a contemporary and secure data fabric facilitates integration, which is essential for bringing different company data from many contexts together and providing thorough insights and influential decision-making (Appian, 2023).

3. Measure and analyze process performance

Process execution alone is not the end of effective BPM with LCDP. Instead, BPM demands constant development. During this phase, data is collected and analyzed to assess process performance. Technology is employed to draw attention to the areas that still need work as well as those that have been handled effectively (Appian, 2023).

Furthermore, by closely analyzing operating system log files, a given data science and machine learning-driven process mining software is crucial to producing intelligible process maps. This data-centric approach takes the role of subjective interviews and offers insights into actual work processes. Process mining becomes an ally of BPM by aiding in continual optimization through the improvement of processes with identified inefficiencies (Appian, 2023).

Additionally, automation is a significant player that extends beyond process mining due to its ability to incorporate real-time management tools. Task reassignment is made possible by these technologies and analytics, which track ongoing operations and increase efficiency. Quick adjustments are made possible by the following visibility, which has a significant favorable effect on company results (Appian, 2023).

4. Enhance and optimize processes

Continuous BPM is essential for ongoing process improvement, adapting to changing circumstances, and proactively removing bottlenecks. As BPM software, LCDP helps enterprises to quickly adjust to changes in laws and business events, which promotes continual optimization (Appian, 2023).

It encourages intelligent, self-optimizing procedures based on historical performance data by utilizing predictive analytics. It ensures the development of company performance by offering insights for continuous improvement through real-time reporting and dynamic visibility into business activities (Appian, 2023).

2.7 The problem of deploying LCDP solutions for BPM

The decision to use LCDPs for BPM in an organization may encounter resistance from every department. This is mostly because of a misunderstanding regarding LCDPs. Low code, for instance, is frequently seen as a new technology that threatens jobs because of the related rise in automation and digitalization. Therefore, it is crucial to incorporate a company's works council as soon as possible and persuade them of the advantages of minimal code, particularly in this context (Elshan et al., 2023).

The primary issue with LCDP systems for BPM is vendor lock-in, or reliance on a single provider. The primary cause of this is because the majority of LCDP providers do not

provide automated code creation for the user. The code of the generated apps is now kept in an untraceable file format, like an opaque black box, and is only interpretable in terms of a runtime environment while the program is being developed. Furthermore, the situation may also arise in which an LCDP develops the source code but forbids its deployment outside of the provider's environment (Elshan et al., 2023).

The potential that providers would suddenly stop running their platform exists because the LCDP industry is still very new, as was the case with Google App Maker (Elshan, 2023). In Jan 2020, Google announced not to continue with Google App Maker. Shortly after that, however, Google announced a no-code platform called AppSheet (Alamin, 2022).

Furthermore, because of this reliance, users are forced to accept provider price hikes (Atlassian, for instance, has raised the cost of their membership), otherwise all previously produced apps would be lost (Oxalis, 2023).

Additionally, the fact that LCDPs' field of application is (currently) limited presents additional difficulty when implementing LCDPs for BPM. A corporation will still need to do traditional development work in addition to using some LCDPs since some business processes that need to be mapped are too complicated for LCDPs. Because of this, a lot of LCDPs are better suited for finished projects that don't need much additional work (Elshan et al., 2023).

It depends on the platform, though. However, according to some research participants, LCDPs are an effective tool that can be used to create everything from simple automation apps to complex client portals (Elshan et al., 2023).

Another possible issue is shadow IT. Applications should, in theory, always go through a number of procedures before being used to guarantee security or compliance with data protection laws. These procedures are typically overlooked when dealing with shadow IT (AlphaSoftware, 2023).

One explanation for the rise in shadow IT is because employees are just ignorant of this concept. For example, they could unintentionally exploit confidential employee data in apps that break privacy regulations. Providing preventive education, outlining responsibilities, and requiring citizen developers to agree to certain terms of usage before using the platform, might all be sensible measures to avoid problems in this area (Elshan, 2023).

The previously noted potential to create apps more quickly may potentially be harmful to enterprises. Although quality may suffer as a result, this speed allows for the loyalty to critical data protection, governance, and programming best practices with less resources needed. Therefore, it is simple to save money and effort in the short run, but these things have drawbacks over time, including upkeep (Elshan et al., 2023).

Finally, the fact that unit tests cannot be performed on low-code apps means that testing them becomes much more challenging because each case requires going through the full

procedure again. Since the modular system's components have all been tested by the provider previously, there is less need to test the applications because they are already more error-resistant from the start than traditional software development. But mistakes do happen, therefore businesses need to set up appropriate quality control procedures. For example, performing a separate technical assessment before applications are submitted (Elshan et al., 2023).

This chapter has laid the groundwork for understanding the importance of LCDPs. in BPM. In the next chapter, the focus will be shifted to the market in which those platforms operate and will therefore examine the corporate finance digital solutions market.

3 THE CORPORATE FINANCE DIGITAL SOLUTIONS/SYSTEMS MARKET

The corporate finance digital market brings together traditional finance and modern digital tools. As companies increasingly use digital solutions to improve their financial operations, understanding of this market is important for the evaluation of how LCDPs can help enhance business processes.

The market for financial services software is expected to develop at a compound annual growth rate (CAGR) of 9.2% from 2022 to 2031, from a valuation of $118.65 billion in 2021 to $282.71 billion (Gartner, 2023b).

In order to support data-driven choices, accounting and finance operations are growing beyond transaction processing and reporting. According to Gartner's prediction, the global market for financial management software is anticipated to be valued at $24.4 billion by 2026 (Gartner, 2023b).

Since financial institutions launched online solutions and innovations like P2P payment, online transfers, notifications, and other such services, the use of financial service software has expanded (Financial Services Software Market Research, 2023).

The integration of risk, performance, and compliance is a crucial aspect of organizational planning, and it involves the use of software such as financial guidance and financial solutions software. It aids in risk monitoring, adjusts organizational management to evolving demands and trends, and facilitates more efficient planning and investment of resources by businesses at the lowest possible cost and time (Financial Services Software Market Research, 2023).

The financial service software market is expanding due to the growing need for workforce efficiency solutions, improved client services provided by financial service software, and the rise in demand for digital banking channels (Financial Services Software Market Research, 2023).

The expansion of the financial service software business is, however, constrained by rising implementation costs, compliance with various political requirements, and regulatory requirements (Financial Services Software Market Research, 2023).

On the other hand, it is projected that the fintech businesses' increased investment in big data, mobile, and cloud technologies would present many prospects for the financial service software market to grow over the projection period (Financial Services Software Market Research, 2023).

Key firms including Accenture, Finastra, FIS, FIServ, Inc., IBM Corporation, Infosys, Oracle Corporation, SAP SE, TCS, and Temenos lead the worldwide financial service software industry (Financial Services Software Market Research, 2023).

Due to the quick uptake of financial software, which can streamline operations by combining several software into a single fully digital ERP solution, the software segment led the financial services software market size in 2022 and is predicted to maintain this trend over the course of the forecast period (Financial Services Software Market Research, 2023).

The service sector, however, is anticipated to develop at the fastest rate in the next few years due to the increased need for sophisticated financial services for improved business process transformation and quick innovation (Financial Services Software Market Research, 2023).

The financial sector benefits from using Business Intelligence (BI) since it streamlines operations and offers them a competitive edge over other organizations. Companies that offer credit cards, banks, insurance, and other financial services need to continuously grow their clientele and increase their market share. BI provides organizations with the data they need to accomplish their objectives (Mordor Intelligence, 2023).

In the financial sector, big data analytics is also seen as a crucial use case for BI. Globally, major corporations hold the belief that analytics will fundamentally alter the competitive environment across several industries. Therefore, failure to implement big data analytics strategies would likely lead to a rapid decline in their market share (Mordor Intelligence, 2023).

Moreover, using technology, such as artificial Intelligence, BI tools, and automation tools, the financial services sector offers new convenience to users, such as digital account opening, chatbots, peer-to-peer payments, and digital loans. According to Accenture, artificial Intelligence will account for USD 1.2 trillion in the financial industry by 2035 (Mordor Intelligence, 2023).

The COVID-19 pandemic presented the financial services industry with a number of business issues, including a lack of liquidity, a brief decline in credit demand, the need to reduce costs in business models, the digitization of critical operational tasks, and the need to adjust to new and updated regulatory regulations (Mordor Intelligence, 2023).

Nevertheless, the financial services software market had a sharp spike in demand during the COVID-19 pandemic epidemic, which was linked to the development in digital advancements in the financial services sector (Financial Services Software Market Research, 2023).

Additionally, customers' positive behaviors in adopting financial services and increased intention to use financial products that help them save money and time have contributed significantly to the growth in the applications of financial services during the pandemic. This is due in large part to the convenience and expanding range of products offered by financial services (Financial Services Software Market Research, 2023).

The increasing emphasis on employee experience and the advantage of digital banking channels are the main factors driving the growth of the market for financial digital solutions (Financial Services Software Market Research, 2023).

The financial service software market is expanding as a result of the banking industry's growing embrace of digital channels including digitalization, mobile banking, UPI payments, blockchain, artificial intelligence (AI) robotics, and other advancements (Financial Services Software Market Research, 2023).

Additionally, fintech firms focus on creating technological solutions, such as new software, apps, procedures, and business models, that assist organizations in managing the financial parts of their operations. This helps to drive the market's expansion. Over the last ten years, fintech businesses have made a sharp increase in investments, which is anticipated to propel the market internationally (Financial Services Software Market Research, 2023).

By offering secure connections, on-touch payments, and a host of other services, the financial services industry is becoming more innovative and digitalized, which is improving the consumer experience (Financial Services Software Market Research, 2023).

Furthermore, a sizable portion of the resources of financial services firms are allocated to customer experience (CX). A Microsoft Dynamics 365 survey of banks, insurers, and other financial services companies found that 86% of them allocate at least 25% of their total budget on CX, while almost half (45%) allocate at least 50%. This propels the market's expansion. (Financial Services Software Market Research, 2023).

Last, but not least, advancements in solutions, including the fusion of staff performance reviews and live chat assistance, aid in the understanding of customer demands and behavior by the companies. Consequently, this accelerates market expansion (Financial Services Software Market Research, 2023).

After having explored the digital finance market and available solutions, it is necessary to understand the technological environment of corporations, which plays a huge role in determining the effectiveness of a company's BPM system.

