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Drag-and-Innovate – How Do Low-Code Development Platforms Enable Digital Innovation in Industry?

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Abstract

Given the increasing shortage of qualified IT professionals and the rising demand for digital technologies, more and more companies are facing the challenge of not being able to satisfy the growing demand for digital applications with their existing IT specialists. Simultaneously, digital innovations are becoming increasingly important for companies to gain a competitive advantage and ensure long-term viability. However, since IT departments are usually responsible for digital innovations, many companies face the problem that they cannot keep up with the pace due to the shortage of skilled workers and thus fall behind. In this context, low-code development platforms (LCDPs) offer a possible solution to counter these problems by eliminating the need to write code and thus making application development accessible to non-IT employees. Consequently, these platforms are promising for leveraging specialist knowledge within an organization and driving digital innovations, as the massive simplification enables non-IT employees to participate in innovation discovery. In light of this, LCDPs represent a promising solution for industrial companies, as this sector must adapt even more quickly and flexibly to the emerging changes and upheavals caused by the advancing Industry 4.0. In response to the growing need for digital innovations, we conduct qualitative research through expert interviews to find out how LCDPs enable digital innovation in the industrial sector. From the perspective of organizational ambidexterity, the paper reveals which types of innovations LCDPs enable and which facilitating conditions industrial companies need to fulfill to unleash this potential. The findings show that industrial companies are currently using LCDPs with a strong focus on internal innovation and that the facilitating conditions are crucial to whether industrial companies can fully exploit the innovation potential of these platforms. Furthermore, we find different usage patterns of how industrial companies use these platforms and their influence on innovation potential. Overall, our findings suggest that LCDPs are a promising way to enable digital innovation in the industry and can be an enabler of organizational ambidexterity. However, our results also indicate that more is currently being exploited than explored with LCDPs and that industrial companies must pay more attention to the facilitating conditions to realize the full innovation potential of these platforms.

Keywords: Ambidexterity, Low-code development platform, Digital innovation, Industry 4.0, Manufacturing companies

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1 Introduction

Currently, around 96,000 IT positions are unfilled in Germany alone (Bitkom 2022), and there are no signs of improvement in the personnel situation. On the contrary, research companies expect the shortage to rise to 1.1 million by 2030 (Strack et al. 2021). Additionally, market research firm Gartner already predicted in 2019 that by 2021, demand for information systems would grow five times faster than IT departments can provide them. Consequently, due to the shortage of IT specialists and the growing need for digital applications, many companies are facing the challenge of not being able to meet the demand for digital applications with their existing IT professionals (Luo et al. 2021; Waszkowski 2019). Nevertheless, digital technologies are increasingly important in achieving competitive advantages and improving internal processes. Developing new applications nowadays requires IT and business expertise, meaning that only professional developers can create applications, and this traditional approach is often expensive, time-consuming, and complex (Iho et al. 2021). However, for enterprises, the success of digital transformation mainly depends on how quickly they can deliver applications and services (Vogelsang et al. 2018). Due to the increasing demand for digital technologies, companies must seek new ways to facilitate application development (Alsaadi et al. 2021; Luo et al. 2021). One possible solution to counteract this problem are low-code development platforms. Low-code development platforms (LCDPs) enable the rapid generation of business applications with minimal programming effort. Therefore, these platforms are the fastest and cheapest way to develop applications. In addition, creating an application with an LCDP requires almost no programming experience or technical know-how, making it quick and easy for non-IT employees to develop applications (Iho et al. 2021; Luo et al. 2021).

Furthermore, not only do businesses need to accelerate application development and make it accessible to non-IT employees, but enterprises also need to shift their focus towards digital innovation increasingly (Krejci et al. 2021). Since the beginning, innovations have been indispensable for companies and can effectively provide a competitive advantage (Souto 2015). However, digital innovations are becoming increasingly crucial for companies due to the digital transformation and now outshine classic innovations (Ciriello et al. 2018). A long-standing challenge of companies in this regard is to innovate incrementally and radically simultaneously, also known as organizational ambidexterity. Organizational ambidexterity refers to a company's ability to exploit existing capabilities and resources to drive incremental innovation while exploring new opportunities to remain competitive and not be displaced from the market, leading to radical innovation. Nowadays, many organizations try to become ambidextrous and avoid a trade-off between these two opposing activities (Gibson and Birkinshaw 2004; O'Reilly III and Tushman 2013) as evidence shows that ambidextrous companies are more successful and viable in the long term (O'Reilly III and Tushman 2008; O'Reilly III and Tushman 2013). Nevertheless, when it comes to digital innovations, IT departments are primarily responsible for simultaneously pursuing both activities, which is associated with great difficulties due to the shortage of skilled workers in IT (Krejci et al. 2021).

Overall, LCDPs thus represent a promising solution to accelerate application development (Richardson and Rymer 2016) and drive digital innovations in the enterprise, as all employees can now be involved in the innovation process (Krejci et al. 2021). However, not all companies use LCDPs by a long shot. The adoption rate of these platforms is 77% worldwide, with Germany comparatively slower in adoption at 69% than the United States at 80% (EU Business News 2021; Mendix Technology 2021). Although acceptance is high, other reports indicate that a shortage of knowledge about low-code and a lack of belief that these platforms can be used to develop the types of applications desired are among the reasons why companies remain hesitant to adopt LCDPs (Alsaadi et al. 2021; Outsystems 2019). Even though companies in Germany are still reluctant to adopt these platforms, they offer a promising solution

for industrial companies in particular, as this sector needs to adapt even faster and flexibly to the emerging changes and upheavals brought about by the advancing Industry 4.0 to avoid falling behind and keeping up with the competition (Sanchis et al. 2019).

Although the desire to accelerate software development has existed for several decades, and the topic of rapid application development is not fundamentally new (Bock and Frank 2021), there is currently only limited scientific research on LCDPs and how these platforms can be used for innovation (Iho et al. 2021; Krejci et al. 2021). In particular, there is almost no scientific research on industrial companies, even though LCDPs will play an increasingly important role here, as there are numerous use cases in this area (Demski 2022). Nevertheless, the number of publications on LCDPs has increased, especially in recent years. In this context, Alsaadi et al. (2021), Bock and Frank (2021), and Sahay et al. (2020) have examined different low-code platforms and compared their functionalities and application areas. Additionally, Iho et al. (2021) investigated how LCDPs support knowledge integration in the enterprise, and Krejci et al. (2021) how innovative ideas are developed with LCDPs. In light of this, LCDPs promote knowledge integration within the company (Iho et al. 2021) and increase the flexibility and autonomy of employees, making them the driving force behind digital innovations (Krejci et al. 2021). Furthermore, Sanchis et al. (2019) and Waszkowski (2019) examined LCDPs in the context of industrial companies and how they can use these platforms to automate business processes.

Nevertheless, there has been comparatively scarce scientific research on LCDPs despite market research firms Forrester and Gartner forecasting significant market growth (Sahay et al. 2020), and more than 65% of all application developments will be based on these platforms by 2024 (Alsaadi et al. 2021; Talesra and Nagaraja 2021). However, none of the scientific articles address the role of LCDPs in driving digital innovation. Similarly, no published article has analyzed yet which innovations LCDPs primarily drive. This need for research also aligns with a statement from Iho et al. (2021), which mentions that future research on the role of LCDPs in supporting innovation is required as more companies adopt these platforms. Furthermore, Krejci et al. (2021) argued that LCDPs are more suitable for incremental innovations than radical ones. However, they emphasized that further research needs to confirm this assumption and investigate how LCDPs support new and existing innovation practices to uncover the role of LCDPs in the digital innovation process (Krejci et al. 2021). Since little is known about innovations related to LCDPs, this bachelor thesis answers the need for research and investigates whether industrial companies can use LCDPs to build on existing capabilities, leading to incremental innovations, or whether LCDPs are also suitable for experimentation, leading to radical innovations. More specifically, this thesis examines the types of innovations LCDPs enable and the facilitating conditions industrial companies must meet to unleash this potential.

Hence, this thesis aims to answer the following research question:

- How do LCDPs enable digital innovation in the industry?

After reviewing the literature, I conducted a qualitative study by holding interviews with companies that use LCDPs to better understand how they use them and how these platforms enable innovation. During this research, 21 participants from 15 companies were interviewed, and a total amount of 21.42 hours of interview material was collected. As a theoretical foundation and guiding lens, I used organizational ambidexterity. Among other observations, it was found that LCDPs can foster organizational ambidexterity but that industrial companies currently exploit more with these platforms than they explore and that the facilitating conditions for a successful implementation of LCDPs in the company are essential to harness the innovation potential.

The remainder of this thesis is structured as follows. The second chapter provides a theoretical overview of digital innovation, ambidexterity, and LCDPs. Also discussed is how these topics relate to Industry

4.0. In addition, this chapter describes the research model and research assumptions. In chapter three, the research methodology of the thesis is outlined, followed by the presentation of the research findings in chapter four. After the presentation of the findings, the discussion section follows. The discussion aims to critically reflect on the results and thus answer the research question. After answering the research question, the implications and limitations of this study are identified, followed by recommendations for future research opportunities. Finally, this thesis concludes with a brief overview of the entire process.

2 Literature Review

The literature review provides an overview of the current state of research and aims to cover the most critical issues of the research topic. Therefore, the following chapter will first provide an overview of digital innovations, types of innovations, and their connection to Industry 4.0. Subsequently, it will discuss the topic of ambidexterity and the necessity for companies to be ambidextrous. Next, a closer look at the domain of LCDPs is given, including the innovations these platforms can create, how they enable ambidexterity, and the link to Industry 4.0. The chapter concludes by introducing the research model and assumptions of this thesis.

2.1 Digital Innovations

2.1.1 Definition

The first definition of innovation came from Joseph Schumpeter, who defined innovation in 1934 as implementing new combinations of ideas (Hidalgo and Albors 2008). In general, however, innovation is a topic that has been around since the beginning of time, as people have always attempted to do things in a novel or better fashion than before. Without thinking differently or in a new direction, some of the most significant and extensive innovations, like the car, the airplane, or printing, would not have been possible (Fagerberg 2004).

In recent decades, the conception of innovations has continuously evolved, and a transition has taken place to digital innovations, which are now in the foreground. In this context, digital innovations refer to the innovation of products and services, processes, or business models through digital technologies. However, the outcome of digital innovations does not always have to be digital as long as digital technologies enable the innovations (Nambisan et al. 2017). With increasing digitization, digital innovations are no longer a topic that only affects IT companies; meanwhile, almost all companies have to deal with this issue to survive in the long term, as digital technologies are a differentiating component and an enabler for most innovations (Ciriello et al. 2018).

Furthermore, digital innovations radically changed products and services, processes, and business models in a novel way. The faster companies achieve digital innovations, the sooner they gain a competitive advantage and possibly a short-term unique selling proposition until competitors imitate the innovation (Nambisan et al. 2017; Tortora et al. 2021). However, to realize its full potential, companies need to move away from the idea that IT just keeps the business running but must create an IT environment that is both stable and supports the existing business, as well as explores new opportunities (Ciriello et al. 2018).

2.1.2 Different Types of Innovations

Innovations can be distinguished based on various characteristics. The most frequently used criteria are the form and the innovation's degree of novelty (Souto 2015). Regarding the form, a distinction can be made between a product, process, or business innovation. In this context, product innovations result from new or improved products, whereas process innovations represent introducing new or significantly improved methods within the company's activities. In contrast, business innovations are new or enhanced management, corporate strategies, or business practices that affect an organization's social system (Kraner 2018; Souto 2015). Moreover, innovations can be distinguished not only by their form but also by their novelty (Souto 2015).