4 TECHNOLOGICAL ENVIRONMENT OF CORPORATIONS

ICT, usually referred to as information technology (IT), is commonly considered in the context of organizations to be the integration of automated and modern facilities into business activities. Modern IT now spreads through organizational operations and is closely correlated with business activities, making it present everywhere (Ko & Fink, 2010).

ICT can lower transactional and product costs by automating and accelerating transactions (Malone et al., 1987). However, when there is less human modification of the original data, ICT deployment also enhances the information environment and permits oversight and control from stakeholders, such as shareholders. By electronically linking the management and stakeholders of multinational and international companies worldwide, ICT can help reduce the communication breakdown that these companies experience (Weill & Ross, 2004; Indjikian & Siegel, 2005).

The success of ICT investment may be influenced by a variety of organizational and environmental factors, which also affect how deeply ICT adoption spreads through organizational practices and procedures and how much adoption of ICT results in improved performance returns (Chin & Fairlie, 2007; Farhadi et al., 2012; Salge et al., 2015).

Corporate governance (CG) is a powerful instrument that affects nearly every aspect of a modern organization, from business performance to the market's perception of a particular ICT investment made by the company (Rubino & Vitolla, 2014).

By developing and directing IT governance, corporate governance (CG) directly affects ICT investment through the selection of procedures, activities, policies, and managerial practices associated with routine operational and decision-making processes (Rubino & Vitolla, 2014).

IT governance may be viewed as a subset discipline of Corporate Governance, with its definition being the following: "specifying the decision rights and accountability framework to encourage desirable behavior in using IT" (Weill & Ross, 2004).

Corporations, on the other hand, make up developed economies. These companies have a huge number of stockholders and a high need for cash. Large businesses are driven to look for improved ICT solutions by growth demand, investments, and access to new market sectors (Houqe et al., 2019).

According to the study conducted on Information and Communication Technology (ICT), Corporate Governance, and Firm Performance from Houqe in 2019, these days, organizations will be more aligned if they use ICT as a true business enabler and take into account how investments in ICT will affect various business aspects when developing

their business cases. ICT is a crucial component of strategic plans and offers vital indicators for them (Houqe et al., 2019).

4.1 ICT for BPM in corporations

Research firm Gartner Inc. coined the term "intelligent BPMS" (iBPMS), which is now used in organizations. These days, BPM suppliers frequently use the term to highlight how the use of cutting-edge technology has increased the data-drivenness and dynamic nature of process automation for businesses. Examples of these technologies include real-time analytics, machine learning (ML), sophisticated event processing, business activity monitoring, and other systems. Additionally, these iBPMS solutions have sophisticated social and teamwork features (TechTarget, 2023).

Though formerly viewed as rivals or at most rivalries, robotic process automation (RPA) and BPM now work together as complementary partners. Businesses are using RPA solutions more and more to scale their process automation, and more BPM software platforms are including RPA in their toolkits (TechTarget, 2023).

RPA programmed software tools, sometimes known as bots, imitate human clicks and typing patterns in corporate applications to automate manual, repetitive, rules-based processes. Another feature that makes this software appealing is that it can automate access to older software programs that do not have contemporary application programming interfaces, or APIs. Complex business processes are not well suited for RPA's automation, however this drawback is lessening as the technology advances (TechTarget, 2023).

Many of the major business software providers, such as Microsoft, ServiceNow, and SAP, have introduced BPMS features through acquisitions or product development in response to the growing corporate need for BPMS (TechTarget, 2023).

The cost of acquiring a corporate BPM solution can vary significantly based on a variety of criteria, including the project's scope, the number of users, the hourly volume of transactions, the number of locations that will access the applications, and the yearly use. Project managers need to choose which BPMS features are essential and which are optional after determining how the organization intends to use BPMS both now and in the future (TechTarget, 2023).

There are computational expenses related to data storage, cloud usage, and tech training fees in addition to the vendor pricing. A BPM suite may cost as little as $50,000 annually to improve one process, or as much as $1 million annually for a major firm utilizing BPMS in several products or processes. The fact that the price is typically flexible when purchasing BPMS by organizations is another crucial consideration (TechTarget, 2023).

Instead of developing intricate process models that might not be realistically implemented or in line with current organizational practices, corporations should concentrate on the actual execution and improvement of processes, guided by the strategic objectives of the organization. At this point we can ask the question, what exactly is a better process?

A process's ability to help an organization achieve its strategic goals defines how good it is. The effectiveness of BPM initiatives to enhance business process performance is determined by how much they contribute to these strategic goals. The emphasis should be on how effectively a process fits with and supports the organization's strategic goals rather than only on intricate process models (Dumas et al. 2013).

As a result, Key Performance Indicators (KPIs), which are quantitative measurements pertaining to several performance factors including time, quality, cost, and flexibility, should be used to assess how successful a process is. The unique organization's strategic objectives determine which KPIs should be measured (van der Aalst et al., 2016).

For instance, organizations may use cycle time, waiting time, or non-value-adding time to measure time; cost per execution, waste, and resource usage to assess cost; and customer satisfaction and error rate to measure quality. Certain KPIs, like cycle time, are rather simple to measure. Some may need more effort and time to measure; for example, gathering information from surveys on customer experiences, product reviews, loyalty programs, etc., may be necessary to measure customer satisfaction (van der Aalst et al., 2016).

Better (control-flow) process models are thought to produce better processes. The process models, however, might not accurately reflect reality when it comes to KPI performance analysis. They mostly rely on information from process participants, obtained through interviews or workshops (van der Aalst et al., 2016).

As a result, they may be swayed by organizational norms and expectations and may have knowledge bias. They frequently don't offer the necessary information as they could idealize or focus on a certain scenario (van der Aalst 2011).

Exploiting event data that is already available in the company is one viable way to more closely connect BPM to the tangible enhancement of process KPIs. For instance, Six Sigma (Pyzdek 2003) has long used statistical analytic techniques to monitor and lower the level of variability in business processes inside a company. The goal is to determine and eliminate the factors that contribute to this variability, such as mistakes in business process output, and to ensure that these processes operate efficiently within the intended performance parameters (Pyzdek & Keller, 2003).

Though the goal of Six Sigma is to enhance business processes by statistical quantification of changes in process performance, the data required for these analyses is usually gathered manually, for example, through surveys or observation. This makes using these procedures, when done correctly, exceedingly expensive and time-consuming (Pyzdek & Keller, 2003).

Techniques that automatically extract process knowledge from event data captured by common information systems, such as ERP or ticketing systems, can be used to avoid this issue. Within this framework, the field of process mining research has arisen, offering a

variety of techniques and instruments for utilizing such data to automatically identify a process model, verify its obedience to current reference models or standards, or identify the reasons behind process variants and deviations (van der Aalst et al., 2011).

Relying on recorded data has the benefit over manually obtained data since any insights derived from it are grounded in facts rather than assumptions, making them a more accurate depiction of reality (van der Aalst et al., 2011).

Furthermore, (real) process performance data, such statistics on activity time and resource consumption, may be added to the artifacts collected by process mining, such as process models. This makes it possible for corporations to examine whole processes. Process mining techniques are currently applied at every stage of the BPM lifecycle, from monitoring to discovery, for these reasons. (van der Aalst et al., 2011).

This brings us to the conclusion that process mining and Six Sigma currently have a gap that needs to be closed in order to improve corporate BPM. A better process can be achieved strategically by combining Six Sigma techniques to identify and assess the effects of various process changes on the process KPIs, as well as process mining techniques to extract precise and detailed process performance measurements (e.g., process models enhanced with performance statistics) (van der Aalst et al., 2016).

4.2 LCDP for large enterprises and corporations

The benefits of both technical and managerial techniques are used to implement the low-code method in large enterprises and corporations (Recker, 2012).

In the first phase of low-code implementation: Assessment and objective formulation, the present (Is-Process) which needs to be digitalized is evaluated. At this stage, the workflow and its specifications (such as the system environment and framework) of the Is-Process are established using techniques such as workshops, expert interviews, and literature study. The following stage also involves using a business process model, such as BPMN modelling, to graphically represent the target process and its capabilities (Recker, 2012).

Based on the findings from the previous phase, an appropriate development platform (LCDP) is chosen for the strategy formulation phase, which is the next stage in which the low-code approach is applied. In addition, a variety of techniques can be used, such as SWOT analysis and market research. (McGivern, 2013; Schawel & Billing, 2012).

Following the selection of the LCDP, an appropriate program architecture is constructed and low-code modules are chosen based on the functionality from the study of the target process. Following that, the program structure and documentation are used to integrate the low-code modules. The last stage involves putting the finished software to the test on actual users and refining the performance of the program depending on their input (Cai, F. Z. et al, 2022).

As an example that shows how LCDP for BPM is implemented into an enterprise I will use the following process improvement case of a German company which was studied in Cai's 2022 research.

In the first phase, as described above, the following was made: The most important data from the IT system was examined through expert interviews and business seminars. Microsoft Windows was the operating system that was already in place, and the business used Microsoft Office.

The desired state of the process was then determined by compiling the requirements for digitization or automation of delivery note processing into a specification sheet.

In addition to its capabilities, the delivery note procedure workflow was condensed into a BPMN format (see Figure 9). In the process when handling delivery notes, it was necessary to manually enter the most crucial data into the system, including the supplier's name, delivery date, delivery number, and cost reference number.

It was determined that the crucial information from the delivery notes should be automatically extracted as they are received in the target process (see Figure 10) during digitization because this process had to be completed around fifty times a day, which was time-consuming. The information should then be automatically saved in a database as key-value pairs in a json file. In the intended scenario, this would enable the workflow to be fully automated and the amount of manual labor to be minimized.

During the second phase, which involves strategy definition, market research was conducted on the top LCDPs currently in use worldwide. The most well-known LCDP suppliers were MatsSoft, Oracle APEX, Salesforce, Microsoft PowerApps, Appian, and Oracle.

The following criteria were used in this use case to filter the appropriate LCDP choice (Cai F.Z. et al., 2022):

• System requirements: Windows, iOS, and Android mobile platforms, as well as Windows, are required for the LCDP to function.

• Organizational and legal restrictions: in order to be digitized, the LCDP needs to comply with European legislation (Goldshteyn & Thelen, 2016; Arning, 2019).

• Cost: There should be minimal running expenses.

• Functional needs: Tabel 4's criteria, such as the ability to identify handwritten characters, may be satisfied by the LCDP's modules.

After applying those criteria to the LCDPs, the company has chosen Microsoft PowerApps as the LCDP.