Any product, process, or business innovation can be classified into two types regarding its degree of innovation novelty, called radical and incremental. In this context, radical innovations are novel breakthrough innovations such as new technologies or ideas that have not previously existed in the market (McDermott and O'Connor 2002; Souto 2015). Consequently, radical innovations require new knowledge, capabilities, and a different market understanding, as these innovations are tailored to the requirements of emerging customers (Raisch and Birkinshaw 2008). However, radical innovations can also be inward-looking and arise within the company if such an innovation causes a significant change (Sandberg and Aarikka-Stenroos 2014). Therefore, a completely new process may also represent a radical innovation if this newly developed process is quite distinct from the already existing processes and activities within the company. As a result, radical innovations are generally associated with higher costs and a greater risk of failure, as it can take several years for a radical innovation to be fully developed (McDermott and O'Connor 2002).

In addition, innovations can be classified as incremental. Incremental innovations usually have a meager degree of novelty, as these innovations already exist in a previous version and have only been improved or extended. Therefore, incremental innovations are less risky and cost-intensive than radical innovations since the basic idea is already available. Likewise, incremental innovations are less likely to achieve breakthroughs since they improve existing things and do not create entirely new products, processes, or business innovations. Nevertheless, incremental innovations are of great importance, as they contribute to continuous improvement (McDermott and O'Connor 2002; Souto 2015) and are focused on meeting existing customers' requirements (Raisch and Birkinshaw 2008).

Evidence shows that both innovations are equally important for businesses today. Incremental innovations ensure short-term profitability, as these innovations improve or extend the product lifecycle until the company develops the next radical innovation. Therefore, incremental innovations are of great importance, especially for retaining existing customers, as they improve existing products and thus increase customer satisfaction. In addition, incremental innovations help companies to work more efficiently by improving existing work processes. Conversely, radical innovations secure a company's long-term profitability and help to ensure that it is not forced out of the market in a dynamic environment and keeps up with its competitors. Consequently, radical innovations primarily aim to satisfy emerging customers' needs to remain competitive in the long term. To be successful, companies must pay equal attention to both types of innovation (Pappenheim 2016; Raisch and Birkinshaw 2008).

2.1.3 Innovations and Industry 4.0

When the topic of digital innovations concerning Industry 4.0 is placed, the question regarding the meaning of digital innovations for Industry 4.0 arises since digital innovations are more specific in this field than in other sectors. Each industrial revolution in the past centuries was characterized mainly by technological leaps that led to paradigm shifts and changed the way of working in production. However, the fourth industrial revolution is probably the most significant technological leap so far, as the digitalization of the entire manufacturing process characterizes it. Consequently, digital innovations play a considerably more substantial role in Industry 4.0 than in other sectors (Caruso 2018; Wilkesmann and Wilkesmann 2018).

Industry 4.0 comprises several technical solutions and devices, including the Internet of Things, Big Data, sensors, and chips (Wilkesmann and Wilkesmann 2018). In this framework, Caruso (2018) describes the essential elements of Industry 4.0 as “the intersection between production, processing processes and flows of information online (Internet of Things, cloud, Big Data), and devices (sensors, chips) that communicate independently with each other […]” (Caruso 2018, p. 380). Subsequently, these digital

technologies can improve existing processes and products on the one hand and thus contribute to improved efficiency in the business. On the other hand, these technologies will also lead to radical changes and innovations as they create new opportunities that were previously impossible. Hence, Industry 4.0 has the potential for digital innovations in both types, incremental and radical (Ibarra et al. 2018; Lenart-Gansiniec 2019).

Industry 4.0 technologies can contribute to digital innovations, which can be incremental or radical. On the one hand, using these technologies can improve internal and external processes, as these technologies optimize the value creation architecture. Optimizing the value architecture can lead to better decisions based on vast amounts of data, cost savings, and improved downtime. In addition, customer experience can be improved as these technologies enable new interactions and a better understanding of customer needs. Since these are improvements of existing things and do not involve significant disruptions, they are incremental innovations. On the other hand, Industry 4.0 can also enable radical innovations, which can give rise to entirely new business models that have not existed before. In this context, industrial companies can use these technologies to offer new intelligent goods and services, such as remote maintenance installation, and thus enter new markets and expand their business (Ibarra et al. 2018).

In summary, innovations have always existed and can be classified according to their form in a product, process, and business innovation and their degree of novelty in radical and incremental. Radical innovations represent novel innovations, whereas incremental innovations represent improvements or extensions of existing inventions (Souto 2015). Due to the acceleration in digitalization, there has been a clear transition to digital innovations in recent years. Digital innovations refer to innovations that arise through the use of digital technologies and are now the main focus of numerous companies contributing significantly to the successful survival of a company (Nambisan et al. 2017). Nowadays, every business has to deal with digital innovations and should create an IT environment in which this is possible (Ciriello et al. 2018). However, digital innovations play a particularly crucial role in industrial companies, as Industry 4.0 is characterized by complete digitalization that is based on digital innovations (Caruso 2018; Wilkesmann and Wilkesmann 2018).

2.2 Ambidexterity

Innovations are essential for organizations and ensure their continued existence. Therefore, companies need to create radical as well as incremental innovations. Frequently, companies focus on an either-or approach and pursue only radical or incremental innovations. However, it is often the case that companies prefer to avoid taking significant risks and, therefore, mainly focus on incremental innovations (O'Reilly III and Tushman 2008). If there is an imbalance and companies exploit more than they explore, there is a risk that shadow IT will emerge and IT departments will secretly develop innovations that have not been controlled or approved. Conversely, this leads to an efficiency creep, as companies do not invest all resources in exploiting (Magnusson et al. 2020). What remains unanswered is whether this can also work together so that industrial companies can pursue both types of innovation simultaneously.

2.2.1 Definition

Sociologist Robert B. Duncan first used the word ambidexterity in 1976 to describe the ability to pursue two different goals (Raisch and Birkinshaw 2008). In this context, organizational ambidexterity refers to an organization's ability to exploit existing capabilities and resources to drive incremental innovations while exploring new possibilities to remain competitive and not squeeze out of the market, thereby creating radical innovations. Nowadays, many companies are trying to become ambidextrous and move

away from a trade-off between these two conflicting activities, as it is proven that enterprises can improve performance and foster innovation if contradictory actions perform simultaneously. However, numerous companies have serious difficulties simultaneously carrying out these two contradictory activities. Therefore, researchers have developed and investigated various approaches to achieve ambidexterity over the past decades (Gibson and Birkinshaw 2004; O'Reilly III and Tushman 2013).

One way to achieve ambidexterity in a company is a sequential approach, where it is claimed that a company can only exploit or explore at the same time. Thus, in this approach, there is a sequential change between an exploring and an exploiting organization (O'Reilly III and Tushman 2013). A second concept of how an enterprise can attain ambidexterity is contextual ambidexterity. Gibson and Birkinshaw (2004) opine that organizations must perform alignment and adaptability simultaneously. To achieve this, employees should have the freedom and autonomy to decide which activity is more important to pursue to balance these two activities (O'Reilly III and Tushman 2013; Raisch and Birkinshaw 2008). A third approach for companies to achieve ambidexterity is structural, which involves structurally separate entities within an organization where these units pursue either exploration or exploitation tasks. Therefore, these business units work separately and have different skills, capabilities, and competencies, but common strategies and values try to keep the teams together (Gibson and Birkinshaw 2004; O'Reilly III and Tushman 2013; Raisch and Birkinshaw 2008). Nevertheless, achieving ambidexterity also depends firmly on the current market situation in which the company operates (O'Reilly III and Tushman 2013).

Since different companies, in reality, are exposed to various competitive markets, the approaches to achieve ambidexterity are more or less suitable depending on the market situation. Sequential ambidexterity could be a promising approach for stable environments that change less quickly or for smaller companies that do not have the resources to pursue the activities simultaneously. In highly dynamic environments, this strategy would be somewhat suboptimal, and contextual ambidexterity would probably have to be chosen as the appropriate method, where both activities can be pursued simultaneously (O'Reilly III and Tushman 2013). However, it is not only the market situation and corporate environment that determine how ambidexterity can be successfully achieved but also the leadership style (Raisch and Birkinshaw 2008).

Strategic leadership is crucial in achieving ambidexterity and fostering innovation within the organization. In this context, leaders must both monitor the external business environment to gain new insights into market trends, competitive conditions, and customer needs and bring this information back into the organization as a conduit to drive new ideas. Therefore, managers must master various skills and leadership styles and create an environment that fosters learning to enable incremental and radical innovations. Consequently, leaders and leadership styles are crucial in empowering organizations to become ambidextrous (Lin and McDonough III 2011).

Moreover, leadership styles are fundamentally different in exploration and exploitation and require specific skills and competencies. Leaders who do not possess the necessary skills often avoid risk and focus more on short-term goals, resulting in an imbalance. In contrast, leaders with the required skills can help the organization successfully manage contradictions and become ambidextrous. Consequently, leadership styles significantly impact mediating the forces of exploration and exploitation. In the case of exploratory activities, leaders need to build loose cultures in which employees can freely unfold. Here, the organization must develop informal and flexible working methods to give employees as much freedom as possible. Such a culture fosters the ability to react quickly to changes, think outside the box, and drive innovations. Conversely, when it comes to exploitation activities, companies must establish a tight culture as the emphasis is on efficiency and stability and thus must be a certain degree of rigor (Lin and McDonough III 2011).

2.2.2 Necessity for Ambidexterity

Organizational ambidexterity means that a company explores and exploits simultaneously. In this context, exploration refers to experimenting and testing new possibilities, and exploitation refers to taking advantage of existing knowledge to achieve greater efficiency in existing processes or products. Consequently, exploiting leads to incremental innovations and ensures short-term survival, while exploring provides long-term success and radical innovations (Lin and McDonough III 2011; O'Reilly III and Tushman 2013). Both innovations are highly significant for a company since ambidextrous businesses have higher organizational performance (O'Reilly III and Tushman 2013).

Various scientists have proven through empirical tests that ambidexterity is related to a company's improved performance. Nevertheless, there are different opinions in research on how ambidexterity can achieve higher performance (Raisch and Birkinshaw 2008). On the one hand, He and Wong (2004) concluded that ambidexterity positively influences sales growth rate, and Lubatkin et al. (2006) found it positively affects firm performance. On the other hand, Tian et al. (2021) gathered that a correlation between exploration and exploitation leads to enhanced innovation performance. Overall, there is evidence that ambidexterity is associated with better performance. Consequently, companies that pursue both contradictory activities simultaneously are more successful and survive longer than those that settle for a trade-off between exploring and exploiting (O'Reilly III and Tushman 2013).

In addition, many companies face increasing competitive pressure and an even-faster pace of change in business conditions. As environments and requirements change at an accelerating rate, organizations must look at their long-term objectives to ensure their future success. However, companies must not only ensure their survival in the long run but also their short-term survival by satisfying and retaining their current customers. Therefore, they must become ambidextrous and simultaneously leverage existing resources to generate incremental innovations that fulfill current customer needs and explore new opportunities to create radical innovations that satisfy emerging customer demands and sustain future success. When companies do not become ambidextrous, they will disappear in the long run (Yigit 2013).

Especially incumbents have problems becoming ambidextrous (O'Reilly III and Tushman 2008). According to a study of the 266 largest US manufacturing companies, only 28 have survived more than 80 years; all others have been replaced by novel forms or forced out of business (Louçã and Mendonça 2002). Nevertheless, despite the high failure rate, some organizations have survived and even grown over long periods. However, these are only companies that have exploited existing resources and simultaneously have evolved, expanded, or completely changed their business areas over time, thus acting ambidextrously. Moreover, the life expectancy of an organization has declined from an initial 90 years in 1935 to 30 years in 1975 and only 15 years in 2005 due to the ever-more rapidly changing business environment (O'Reilly III et al. 2009; O'Reilly III and Tushman 2008). All these points highlight the necessity of ambidexterity and show that companies nowadays have to be ambidextrous to survive and remain competitive in the long term (O'Reilly III and Tushman 2008).