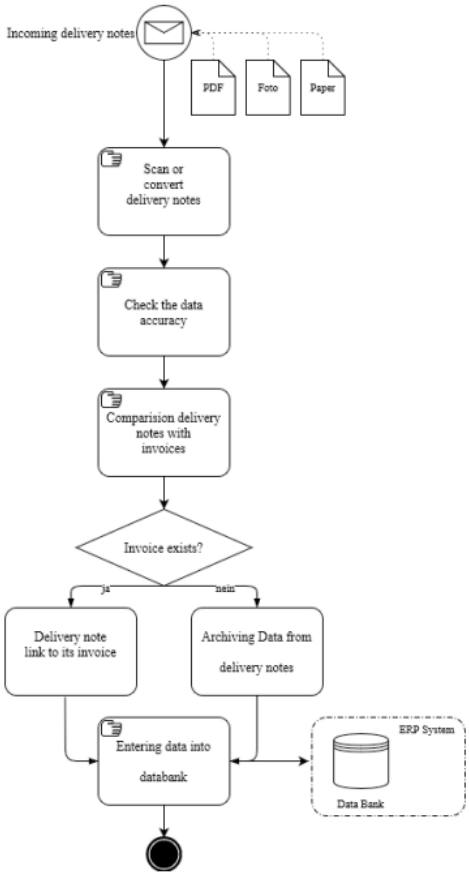
In the last, Implementation phase, LCDP Modules were chosen based on the Functionality Analysis:

Table 4: LCDP Modules and their functionalities

LCDP Module	Functionality
Microsoft Azure Form Recognizer	Extracting text document formats automatically (.pdf, .jpg)
Microsoft SharePoint	Sorting and summary of data in the same data group
Microsoft SharePoint	Importing relevant data into the database automatically
Microsoft Azure cognitive service	Recognizing handwritten characters automatically
Microsoft PowerApp	Mobile application and laptop

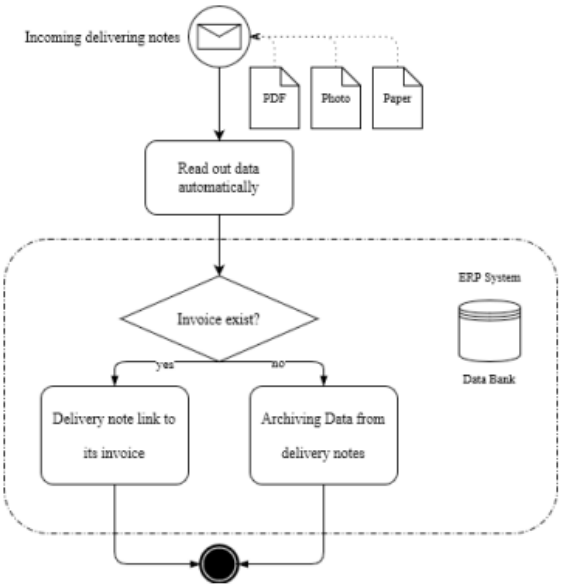
Source: Cai F.Z. et al., (2022)

Figure 9: The BPMN Diagram of Delivery Notes in the current Situation



Source: Cai F.Z. et al., (2022)

Figure 10: The BPMN Diagram of Delivery Notes in the target Situation



Source: Cai F.Z. et al., (2022)

Now that we understand the technology behind BPM systems, I will focus on the specific improvements needed for BPM in Company X. In the following chapter I will look at the current BPM setup in the company and identify the fields for improvement.

5 BPM TECHNOLOGY IMPROVEMENT NEEDS IN COMPANY X

5.1 Methodology

I used participant observation as a research technique which involves systematically watching and recording events or behavior relevant to the research topic in order to gather requirements for process improvement and to understand the views and needs of the key individuals for the process.

The process owner and a SME (subject matter expert) played a key role in my requirements analysis process. They collaborated with key stakeholders and senior management, ensuring that their views, insights and expectations are effectively captured and passed to me through emails and Microsoft Teams meetings which I have then included in a Requirements Specification Document.

The observation was carried out around the actual situation of the company in terms of the equipment purchasing process they had the need to improve. I observed the current equipment ordering process, existing Equipment Ordering Portal and business rules for purchase request approval during Microsoft Teams meetings and daily email communication with the process owner and SME.

During my observation sessions I was taking notes from the meetings I attended together with the process owner and SME as well as from the emails I have got regarding their process improvement requests. The notes I made were the basis for the requirements analysis which was done in the form of a Requirements Specification Document in Microsoft Word.

This document also allowed me to develop process workflow diagrams in Microsoft Visio which are shown in the continuation of the thesis.

In addition to the observation sessions from online meetings and emails, the observation of the existing Equipment Ordering Portal was used to gain insights about the functioning of the current ordering process through that portal and allowed me to include that information in the Requirements Specification Document.

Using the participant observation technique, the input collected from the SME and process owner was a valuable source for analyzing requirements dealing with asset procurement process improvement. The knowledge gained in these sessions can be seen as a basis for the development of a process solution adapted to the needs and goals of the organization.

5.2 Description of the company

The corporation studied in this master's thesis is a nursing home chain. It was incorporated in Delaware in 1999. It is a holding company that owns independently operating branches and facilities with its own management, employees and assets that provide care home services.

The company started with five nursing homes with 710 beds in 1999 and expanded to 61 facilities with 6,777 beds in 2007. It also had 566 assisted living and independent living units with 671 beds, for a total of 7,448 beds.

As of 2023, Company X operates 299 healthcare facilities across 14 states. These facilities include 29 senior living operations that provide assisted living and independent living units (Company X official website, 2024).

In terms of bed count, the company has seen a significant growth in its total capacity. Recent acquisitions include properties such as Elmwood Senior Living and River Park Post Acute in Chandler, Arizona, which together account for 66 skilled nursing beds, 45 assisted living units and 119 independent living units (Senior Housing Business, 2024).

Unlike some other nursing home chains that sell properties and manage properties for real estate trusts, the company has spun off some properties while increasing its own real estate investments. The company's reports indicated that it continued to buy both low-performing and high-performing companies, even during the pandemic (Kingsley & Harrington, 2022).

The company's stated growth strategies are based on:

- identifying and developing future leaders,
- organizing and operating its subsidiaries into portfolio companies with their leaders who can build relationships with local stakeholders in communities,
- increasing the overall percentage of patients with greater needs,
- focus on organizational growth and operational efficiency,
- expansion and renovation of existing activities and
- strategic investment and integration of other activities after acute care.

The financial indicators of the organization have steadily increased despite economic fluctuations in the US economy between the severe economic crisis of 2008 and the pandemic of 2020 to 2021 (Kingsley & Harrington, 2022).

The average facility had 110 beds, slightly more than the US average, and occupancy rates were slightly lower than the national average. With approximately 24,000 employees, the company reported that 77.6% of revenue was spent on services and operating expenses, including administrative and real estate costs; 5.4% for rent, and 7.0% for general administrative costs. With its extensive property holdings and its real estate investment trust, the company has the financial resources to invest in modernizing its care homes into private rooms, meeting modern small home standards and digitization of business processes (Kingsley & Harrington, 2022).

5.3 BPM in the company

Company X exemplifies a robust approach to BPM by leveraging advanced tools such as DocLink to comprehensively automate business processes.

As a leading provider of senior living and assisted living facilities, it places a strategic focus on optimizing its operational workflows to improve resident care, simplify administrative processes and ensure regulatory compliance.

The company fosters a culture of continuous improvement by encouraging employees at all levels to identify areas for process optimization and innovation. The company's growth strategy includes both the acquisition and leasing of new facilities, in line with a disciplined approach of ensuring they have the right leaders in place and appropriate pricing for each acquisition. These recent acquisitions included skilled nursing facilities and senior living operations in Kansas, Nevada, Tennessee and Texas (Company X official website, 2024).

In 2022, Company X became the largest nursing home operator in the USA by surpassing Genesis HealthCare. This happened as a consequence of a series of acquisitions that increased Company X's portfolio to 268 healthcare operations across 13 states (Skilled Nursing News, 2022).

As part of the strategic alignment of BPM, the corporation under study aligns its BPM initiatives with its overall mission of delivering high quality care and operational

excellence in its facilities. The company identifies key business processes that are critical to resident satisfaction, staff productivity and regulatory compliance.

Additionally, the company prioritizes change management and stakeholder engagement throughout the BPM lifecycle. They actively engage field employees, managers and executive leaders in the design, implementation and evaluation of BPM solutions, ensuring widespread adoption and alignment with the organization.

Process discovery and documentation is done by systematically documenting and analyzing its business processes using DocLink, a powerful document management and business process automation solution. By accurately mapping and documenting processes, the company gains insight into process inefficiencies, bottlenecks and opportunities for improvement.

DocLink serves as a catalyst to drive process improvement initiatives by automating repetitive tasks, reducing manual errors and improving workflow efficiency (DocLink, 2024).

The power of DocLink is harnessed in order to automate key business processes such as invoicing, compliance documentation and tenant records management. Using this BPM tool, the company simplifies administrative tasks, speeds up decision-making and improves overall operational agility. By using DocLink's reporting and analysis capabilities, the company also tracks key performance indicators (KPIs), analyzes process metrics and identifies opportunities for optimization and improvement (DocLink, 2024).

Due to the large number of branches and departments within them, the organization emphasizes cross-functional collaboration and communication for the effective implementation of BPM initiatives. DocLink enables collaboration between different departments and stakeholders with a centralized platform for document sharing, version control and workflow automation in this case (DocLink, 2024).

However, while DocLink offers customization and configuration options to tailor workflows and processes to specific business needs, it does not offer the same level of application development capabilities the company would need as low-code platforms do. It is not classified as a LCDP, which allows users to visually design and build applications with minimal hand-coding, often using pre-built components (DocLink, 2024).

5.4 Equipment purchasing process in corporations

The equipment purchasing process in large scale organizations consists of the following steps:
needs assessment and specification, budget approval and planning, supplier selection and sourcing, negotiation and contracting with suppliers, purchase order creation, receiving and inspection, and post-purchase evaluation (Pohl & Förstl, 2011).

When identifying the needs, departments of a large scale organization assess their specific needs. For this, they need to consider both current and future requirements of the organization. This process involves evaluation of the existing equipment performance and determination if new technology is required to improve productivity. After that, detailed technical specifications for the required equipment are developed. They must ensure compatibility with existing systems and meet the operational requirements (Pohl & Förstl, 2011).

The next step of the purchasing process is budget approval and planning. This step consists of cost-benefit analysis and securing a budget. The cost-benefit analysis must be conducted in order to justify the purchase. It includes the initial costs, maintenance expenses, potential downtime savings and the short-term and long-term productivity gains for the organization. The finance department then reviews the budget and if the purchase aligns with the company's financial planning and strategic goals it approves the budget (Flechsig & Anslinger, 2022).