In a nutshell, ambidexterity is a concept that is already well-researched and recognized in various research streams. This theory deals with the ability of an organization to pursue two opposing activities simultaneously, exploiting existing capabilities and exploring new, unknown possibilities. In this context, exploitation refers to incremental innovations and exploration to radical innovations, and if companies manage to pursue these two contradictions simultaneously, they are considered ambidextrous (Gibson and Birkinshaw 2004; Lin and McDonough III 2011; O'Reilly III and Tushman 2013). Therefore, researchers have developed various approaches to how a company can pursue these contradictions simultaneously in the past years (O'Reilly III and Tushman 2013). Nevertheless, many organizations have difficulties in simultaneous execution and primarily focus on efficiency increases since incremental in-

novations are less risky and success is directly visible. However, if a company succeeds in being ambidextrous, it has been proven that this is directly related to positive company performance and ensures long-term survival (O'Reilly III and Tushman 2008; O'Reilly III and Tushman 2013).

2.3 Low-Code Development Platforms

Ambidexterity is essential for company success as it allows them to continuously innovate and exploit existing resources and capabilities, thereby creating a competitive advantage. Even though researchers have developed various approaches in recent years on how organizations can achieve ambidexterity, many companies struggle to pursue the contradictions simultaneously (O'Reilly III and Tushman 2008). Especially when innovations are digital, IT departments are often responsible for exploring and exploiting them simultaneously (Lee et al. 2015). Unfortunately, the increasing shortage of IT professionals makes it difficult for many companies to perform both tasks equally well (Krejci et al. 2021). Therefore, the question of how manufacturing companies, even with limited IT capacities, can simultaneously pursue digital innovations to achieve organizational ambidexterity arises.

2.3.1 Definition

Low-code development platform (LCDP) originated from the market research firm Forrester Research, which first coined the term in 2014. Forrester Research describes LCDPs as "platforms that enable rapid application delivery with a minimum of hand-coding, and quick setup and deployment, for systems of engagement" (Richardson and Rymer 2014, p. 2). In this framework, LCDPs have a graphical interface where users can quickly and easily combine pre-programmed components into functional applications using drag-and-drop. Due to the simplification of application development and the pre-programmed features, employees without in-depth IT knowledge can develop applications (Talesra and Nagaraja 2021) and participate in the innovation process within the company (Krejci et al. 2021). In this context, the developers of these platforms, who are usually located in the business departments and therefore possess limited or even no development experience, are often referred to as citizen developers (Iho et al. 2021).

However, LCDPs have targeted not only citizen developers but also professional developers. For IT professionals, these platforms primarily aim to speed up software delivery by allowing them to work more productively. Therefore, experienced developers can use these platforms for various use cases and even create business-critical applications. For citizen developers, these platforms are primarily intended to lower the entry barrier and enable them to help themselves with minor issues. Consequently, citizen developers should only implement use cases with these platforms up to a specific limit and thus only create medium-sized applications. Overall, these platforms support IT and business employees in application development, meaning both sides benefit from LCDPs (Rymer 2017).

Besides their graphical interface, LCDPs have four other vital features that simplify and speed up application development for IT professionals and citizen developers. First, LCDPs have a centralized structure where all configuration and administration occur. Second, as mentioned above, reusable components enable quick and easy application creation via drag-and-drop. IT departments or vendors can extend or optimize these components over time. Third, these platforms offer real-time editing where users can add or remove components and see the result immediately. This is also a benefit when working with customers, as the changes are visible directly, simplifying the coordination effort. Fourth, the ease of use of these platforms is also worth mentioning (Iho et al. 2021; Richardson and Rymer 2014).

According to the market research company Forrester, total spending on low-code will exceed $21 billion by 2022. As a result, large manufacturers, such as Microsoft, Siemens, or IBM, are entering the market

and offering low-code solutions (Iho et al. 2021; Sanchis et al. 2019). This is not surprising since LCDPs accelerate application development ten times compared to traditional application development (Rymer 2018). On the one hand, these platforms minimize manual coding through pre-programmed reusable components. On the other hand, their visual interface even allows citizen developers to quickly and easily build their applications via drag-and-drop. By reducing technical complexity, application development is accessible to the majority (Richardson and Rymer 2014), which noticeably reduces the workload of IT departments and allows them to focus more on their core business (Mendix Technology 2021).

LCDPs can shorten the application development time tenfold compared to traditional methods. Due to this enormous speed, developing a custom app takes just three weeks with an LCDP, compared to four months for conventional programming. A more significant illustration is the development of a web channel and administration system for a Spanish insurance provider, which was developed in less than two months using an LCDP, compared to more than 2.5 years using traditional programming. Thus LCDPs speed up application development enormously and allow companies to respond to continuously changing customer requirements and market conditions in the shortest time possible (Richardson and Rymer 2016).

Nevertheless, there are some critical aspects regarding LCDPs. Some authors criticize the scalability of these platforms, arguing that they are only suitable for minor applications rather than large or growing applications and are, therefore, not scalable. Furthermore, it is also a misinterpretation that these platforms do not require any programming skills. LCDPs reduce technical complexity and thus lower the barrier to application development, but not all activities can be performed entirely without programming capabilities. Some programming skills are required, for instance, to integrate with other applications and databases or to create customer-specific algorithms. Another risk is that many small LCDP vendors offer their solutions for a low budget but do not consider the company's architecture strategies and standards. Hence the solutions will already be obsolete in a few weeks or months (Richardson and Rymer 2016; Sanchis et al. 2019). Despite these critical aspects, the acceptance of these platforms within IT departments at 92% and business units at 79% is high. The main reasons for such high acceptance are accelerated application development, improved collaboration between business departments and IT, and decreased shadow IT (Mendix Technology 2021).

2.3.2 Innovations Through LCDPs

To remain competitive and thrive long-term, a company must continuously improve its existing capabilities and resources, make them more efficient, and seek out, discover, and try new opportunities. Usually, IT departments are responsible for improving and exploring digital technologies (Lee et al. 2015). However, due to the shortage of IT professionals, more and more companies are having trouble performing both tasks equally well (Krejci et al. 2021). In addition, a growing number of IT departments are falling into a project backlog, causing more and more software projects to be delayed (Mendix Technology 2021). LCDPs are one way to mitigate this situation, as citizen developers can be directly involved in developing digital innovations (Krejci et al. 2021). On the one hand, these platforms create an environment where new ideas can be explored and tested (Richardson and Rymer 2014).

LCDPs open up application development, allowing employees to experiment with ideas and explore new possibilities. Especially in large or complex projects where the requirements are often unclear at first, these platforms can quickly create working prototypes from initial ideas, which can then be tested and evaluated (Richardson and Rymer 2014). In addition, companies can involve customers in the feedback process, thus avoiding misunderstandings early on and saving resources for functionalities that the customer does not need (Richardson and Rymer 2016). Through LCDPs, companies can quickly and easily

experiment with new product and service ideas. On the other hand, LCDPs can contribute to the enhancement of existing processes and applications (Bratincevic et al. 2021).

Business employees have deep knowledge of their workflows and are aware of problems preventing them from working more efficiently. However, because of previous technical barriers, they could not develop applications and always had to approach IT departments to do so. By lowering software development barriers and enabling every employee to build applications and enhance or extend them, LCDPs can continuously improve existing workflows (Bratincevic et al. 2021; Kissflow 2022; Workerbase 2019). In this regard, business employees can develop applications as soon as a problem arises, refine and enhance them independently, and no longer rely on IT departments (Bratincevic et al. 2021; Iho et al. 2021). Thus, LCDPs play an essential role in experimenting with ideas and improving existing processes and workflows, generating incremental and radical innovations (Krejci et al. 2021; Richardson and Rymer 2014).

2.3.3 Enabler of Ambidexterity

As outlined above, business employees from different departments can now be involved in developing digital innovations through LCDPs. When business employees are included in this process, a company can quickly develop digital innovations even with a limited number of IT professionals (Iho et al. 2021). Since LCDPs have the potential for incremental and radical innovations, these platforms can help companies drive digital innovations for both types of innovations, enabling them to exploit and explore (Krejci et al. 2021).

On the one hand, LCDPs can be used for incremental innovation by developing applications on these platforms and then improving, refining, or extending them over time (Iho et al. 2021), as well as by empowering employees to participate in continuous improvement within the company (Bratincevic et al. 2021; Kissflow 2022; Workerbase 2019). On the other hand, LCDPs can also enable radical innovations since these platforms offer a perfect environment for experimenting and trying new ideas that can quickly be turned into working prototypes (Krejci et al. 2021; Richardson and Rymer 2014; Richardson and Rymer 2016). Moreover, radical innovations are often associated with a high risk of failure. As a result, companies often waste a lot of resources on ideas that prove to be useless in retrospect or even avoid radical innovation in the first place (McDermott and O'Connor 2002). LCDPs allow companies to explore new opportunities with less risk because prototypes can be developed quickly and with few resources. Should the prototype prove to be unsuccessful, companies can discard the idea without much loss and continue experimenting (Richardson and Rymer 2014; Richardson and Rymer 2016).

Thus, in 2015, a company called Sprint was able to quickly create a prototype through an LCDP for a new service called Direct 2 You that offers home delivery to customers who purchase or upgrade their mobile devices. Through this prototype, the company was able to prove the value of the new service and further refine the entire offering. Based on the successful example of the company, it becomes clear that LCDPs are well suited in an early stage of the innovation process to create functional prototypes quickly, which customers or employees can then test. If the prototype proves to be good and meets the requirements, it can be developed further or directly refined (Richardson and Rymer 2016).

2.3.4 LCDPs and Industry 4.0

LCDPs represent a promising solution for manufacturing companies in particular. On the one hand, Industry 4.0 and its technologies require specialized applications and platforms that are often expensive. Since LCDPs can be integrated with the latest technologies, industrial companies can utilize the most recent Industry 4.0 technologies, such as cloud computing or the Industrial Internet of Things. On the other hand, industrial processes are becoming increasingly complex, and the industrial environment is

changing rapidly, where traditional development methods can no longer keep up. Given that LCDPs have a much shorter development time, they can help implement applications and process improvements in the shortest time possible and keep up with the rapid pace of industrial solutions (Demski 2022; Neurisium 2021).

A significant claim of LCDPs is that they accelerate the path to Industry 4.0 and lower the entry barrier (Neurisium 2021). Especially industrial companies have an ever-increasing problem of developing applications on time. Currently, 75% of manufacturing companies are falling behind in delivering software projects, and the gap is growing (Mendix Technology 2021). Through LCDPs, development cycles can be shortened tenfold, saving costs and personnel (Richardson and Rymer 2016; Rymer 2018). Likewise, fewer IT specialists are required, which are currently unavailable in sufficient quantities on the labor market. As a result, not only sizable but small manufacturing companies can take a step towards Industry 4.0, which have so far tended to have a disadvantage due to enormously high costs caused by the digital transformation and the workforce shortage (Neurisium 2021).

Furthermore, many industrial companies still have legacy systems that are often isolated from the other information systems within the company. A further advantage of LCDPs is that they are often compatible with legacy systems and new techniques. Therefore, LCDPs can release legacy systems from isolation and integrate them into the IT system landscape, enabling each process to be monitored and evaluated to identify areas for improvement. Furthermore, this allows a complete digitalization of production, which is necessary for the transition to Industry 4.0. As a result, LCDPs offer a better alternative for integrating different technologies (Neurisium 2021).