When this step is completed, supplier selection and sourcing can start. The procurement team conducts market research in order to identify the potential suppliers. The suppliers are being evaluated based on their reliability, reputation, and quality of their products. To the suppliers that meet the conditions and are shortlisted, an RFP (Request for Proposal) is issued. The RFP outlines the equipment specifications, delivery timelines, quantities and other requirements. The bids from the suppliers are then evaluated based on criteria such as quality, warranty, cost, service support and delivery terms (Schiele, H., 2019).

This leads to the next phase of negotiation and contracting. In this phase, the procurement team negotiates with suppliers to achieve the best possible terms while discussing topics such as price, delivery schedules, payment terms and after-sales support. After discussion, detailed contracts are crafted and signed (Pohl & Förstl, 2011).

Once the contract is finalized, issuing purchase orders can be created and sent to the supplier. The purchase order must include all the necessary details including quantity, description, agreed price and delivery (Flechsig & Anslinger, 2022).

In the next step of receiving and inspection, the logistics team coordinates the delivery of the equipment. Upon arrival they need to inspect the equipment in order to ensure that it matches the order specifications and doesn't include any defects. As well, the equipment goes through acceptance testing, so that it is verified that it meets the performance and quality standards outlined in the specifications.

Lastly, in the post-purchase evaluation, the performance of the new equipment is monitored and feedback is collected from employees to ensure the expected standards are met and any issues are addressed (Hauck & Rabta, 2023).

5.5 Company’s characteristics in the area of the studied process

The company has identified the process of asset procurement for its employees as a focal point for transformation. As described in chapter 5.3, the company aims to automate a number of employee tasks in order to enhance operational efficiency and achieve the objective of modernizing day-to-day operations. As a consequence, the equipment purchasing process takes on a crucial importance for the future success of the company.

At the time of my involvement in the project, the company had already developed an internal web application called the "Equipment Ordering Portal" for use by employees in various departments (Marketing, Finance, Accounting, Legal, IT,..). This portal was presented to me while I was on-boarding to the project.

Before I started working on the project, the company had already recognized the need to improve and automate the purchasing process and made progress by allowing employees to place orders for equipment procurement.

However, the approval process was not defined yet. This would require placing purchase requests and approval or rejection by the employee's manager. Before the introduction of the ordering portal, only the managers had the right to purchase assets or professional equipment on an as-needed basis.

5.6 Existing situation in the company

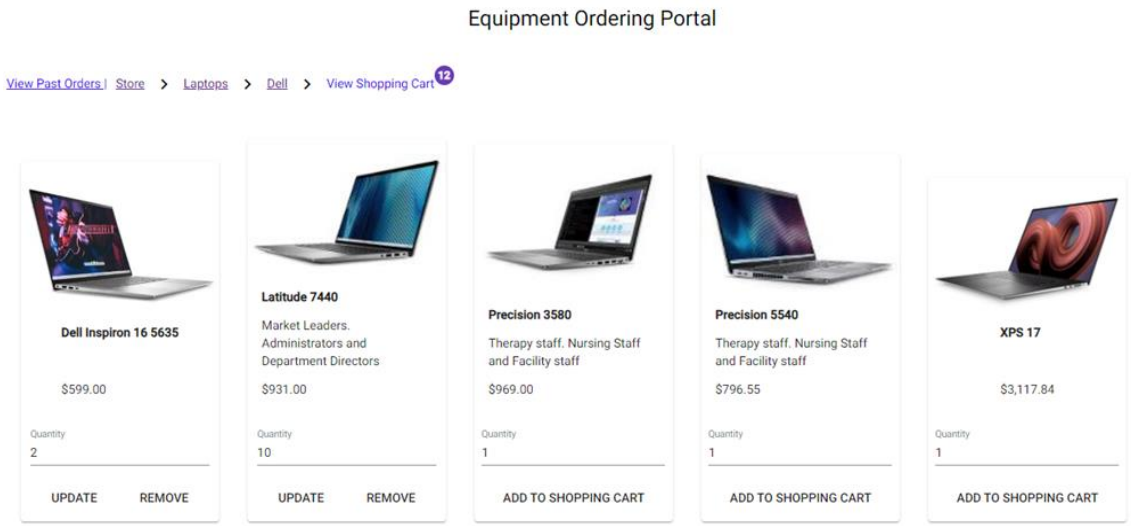
The starting equipment purchasing process at Equipment Ordering Portal (see Figure 14) was the following:

The process begins when an employee/requester logs into the home page of the Equipment Ordering Portal. After logging in, the home page displays various categories of products available for purchase. These categories include Accessories, Chromebooks, Desktops, Laptops, Monitors, Nursing Carts, Nursing Stands, Printers & Copiers, Tablets, and Timers, each with accompanying images for easy understanding.

After selecting a category, the requester is redirected to a page that displays the various brands available in the selected category. For example, if the user selects the Laptops category, they will be shown brands such as Dell, HP, Microsoft, and StarTech. From here, the user can select a specific brand for further research.

After choosing a brand, the requester is redirected to a page that shows all available products offered by the selected brand in the selected category (see Figure 11). On this page, requesters can edit the quantity of products, add products to their shopping cart, update the quantities of selected products, or remove products from the shopping cart.

Figure 11: Equipment Ordering Portal, Product Page 2023

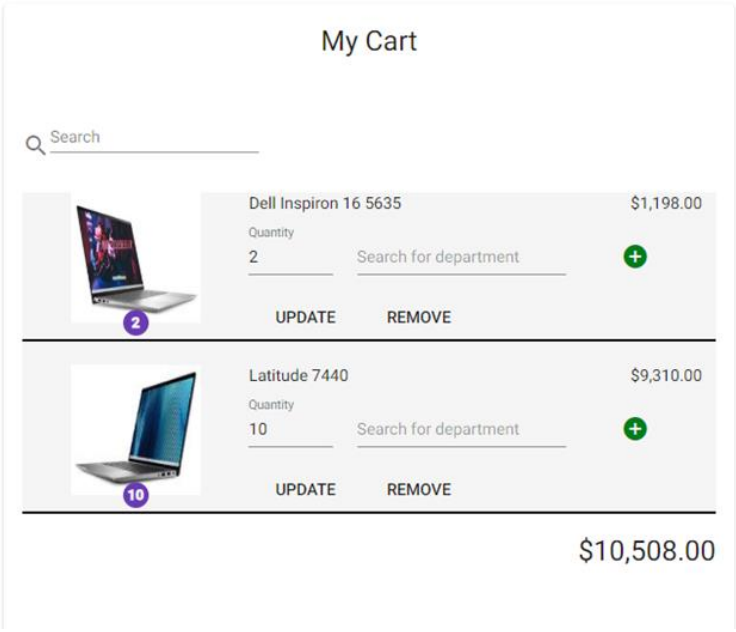


Source: Equipment Ordering Portal, Company X, 2023

Once the user has added the desired items to their shopping cart, they can continue to check out the shopping cart. The shopping cart page contains two sections: "My Cart" on the left side of the screen and the "Checkout" form on the right side of the screen.

In the "My Cart" section, users can search for specific products, update quantities, remove products and are prompted to select the department for which the order is intended (see Figure 12).

Figure 12: Equipment Ordering Portal, My Cart section, 2023



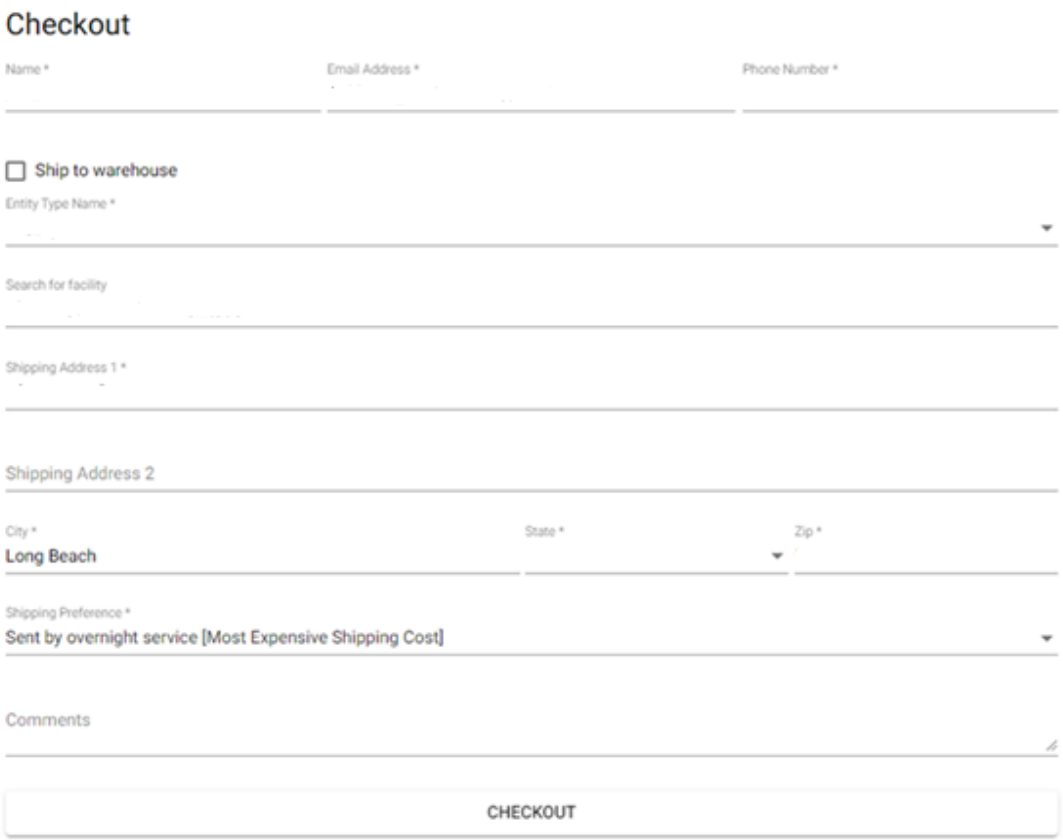
Source: Equipment Ordering Portal, Company X, 2023

In the "Checkout" section (see Figure 13), the requester is required to fill in the mandatory fields, including Name, Email Address, Phone Number, Entity type name, Facility, Warehouse (displayed if Ship to warehouse is checked), Delivery Address 1, City, Country and Postal Code.