Additionally, every manufacturing company strives for continuous improvement. Continuous improvement requires all employees to find solutions for existing problems. Frequently, when frontline employees are asked about their issues, they can identify what is preventing them from working more effectively, as well as propose comprehensive solutions. Nevertheless, these solutions usually require developing an application, which only IT departments could previously do. However, because frontline employees have deep business knowledge, LCDPs can help optimize production by empowering citizen developers to develop their applications to solve existing problems, enabling continuous improvement along the entire value chain (Demski 2022; Kissflow 2022; Workerbase 2019).

In summary, LCDPs are attracting increasing attention because they enable rapid application development with a minimum of manual code. LCDPs are targeted at both professional developers and citizen developers. IT professionals can use these platforms for faster and more productive software development, while these platforms reduce technical complexity for citizen developers and enable them to develop applications quickly and easily (Rymer 2017). Due to the shortage of skilled IT professionals and the long time required for a manually programmed application, LCDPs can provide relief since the application development is ten times faster than conventional methods (Rymer 2018). As a result, it is now possible for business employees to participate in developing digital innovations, as LCDPs support both incremental and radical innovations (Krejci et al. 2021). On the one hand, these platforms provide an environment for testing and experimentation to develop prototypes quickly, resulting in radical innovations (Krejci et al. 2021; Richardson and Rymer 2014; Richardson and Rymer 2016). On the other hand, these platforms can create, improve, and extend applications, resulting in incremental innovations (Iho et al. 2021; Krejci et al. 2021). Therefore, LCDPs appear to be an emerging solution for Industry 4.0, where processes are becoming increasingly more complex, and the industrial environment is changing at an ever faster pace (Demski 2022; Neurisium 2021).

2.4 Research Model

This thesis examines how LCDPs enable digital innovation in industrial companies and what facilitating conditions they must meet to unleash this potential. Based on the previously elaborated theoretical background and the acquired knowledge, it is now possible to form the following research model and formulate the initial research assumptions.

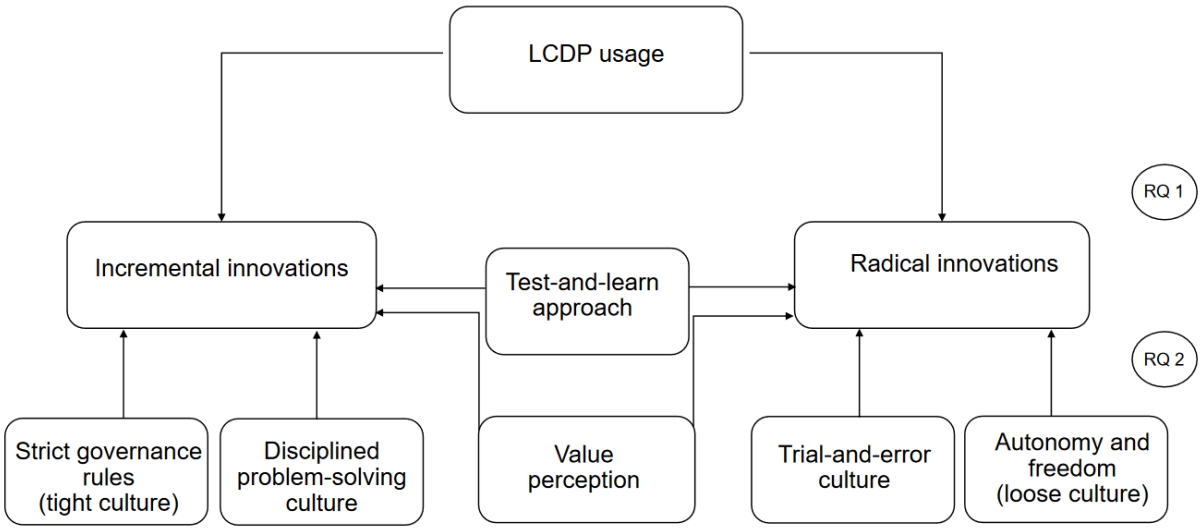

Figure 1: Research Model

First, LCDPs support industrial companies in pursuing both types of digital innovation, radical and incremental. On the one hand, these platforms are suitable for experimenting and testing new ideas (Richardson and Rymer 2014). On the other hand, they help to create continuous improvement within the company by allowing non-IT employees to participate directly in its improvement culture (Bratincevic et al. 2021). Therefore, the first initial assumption results from these findings:

A1: LCDPs enable organizations to be ambidextrous and thus support organizations in developing both types of digital innovation, radical and incremental.

Moreover, LCDPs are used differently depending on the type of innovation. For radical innovations, LCDPs achieve prototypes quickly and with the fewest possible resources, enabling companies to experiment with new ideas and explore new opportunities without taking significant financial risks (Richardson and Rymer 2014; Richardson and Rymer 2016). Conversely, LCDPs are used for incremental innovations to develop applications and gradually improve or extend those applications running on these platforms (Iho et al. 2021). In addition, employees can participate in continuous improvement within the company and develop solutions to existing problems (Bratincevic et al. 2021; Kissflow 2022; Workerbase 2019). Hence, this results in the following assumptions:

A2: For radical innovations, LCDPs achieve prototypes quickly and with the fewest resources possible.

A3: For incremental innovations, LCDPs are used to develop and gradually refine the application.

However, various facilitating conditions must be in place for a company to implement LCDPs successfully and enable both types of innovations. In the case of incremental innovations, the focus is on effi-

ciency, productivity increases, and control. Conversely, radical innovations often require increased flexibility, risk-taking, and autonomy since experimentation is emphasized (O'Reilly III and Tushman 2008). Since these are fundamental contradictions that create tension, the next assumption is as follows:

A4: There are different facilitating conditions for radical and incremental innovation, and only in some cases do the same conditions apply to both types of innovation.