In addition, requesters must select their preferred shipping options from a drop-down list indicating shipping speed and cost. Optional fields include the Ship to Warehouse checkbox, Shipping Address 2, and Comments.

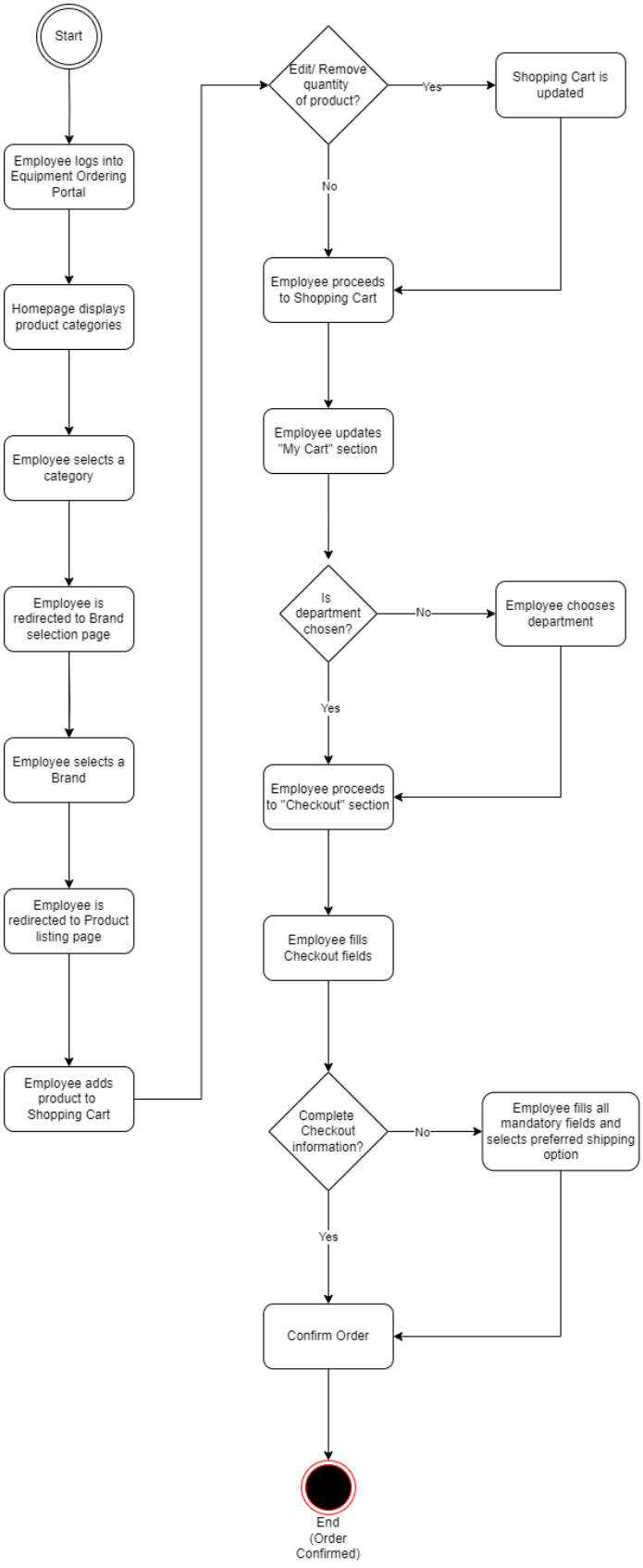
Once all the required information is provided, requesters can proceed with the checkout process by selecting the checkbox button to confirm their order.

Figure 13: Equipment Ordering Portal, Checkout section, 2023



Source: Equipment Ordering Portal, Company X, 2023

Figure 14: Flowchart of company's equipment ordering process



Source: Own work

The company has also identified who the approvers should be for the purchase request made on the Equipment Ordering Portal. This information has also been passed to us on the initial meeting and the content was the following:

- If Facility is chosen as an Entity Type Name on the Equipment Ordering Portal the purchase order must be approved/denied by the Executive Director.
- If Market is chosen as Entity Type Name on the Equipment Ordering Portal the purchase request must be approved/denied by the Market Leader. The purchase request should also need approval by the Market if it wasn't approved by the Executive Director for 3 days.
- If Service Center is chosen as Entity Type Name on the Equipment Ordering Portal the purchase order must be approved/denied by the Department Manager.
- If the Ship to Warehouse checkbox is checked on the Equipment Ordering Portal and the Amount is higher than 20.000$ the purchase order must be approved/denied by the Procurement Manager. Otherwise, approval is not needed, and the purchase order can continue to be prepared.

5.7 Company's requirements for process improvement

This chapter describes the identified requirements for the process improvement in the company, based on the insights obtained through participant observation technique. The requirements presented represent essential criteria and goals that the organization wants to achieve in order to improve the operational efficiency and achieve its strategic goals.

5.7.1 Summary of Company's Requirements

In this section I classified the defined requirements for process improvement into business, functional and non-functional requirements, which enables a comprehensive understanding of the organization's process improvement needs and priorities.

Business Requirements:

Business requirements include general goals and tasks that drive initiatives to improve processes in the organization. These requirements are directly related to the company's strategic vision and priorities. I divided the business requirements for the Equipment purchasing process into two scenarios: first, when procurement request approval is needed and second, when procurement request approval is not needed.

Business requirements for the scenario when procurement request approval is needed:

- Requirement 1: Design purchase request approval process after the order has been placed on the Equipment Ordering Portal.
- Requirement 2: Allow for the requester to receive Approval/Rejection email upon their purchase order on their corporate email address.

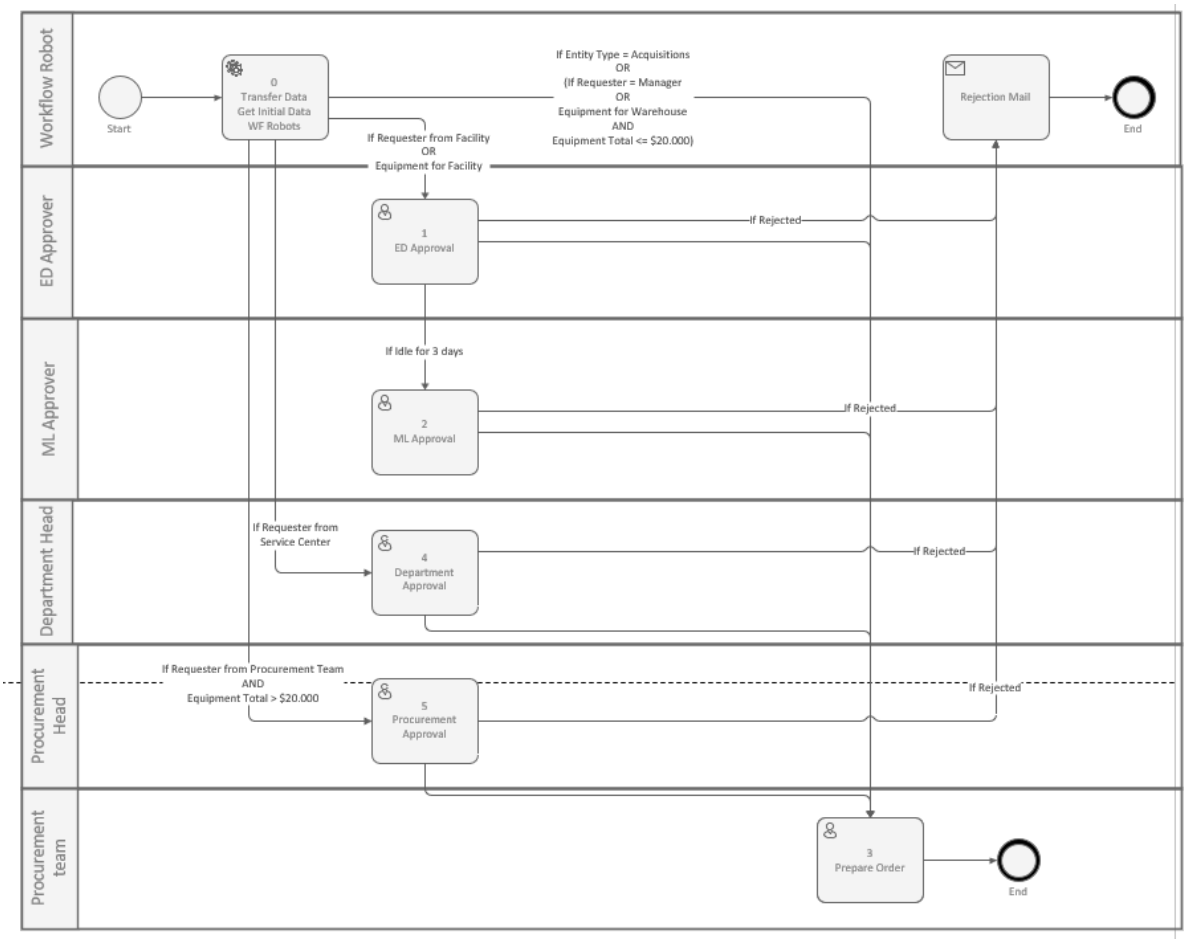
- Requirement 3: If the equipment is not in stock make ordering from a Vendor an option.
- Requirement 4: In case when the order from Vendor needs preparation or requester wishes for the order to be shipped to warehouse, include shipping to warehouse and from warehouse to the requester as a part of the process.
- Requirement 5: For shipping of the equipment from the warehouse allow the dispatching or self-pick-up options.

Business requirements for the scenario when procurement request approval is not needed:

- Requirement 1: If Acquisitions is chosen as Entity Type Name on the Equipment Ordering Portal, order preparation can be done without the need for approval.
- Requirement 2: When the requester is the Manager, order preparation can be done without the need for approval.
- Requirement 3: When the equipment ordered for Warehouse is less than the threshold amount ($20.000), order preparation can be done without the need for approval.

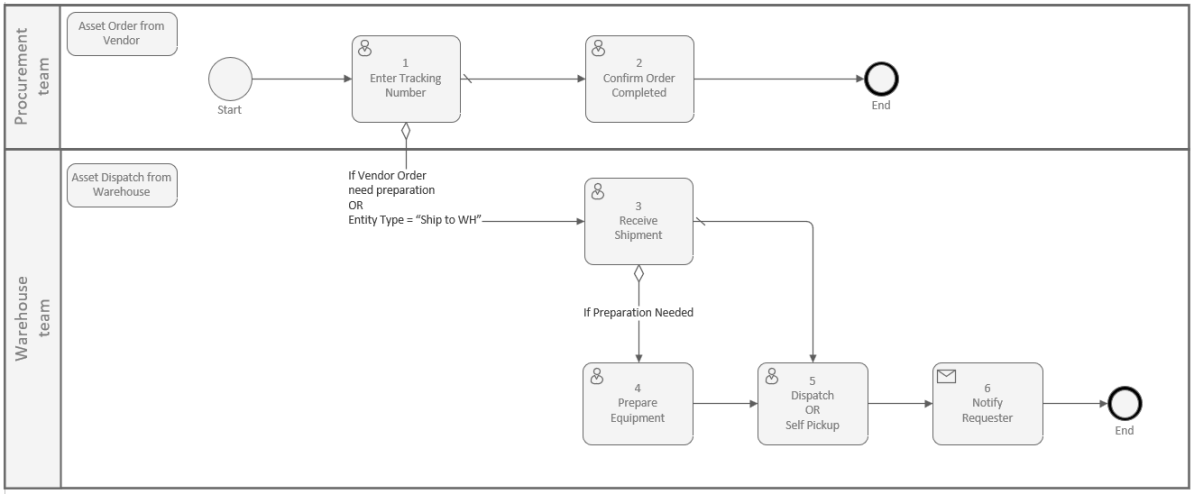
Based on the gathered business requirements I constructed the process workflow diagram (see Figures 15 and 16) in Microsoft Visio, by presenting the three subprocesses: Asset Procurement Request, Asset Order from Vendor and Asset Dispatch from Warehouse. Regardless of the business scenario, subprocesses Asset Order from Vendor and/or Asset Dispatch from Warehouse are launched based on the nature of the order. I have presented this in the cross-functional flowchart diagrams shown below.

Figure 15: Asset Procurement Request Cross-Functional Flowchart Diagram



Source: Own work

Figure 16: Asset Order from Vendor and Asset Dispatch from Warehouse, Cross-Functional Flowchart Diagram



Source: Own work

Functional Requirements:

Functional requirements specify the specific functionalities and features that a process improvement system must have in order to meet user needs and business goals. These requirements describe the desired behavior and capabilities of the system from the user's perspective. Based on the functionality requirements of the company which I gathered in the Requirements Specification document, I divided the functional requirements in the following groups: Asset Procurement Request, Asset Order from Vendor, Asset Dispatch from Warehouse, Revision Trail, Email Notifications and Order Management Application.

Functional requirements for Asset Procurement Request subprocess:

- Requirement 1: The BPMS must include a functionality which allows the user to review order items and order information.
- Requirement 2: The BPMS must include a functionality which allows the user to change shipping reference if needed.
- Requirement 3: The BPMS must include a functionality which allows the user to add new item/s if needed.
- Requirement 4: The BPMS must include a functionality which allows the user to approve/deny the purchase request.
- Requirement 5: The BPMS must include a functionality which allows the user to add order/s from Vendor and order from different Vendors.
- Requirement 6: The BPMS must include a functionality which allows the user to add item transfer from Warehouse if the item is in stock.
- Requirement 7: The BPMS must include a functionality which allows the user to Confirm/Cancel Orders

Functional requirements for Asset Order from Vendor subprocess:

- Requirement 8: The BPMS must include a functionality which allows the user - Procurement Specialist to enter Order Tracking Number
- Requirement 9: The BPMS must include a functionality which allows the user - Procurement Specialist to enter Estimated Delivery Date
- Requirement 10: The BPMS must include a functionality which allows the user - Procurement Specialist to edit Order Information if needed.
- Requirement 11: The BPMS must include a functionality which allows the user - Procurement Specialist to edit Vendor Order Information if needed.
- Requirement 12: The BPMS must include a functionality which allows the user - Procurement Specialist to review Vendor Order Items.
- Requirement 13: The BPMS must include a functionality which allows the user - Warehouse Manager to enter Date the shipment was received.

- Requirement 14: The BPMS must include a functionality which allows the user - Warehouse Manager to edit Order Information, Vendor Order Information and Location Information if needed.
- Requirement 15: The BPMS must include a functionality which allows the user - Warehouse Manager to set the products from the order to specific Store Room, Rack and Shelf and add a comment about the order if needed.

Functional requirements for Asset Dispatch from Warehouse subprocess:

- Requirement 16: The BPMS must include a functionality which allows the user - Warehouse Manager to edit Warehouse Transfer Order Information if needed.
- Requirement 17: The BPMS must include a functionality which allows the user - Warehouse Manager to review items that require preparation.
- Requirement 18: The BPMS must include a functionality which allows the user - Warehouse Manager to confirm equipment was received/cancel orders.

Functional requirements for Revision Trail:

- Requirement 19: The BPMS must include a functionality which allows the user - defined by the company, to have a historical overview of who submitted the task in the process, at which step as well as date and time of the executed task.

Functional requirements for Email Notifications:

- Requirement 20: The BPMS must include a functionality which allows email automation for emails sent to Requester and Approver.

Functional requirements for Order Management Application:

- Requirement 21: The BPMS must include a functionality which allows integration with an application for order management, which consists of overview as well as adding and editing options for internal orders, external vendor orders, warehouse transfer orders, inventory stock, item catalogue list and vendor list.

Non-Functional Requirements:

Non-functional requirements define the quality attributes and constraints that determine the overall performance, reliability and usability of the process improvement system. These requirements address factors such as security, scalability, performance, and usability.

- Requirement 1: Ensure data security and privacy compliance with industry regulations (e.g. username authentication, user access rights depending on the department).
- Requirement 2: Optimizing system performance to handle maximum loads and ensure responsiveness during intensive use.
- Requirement 3: Improve system resiliency and fault tolerance to minimize service failures and disruptions.

5.8 Expected benefits

By meeting these requirements, the company's goal was to achieve tangible improvements in the equipment purchasing process, user experience, data security and compliance, which will lead to increased operational efficiency, cost savings and business growth. The expected business benefits of these requirements include:

1. Improved efficiency of the procurement process:

Automating the approval workflow will improve the equipment purchasing process by reducing the times spent on manual tasks such as paperwork handling and physical storage. Integrating an automated approval workflow could reduce the decision-making time, eliminate administrative work and lead to cost savings (Deskera, 2024). According to Bain & Company, fully automated procurement functions could save Global 5000 companies up to $86 billion annually. For Company X, which operates within a large healthcare environment, these efficiencies could lead to large financial benefits.

2. Simplified approval process and direct ordering from suppliers:

By simplifying the approval process and integrating it with the Equipment Ordering Portal, order processing times are expected to decrease. This no-touch order processing capability, as highlighted by McKinsey, will minimize manual interventions and improve reliability, which will lead to faster equipment delivery. Furthermore, enabling direct ordering from suppliers could reduce the lead times associated with traditional approval processes, leading to improved responsiveness of the supply chain, which is particularly important in the healthcare sector (McKinsey & Company, 2016).

3. Improved communication and transparency:

The implementation of email notifications for approval, rejection and order status updates will improve communication among employees in Company X, leading to improved transparency and accountability. This is particularly important given that communication barriers can lead to huge productivity losses. A survey of 400 multinational corporations in the USA and UK revealed that communication barriers cost an average of $64.2m in

lost productivity and currently globally each employee wastes between $1.600 and $3.200 a year on ineffective communications (Papirfly, 2019).
For Company X, reducing these barriers will not only improve internal communication but also cut the costs associated with the equipment purchasing process.

4. Improved user experience:

Functionalities that allow users to review, modify and approve orders will provide the employees of Company X with greater control over their purchasing activities. The integration of these functionalities with the Order Management Application will create a centralized platform for efficient order tracking and management. As an example, the successful implementation of Coca Cola's centralized inventory management system led to reduced inventory costs which improved operational efficiency (Cash Flow Inventory, 2023). For Company X, improved user experience could lead to better management of equipment purchasing and overall employee satisfaction.

5. Efficient task monitoring and audit trail:

The introduction of audit trail functionalities will allow Company X to monitor tasks effectively and maintain records of all procurement activities. As every process submission can be tracked and reviewed historically, this will ensure transparency and accountability.

6. Improved data security and compliance:

Non-functional requirements of Company X that focus on system security, performance optimization and resiliency, support data integrity and system reliability. Compliance with industry regulations and data security standards will ensure the protection of sensitive data and reduce the risks associated with data security breaches. Given the fact that according to the latest report by IBM, the average data breach in 2023 costs companies a record $4.45 million, maintaining strong security protocols is critical (Field Effect, 2024).

7. Scalability and flexibility:

A system designed with scalability in mind will ensure that Company X can adapt to increased workload demands and a growing number of users without compromising performance. This is particularly important as the healthcare industry faces constant changes and increasing demands. Moreover, the implementation of error handling and recovery mechanisms allows for timely detection and resolution of errors. Automated processes such as restarting failed components or rerouting requests can minimize downtown and ensure that Company X's critical functions remain operational even in the

face of system failures. At the same time, this will maintain trust among employee users who can rely on uninterrupted services (Business Tech Weekly, 2023).

After reviewing Company X's BPM system requirements and finding expected benefits, in the next chapter, I will evaluate how well LCDPs could work as a solution. For that I will compare different LCDP vendors and see if they meet the company's needs.

6 ASSESSMENT OF THE SUITABILITY OF THE LCDP FOR BPM AS A BUSINESS SOLUTION

For assessing the suitability of the LCDP as a business solution for the Equipment purchasing process improvement, I divided the requirements into the following six categories: Ease of Use and User Experience, Customization and Flexibility, Integration Capabilities, Compliance and Security Features, Performance and Scalability, ROI and Cost-Effectiveness.

After that, I examined each LCDP's (IBM, Appian, Ultimus) features, capabilities and strengths, and based on the analysis of these vendors from chapter 2.6, evaluated each platform whether it meets the criteria.

6.2 Company's Requirements for Equipment Purchasing Process Improvement

In an effort to improve the equipment purchasing process, stakeholders expressed specific requirements to improve efficiency, transparency and user experience, which I detailed in chapter 5.7.1. I have classified the business requirements into two scenarios: when an order request approval is required and when it is not.

The business requirements can be summarized as the following:

Procurement request approval business scenario:

- Standardized approval process after order placement needed.
- Immediate email notifications for requesters upon order submission needed.
- Option to order from vendors if items are out of stock needed.
- Inclusion of warehouse shipping options needed.

Procurement without approval business scenario:

- Ability to skip approval for certain scenarios needed.

The functional requirements for the LCDP BPMS included the following:

- Implementation of Asset Procurement, Order from Vendor and Dispatch from Warehouse subprocesses.
- Ability to automate email notifications for status updates.

- Revision Trail functionality for task history tracking.
- Integration ability with an Order Management Application.

Last but not least, the non-functional requirements included system performance, resilience and fault tolerance and data security compliance.

5.3 Evaluation Criteria

To assess the suitability of the LCDPs for meeting the company's requirements I divided the requirements into the categories below, which formed the chosen evaluation criteria. These criteria were identified through a detailed analysis of the company's requirements for the BPM solution, best practices of BPM software and the features that are commonly offered by the leading LCDP vendors in the market.

1. Customization and Flexibility:

- Ability to view, modify and add items to purchase orders.
- Flexibility to change shipping references and order information as needed.
- Ability to add orders from multiple vendors and different warehouses.
- Support for configuring approval workflows based on organizational hierarchy and procurement policies.
- Ability to customize email templates and notifications for different stages of the procurement process.

2. Ease of Use and User Experience:

- Design the process of approving a purchase request after placing an order on the Equipment Ordering Portal.
- Enable the requester to receive an approval/decision email to their work email address upon purchase order.
- Include shipping options such as dispatching or self-pick-up from the warehouse for equipment delivery.
- Provide a user-friendly interface for viewing, modifying and approving orders.
- Ensure intuitive navigation and minimal training requirements for users from different departments.

3. Integration Capabilities:

- Integration with the Order Management Application, including the ability to review and edit internal orders, external supplier orders, warehouse transfer orders, inventory, product catalog list and supplier list.
- Seamless integration with the Equipment Ordering Portal and corporate email (Outlook) for notifications and updates.
- Support for APIs and web services to connect to third-party applications and services.

4. Performance and Scalability:

- Ability to handle increasing workload demands and user transaction demands due to the growing procurement process.
- Scalability of the system architecture, which will allow the installation of additional functions and features in the future.

5. Compliance and Security Features:

- Ensure data security and privacy compliance with industry regulations.
- Provide role-based access control and authentication mechanisms to protect sensitive procurement data.
- Implement encryption and secure transmission protocols for communication between systems.

6. ROI and Cost-Effectiveness:

- Potential return on investment (ROI) associated with the platform deployment.
- Consideration of implementation costs, license fees and ongoing maintenance costs.

6.4 Overview of compared LCDPs

The below presented overview of the compared LCDPs provides insight into how each LCDP meets, partially meets or doesn't meet the requirements of the Asset Procurement process for each of the evaluation criteria.

Table 5: Overview of compared LCDPs

Criteria	**Appian**	**IBM BPM**	**Ultimus BPM**
Customization and Flexibility	Meets criteria: Offers robust customization capabilities, supports complex workflows and customizable email templates (Deep Analysis, 2024).	Meets criteria: Offers strong support for configuring complex workflows and customizations, though the initial setup can be complex (Carlson-Neumann, 2016).	Meets criteria: Highly customizable with low-code and pro-code options, it supports complex workflows and custom notifications (Vignette, 2021).

(table continues)

(continued)

Table 5: Overview of compared LCDPs

Criteria	**Appian**	**IBM BPM**	**Ultimus BPM**
Ease of Use and User Experience	Meets criteria: User-friendly interface, intuitive navigation, minimal training required, includes comprehensive approval processes and options (Appian, 2024).	Partially meets criteria: It is user-friendly, has strong documentation support, but may require more training for non-technical users (Carlson-Neumann, 2016).	Meets criteria: User-friendly with intuitive navigation and minimal training needed for basic functions, comprehensive support for approvals and notifications (Ultimus, 2024).
Integration Capabilities	Meets criteria: Provides strong integration with SAP, Oracle, Salesforce, etc., supports third-party APIs and web services, provides seamless email integration (Deep Analysis, 2024).	Meets criteria: Provides integration with IBM services, supports APIs and web services, seamless integration with corporate email (Carlson-Neumann, 2016).	Meets criteria: Strong integration with third-party applications, supports APIs and web services, seamless email and portal integration (Vignette, 2021).

(table continues)

(continued)

Table 5: Overview of compared LCDPs

Criteria	Appian	IBM BPM	Ultimus BPM
Performance and Scalability	Meets criteria: Scalable architecture, handles increasing workloads and user transactions, allows for installation of additional features (Deep Analysis, 2024).	Meets criteria: Cloud-based solution that ensures scalability, handles significant workloads and allows for future expansion of features (Carlson-Neumann, 2016).	Meets criteria: Scalable system architecture designed for increasing workloads and complex processes, supports the addition of new features (Vignette, 2021).
Compliance and Security Features	Meets criteria: Strong focus on data security, role-based access control, authentication mechanisms, and secure transmission protocols (Appian, 2024).	Meets criteria: Ensures data security, robust role-based access control and authentication, strong encryption and secure communication protocols (Carlson-Neumann, 2016).	Meets criteria: Comprehensive compliance with industry regulations, strong role-based access control and authentication, robust encryption protocols (Vignette, 2021).

(table continues)

(continued)

Table 5: Overview of compared LCDPs

Criteria	Appian	IBM BPM	Ultimus BPM
ROI and Cost Effectiveness	Partially meets criteria: High potential ROI, high customer satisfaction, but high initial and ongoing costs may impact smaller organizations (Deep Analysis, 2024).	Meets criteria: Cost-effective due to cloud model reducing infrastructure needs, various editions exist for different budgets, though initial costs can be high (IBM BPM, 2024).	Partially meets criteria: High potential ROI with versatile capabilities, flexible pricing, but initial setup and learning costs may impact immediate cost-effectiveness (Vignette, 2021).

Source: Own work

Based on the detailed evaluation of Appian, IBM BPM and Ultimus BPM against the requirements that were specified by the company for their equipment purchasing process, the following suggestions are made in order to optimize the selection and implementation of a LCDP BPM business solution.

Regarding customization and flexibility, the company needs a solution that can handle various aspects of purchase order management, from viewing and monitoring orders to adding orders from multiple vendors and warehouses. All three evaluated LCDPs - Appian, IBM BPM and Ultimus BPM meet these requirements.

The ease of use and user experience is critical for ensuring that users from different departments can navigate the system with minimal training. Both platforms Appian and Ultimus BPM offer user-friendly interfaces and require minimal training, making them suitable for the company's diverse employees. They provide intuitive navigation and user-friendly process design for approvals. While IBM BPM offers this comprehensive set of features, it requires more training for non-technical users. However, if the company can invest in adequate training resources, IBM BPM still remains a strong competitor.

Integration with existing systems, including the Order Management Application and corporate email (Outlook), is of high importance for the Equipment purchasing process. The studied platforms provide extensive support for APIs and web services, ensuring integration with third-party applications and services. This makes them highly suitable for the company's requirements to connect with the Equipment Ordering Portal and other corporate systems.

As the company's procurement processes grow, the chosen BPM solution must handle the increasing workloads and scale in order to meet future functionalities. All three solutions offer scalable architectures that can manage growing demands. Therefore, my suggestion is that the company evaluates the specific scalability features of each platform in order to ensure which one is the most suitable one for them in the long-term.

Ensuring data security and compliance with industry regulations is non-negotiable for the Equipment purchasing process. Appian, IBM BPM and Ultimus BPM, provide strong compliance and security features. These include role-based access control, authentication mechanisms, encryption and secure transmission protocols. The company can confidently choose any of these platforms for this matter.

The ROI and cost-effectiveness are essential in the final decision-making process. Although Appian has high initial and ongoing costs, its comprehensive features and high potential ROI make it a worthwhile investment for the company. IBM BPM offers cost-effectiveness due to its cloud model infrastructure, which can reduce long-term infrastructure costs. On the other hand, Ultimus BPM with its flexible pricing is suitable for companies with varying budgets. The company should also consider Ultimus BPM if immediate cost-effectiveness is not a critical factor for them.

Considering the weaknesses of each BPM solution, the company must carefully weigh these factors against their specific needs and resources. High implementation and ongoing costs of Appian might be significant barriers. If budget and training resources are limited, Appian could be less suitable despite its powerful features.

The complexity of initial setup and dependency on IBM support could delay deployment and also affect operational efficiency. Therefore, the company should assess whether they can manage these complexities and dependencies.

While Ultimus offers low-code capabilities, it still relies on pro-code for more complex automation projects. This dependence on higher technical expertise could be a barrier for the company, particularly if they lack a strong IT background. If the company lacks technical expertise or seeks a simpler, low-code solution, Ultimus might not be the best fit.

The evaluation of the LCDP vendors has given a clear understanding of how well they can meet Company X's needs. Next, I will combine the theoretical insights with the case study results to discuss the practical implications of the study and address its limitations.

7 DISCUSSION

The integration of LCDPs into BPM offers a significant opportunity for organizations that are seeking to streamline their operations, enhance flexibility and reduce their development times. This chapter will provide a synthesis of the theoretical insights from the literature and practical findings from the case study of Company X. By connecting

these insights, the aim of this chapter is to provide a comprehensive understanding of the potential and challenges that appear when adopting a LCDP BPM solution.

7.1 Practical findings from the case study

The case study on Company X provides valuable insights into practical application of LCDP BPM solutions. Company X, a large company in the healthcare sector, currently faces several challenges in its BPM approach, including fragmented processes, lack of integration and inefficiencies in the equipment purchasing process. Therefore, the company's requirements for BPM improvement include enhanced process automation, better data integration and increased flexibility to adapt processes business environment changes.

Hence, the assessment of selected major LCDP vendors - Appian, IBM and Ultimus, revealed their strengths and weaknesses and their suitability as LCDP BPM solution.

Appian offers comprehensive purchase order management capabilities and supports the customization of email templates and notifications. However, high initial and ongoing costs together with the need for extensive customization, can be seen challenges for Company X (Deep Analysis, 2024).

IBM's cloud infrastructure, strong integration with the Order Management Application and strong security features make it a suitable choice for the company. However, the complexity, reliance on IBM support and higher initial cost of IBM's solutions need to be considered (Carlson-Neumann, 2016).

Ultimus provides a user-friendly interface and extensive pre-configured components, which can accelerate the deployment of BPM solutions. Nonetheless, scalability concerns and pro-code reliability could impact its suitability for the company (Vignette, 2021).

7.2 Implications for practice

The theoretical benefits for LCDPs, such as enhanced efficiency, democratization of development and cost savings, are reflected in the practical findings from the case study. The company's need for rapid development and deployment of BPM solutions aligns with the theoretical advantages of LCDPs, which include faster application development cycles and greater involvement of business professionals in the development process.

Furthermore, the theoretical challenges of LCDPs, which include high license cost, security risks, vendor lock-in and limited customization, were also evident in the case study. Company's concerns about the high costs associated with some LCDP vendors, the need for extensive customization to meet specific requirements and security concerned features as role-based access control and authentication mechanisms, also highlight these theoretical limitations.

Based on the theoretical and practical findings, I would like to suggest the following detailed implications for the company, when deciding about the adoption of LCDP BPM solutions:

Implementing pilot projects in controlled environments can help the company evaluate the practical applicability of the LCDP BPM solution. These pilots can focus on specific processes within the equipment purchasing domain, allowing the company to identify potential challenges and make necessary adjustments before the full-scale implementation of the software. Pilot projects also provide a good opportunity to gather feedback from end-users, in this case employees, which can be very valuable when refining the solutions.

The second implication I would like to point out is the establishing of a strong governance framework, which is essential to address security risks and ensure compliance with regulatory requirements. This framework should include clear policies for managing shadow IT, vendor management and data governance. Moreover, implementing role-based access controls and authentication mechanisms can protect sensitive procurement data and ensure that only authorized employees can access critical systems.

Finally, investing in training programs for both IT staff and business professionals is very important. This can enhance the effective use of LCDPs and ensure that the employees are well skilled to leverage the full capabilities of the platform. Providing ongoing support, including access to vendor resources and community forums can reduce the issues related to limited technical expertise and ensure smooth adoption of the solution.

7.3 Limitations

This study is subject to several limitations that need to be acknowledged, both in the research process and in the practical implementation of the findings.

Firstly, the scope of the research of this thesis was limited to a specific set of LCDP vendors (Appian, IBM and Ultimus). This selection, while justified by their importance in the market, excludes other potentially good choice platforms that could offer different insights. Thus, the findings may not be fully true across the entire landscape of LCDPs.

Next, the research methodology, which included the observation method for the case study, is a subject to biases that exist in qualitative research. The observations made during the study might reflect individual biases that do not represent broader trends. Additionally, the case study was conducted within a specific organizational context, which also may limit the applicability of the findings to other companies with different organizational structure, culture and processes.

Furthermore, the study heavily relied on secondary data from existing literature and vendor-provided information, which does not always present an unbiased view. Therefore, we cannot overlook the potential for vendor marketing material influencing the perceived strengths and weaknesses of the platforms.

In terms of practical implementation, one significant limitation is the dynamic nature of LCDP technology. LCDP vendors frequently update their platforms by adding new features and capabilities that could change the suitability and performance of these solutions.

The rapid pace of this technological change means that the findings and recommendations may become outdated relatively quickly. Consequently, it is worth mentioning that the assessment of each platform's capabilities was based on the current state of the LCDP technology and available features at the time of the study.

Moreover, another practical limitation is the dependency on organizational capacity and readiness for change. A successful implementation of LCDP BPM solution requires not only financial investment, but also a cultural shift towards embracing new technologies for process improvement. Organizations with resistance to change or rigid structure might struggle to realize the full added value of these low-code solutions.

Last, but not least, this study assumes a certain level of standard technical expertise within the company for the deployment and maintenance of the LCDP BPM solution. The availability of skilled employees and adequate training programs can significantly influence the success of implementations in reality.

8 CONCLUSION

I conducted this study to explore the extent to which LCDPs can meet a corporation's business requirements for BPM improvement. The research aimed to address the main research question and three subquestions: what are the LCDP BPM solution requirements in relation to the company's business needs, whether the characteristics of the company have a strong influence on the choice of LCDP BPM solution, and whether it makes sense to introduce an LCDP BPM solution in a corporation.

RQ: To what extent can LCDPs meet a corporation's business requirements for BPM improvement?

Based on the analysis of the theoretical framework and practical case study, it is evident that LCDPs can meet a corporation's business requirements for BPM improvement. LCDPs offer a range of capabilities which include customization and flexibility, ease of use, comprehensive integration, scalability, compliance and cost-effectiveness. These LCDPs enable rapid application development which allows business professionals with limited coding skills to participate in the software development process. Therefore, they are democratizing software creation and aligning solutions closely with the business needs.

SQ1: What are the LCDP BPM solution requirements in relation to the company's business needs?

The requirements for LCDP BPM solution, as identified in this case study, include the following:

- Ease of use and user experience: user-friendly interface, intuitive navigation, minimal training required, support for various delivery options.
- Customization and flexibility: ability to manage purchase orders, configure approval workflows and customize email templates.
- Integration capabilities: integration with order management application, corporate email (Outlook), and other third-party applications through APIs and web services.
- Performance and scalability: capacity to handle increasing workloads and scalability for future growth.
- Compliance and security features: Ensuring data security, role-based access control and authentication, encryption and obedience of industry regulations.
- ROI and cost-effectiveness: favorable return on investment, reasonable implementation costs and manageable ongoing maintenance expenses.

SQ2: Do the characteristics of the company have a strong influence on the choice of LCDP BPM solution?

The characteristics of the company have a high influence on the choice of an LCDP BPM solution. Factors such as the company's existing IT infrastructure, technical expertise, the complexity of the business processes and budget constraints play big roles in decision-making. E.g., companies with advanced IT infrastructure and higher technical expertise may benefit more from platforms like Appian, which offers extensive customization and integration capabilities. On the other side, organizations with limited technical resources might find IBM's BPM solution more suitable due to its guided implementation and strong support.

SQ3: Does it make sense to introduce LCDP BPM solution in a corporation?

The introduction of a LCDP BPM solution is not only reasonable but also has many advantages. The practical part of the thesis which involved the case study and detailed assessment of the selected vendors has shown significant benefits. The practical suggestions for the company for the implementation of LCDP as a BPM solution emphasize enhanced user satisfaction, increased flexibility, improved process visibility and workflow automation, leading to overall operational efficiency. However, inhibitors such as vendor lock-in and high licensing cost must be addressed, in order to ensure successful implementation in the long-term.

8.1 Further research

There is enough place for further research building on this study. Below, I outline three main research paths and describe the different study ideas that could inspire future researchers.

Strategies for overcoming inhibitors to LCDP adoption - investigating practical strategies for overcoming common inhibitors to LCDP adoption that were also found in this study, such as limited portability, vendor lock-in and lack of governance, could provide valuable insights. The focus of this research could be on the development of frameworks and best practices that organizations can use to deal with these challenges and ensure successful adoption of LCDP BPM solutions.

Long-term impact of LCDP adoption on organization's innovation and flexibility - the future studies regarding this topic could explore how the implementation of LCDPs influences organizational flexibility and innovation over a long period. Longitudinal studies across different industries could assess if LCDPs consistently over time deliver their promise of increased flexibility and faster time-to-market development of new applications.

The role of AI and ML in enhancing LCDP for BPM - this research path could explore how the integration of AI and ML capabilities can build up on LCDP functionalities in BPM solutions. The research studies in this field could focus on process optimization, predictive analytics and automated decision-making, to provide insights into the future of intelligent BPM software.

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APPENDIX

Appendix 1: Summary in the Slovenian language

V današnjem digitalno usmerjenem poslovnem okolju se podjetja ter predvsem velike korporacije soočajo z vedno večjo kompleksnostjo upravljanja poslovnih procesov, hkrati pa z omejenimi viri na področju razvoja programske opreme. To pomanjkanje usposobljenih razvijalcev in naraščajoča potreba po digitalni transformaciji sta spodbudna faktorja za uporabo platform za nizko-kodno razvojno okolje (LCDP - Low-code development platforms), saj omogočajo hitrejše razvijanje aplikacij z minimalnim programerskim znanjem.

To magistrsko delo se osredotoča na uporabo teh platform za izboljšanje procesov upravljanja poslovnih procesov (BPM) na primeru velike korporacije iz zdravstvene panoge. Raziskava preučuje do kakšne mere lahko LCDP zadostijo specifičnim zahtevam korporacije pri izboljšanju procesa nabave opreme. Hkrati identificira tudi dejavnike, ki vplivajo na uspeh vpeljave LCDP kot poslovne rešitve. Posebna pozornost je pri tem namenjena avtomatizaciji procesov odobritve naročila, integraciji nizko-kodne programske rešitve z obstoječimi programi podjetja in izboljšanju uporabniške izkušnje.

V okviru praktične študije primera je bilo ugotovljeno, da lahko uporaba LCDP-jev v procesu nabave opreme izboljša učinkovitost, saj avtomatizacija in integracija sistemov zmanjšata potrebo po ročnih opravilih, s tem pa se tudi skrajša čas obdelave naročil in poveča zanesljivost postopka. Dodatni dejavniki, ki pripomorejo k temu so tudi enostavnost uporabe, skalabilnost in možnost celovite integracije te rešitve. Kljub temu, raziskava izpostavlja tudi nekatere omejitve, med katerimi so odvisnost od ponudnika in težave z nadaljnjo razširitvijo rešitev. Prav tako je za uspešno implementacijo potrebno zagotoviti varnost podatkov in skladnost s predpisi panoge podjetja.

Magistrsko delo poleg tega obravnava vpliv značilnosti podjetja na izbiro LCDP rešitve. Kot je bilo ugotovljeno, organizacijski dejavniki kot so velikost podjetja, kompleksnost procesov, proračunske omejitve ter tehnična usposobljenost zaposlenih, pomembno vplivajo na odločitev glede izbire platforme. Na osnovi te analize so podani tudi konkretni predlogi glede uvedbe LCDP rešitve v podjetju, z namenom izboljšanja operativne učinkovitosti: izvajanje pilotnih projektov v nadzorovanem okolju, vzpostavitev močnega okvira upravljanja za obravnavo varnostnih tveganj ter vlaganje v izobraževalne programe za zaposlene v IT oddelku in poslovnih oddelkih.

V zaključku, delo predlaga nadaljnje raziskave v več smereh. Prva raziskava bi se lahko osredotočila na strategije za premagovanje omejitev pri sprejemanju LCDP, kot so omejena prenosljivost in odvisnost od ponudnika. Druga možna raziskava bi lahko šla v smeri dolgoročne analize vpliva uvedbe LCDP na inovativnost in prilagodljivost organizacij, kjer bi se preverjalo ali te platforme dolgoročno res izpolnjujejo obljube o hitrejšem razvoju novih aplikacij. Kot tretje raziskovalno področje pa na koncu vidim tudi

raziskovanje vloge umetne inteligence in strojnega učenja pri izboljšanju funkcionalnosti LCDP v BPM rešitvah, kjer bi fokus bil na avtomatiziranem odločanju in napovedni analitiki.