Companies that use LCDPs for radical innovation must give employees more autonomy and freedom. In this context, employees should not have to obtain approval for every experiment; otherwise, they will revert to traditional methods (Bratincevic et al. 2021). Furthermore, companies must have a certain level of risk acceptance when developing radical innovations with LCDPs, expecting that not all explored paths will succeed and therefore need to build up a trial-and-error culture. Thus, the better a company handles failures and learns from them for the future, the more likely it will succeed in the long term. For instance, one large enterprise messaging provider introduced several new services between 2008 and 2012 by being open about failures and dealing with them flexibly. In this regard, the company quickly built many prototypes, tested them, gathered feedback, and refined them. If a prototype proved to be unsuccessful during this process, it was dropped without further cost, and the teams were allowed to continue exploring (Du et al. 2020). These observations lead to the following initial assumptions:

A5: To successfully use LCDPs for radical innovation, a loose corporate culture with autonomy and freedom is needed to allow employees to experiment and test quickly.
A6: To successfully use LCDPs for radical innovation, companies must be willing to take risks and establish a trial-and-error culture.

Conversely, stricter governance rules must be introduced when LCDPs are used for incremental innovations, as the focus here is on increasing efficiency and saving as many resources as possible. Therefore, companies must distribute tasks and roles and centralize decision-making, as superior stability is required. Furthermore, disciplined problem-solving is also essential for exploitation activities. In this context, it is crucial that employees continuously question whether the existing work processes are suitable or should be improved to ensure continuous improvement. To achieve this, companies must enable employees to think independently, question existing processes or workflows, and act autonomously to a certain extent (Bratincevic et al. 2021). Hence the following two assumptions can be derived:

A7: To successfully use LCDPs for incremental innovation, a tight corporate culture with strict governance rules is required since the focus is on increasing efficiency and productivity as well as saving as many resources as possible.
A8: To successfully use LCDPs for incremental innovation, companies must foster a disciplined problem-solving culture where employees are empowered to challenge existing workflows and independently act autonomously within a specific framework.

Moreover, LCDPs for radical and incremental innovations are only feasible if the company gives employees a certain degree of freedom to experiment and test. Therefore, companies must pursue a test-and-learn approach where employees can test innovations early and obtain feedback. For radical innovations, it is essential to test ideas through prototypes early to avoid wasting resources. Through LCDPs, employees can create a prototype based on limited requirements within a few weeks and then test it with the target group, gather feedback and refine it or start from scratch (Richardson and Rymer 2014). This facilitating condition is also appropriate for incremental innovations since the focus here is on increasing efficiency. In this context, the test-and-learn approach can also help to ensure that resources

are not wasted within the company, as customers or employees are involved in the feedback process early on, thus achieving greater efficiency. Hence, this leads to the following assumption:

A9: Companies must pursue a test-and-learn approach to use LCDPs successfully for incremental and radical innovation.

Additionally, it was possible to determine that LCDPs utilized close to value creation, as products and services are developed directly for customers through these platforms. If the customers opine the designed products and services beneficial and perceive the value, LCDPs can be successfully used for customer-facing applications. In addition, LCDPs can also create added value for the employees within the company, as this means that all employees can be involved in the development process. On the one hand, business employees feel more valued, which can increase efficiency because their previous requests were slow to be addressed due to time constraints in the IT departments. On the other hand, the IT departments are relieved because they no longer have to deal with minor use cases, which allows them to focus more on their core business. At the same time, these platforms enable IT departments to provide software more productively and quickly (Mendix Technology 2021; Outsystems 2019). Consequently, LCDPs should be perceived as valuable by the company's employees and customers. Otherwise, LCDPs cannot be successfully implemented and used for incremental or radical innovations in the company. This results in the following assumption:

A10: Customers and employees must perceive LCDPs as valuable to be successfully implemented in a company and used for incremental and radical innovations.

3 Research Method

The following chapter aims to present the research methodology of this thesis. In the beginning, the selected research method is characterized and presented. Likewise, it is justified why the research method is suitable for answering the research question. Then the sampling method and the investigated companies are shown. After that, the data collection process is outlined, and the interview partners are introduced. The methods chapter concludes with the data analysis section, which describes the entire data analysis process.

The overall objective of this work was to investigate the conditions under which LCDPs are used in the industrial sector, meaning whether industrial companies utilize LCDPs for the development of incremental or radical innovations and what facilitating conditions must be given in each case. Through a qualitative research approach, the following research question was answered:

- How do LCDPs enable digital innovation in the industry?

According to Aspers and Corte (2019), qualitative research has four characteristics: (1) distinction, (2) process, (3) closeness, and (4) improved understanding. First, new distinctions are made in qualitative research, which is not the case in the quantitative analysis since quantitative analysis works with presupposed variables. Second, qualitative research involves an iterative process with several phases and possible data changes when new findings emerge. Third, qualitative research methodology brings the researcher into close contact with the participants and the data that has to be analyzed. Finally, the fourth characteristic is improved understanding. Through qualitative research, new scientific knowledge is gained that was previously unknown in the research community. According to the features, the authors define qualitative research as “an iterative process in which improved understanding to the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied” (Aspers and Corte 2019, p. 155).

A qualitative approach was chosen for this thesis as the overall research objective is to understand and explore how industrial companies utilize LCDPs. According to Creswell (2007), it is appropriate to conduct qualitative research whenever a problem or issue needs to be explored, for instance, by studying a group or identifying variables that cannot be easily measured. Furthermore, it is also appropriate to conduct qualitative research when a complex and profound understanding of a topic is needed, which can only be obtained through direct interviews. Therefore qualitative research focuses on a person's or group's experiences with a phenomenon under context-specific conditions, whereas quantitative research focuses on static evaluations to test an existing theory (Cypress 2015). Given the scarcity of research articles on LCDPs (Iho et al. 2021) and a research question that is impossible to quantify, a quantitative research approach is fundamentally unsuitable for this work. Typically, whenever a quantitative research approach proves inappropriate, a qualitative approach is chosen as the appropriate research method (Aspers and Corte 2019; Creswell 2007). Moreover, qualitative research contributes to understanding a phenomenon about which little is known (Cypress 2015). Due to these points, a qualitative approach is the appropriate way to answer the research question above since the experiences and perspectives from the participant's point of view are of particular interest.

Therefore, in this bachelor thesis, expert interviews were conducted to obtain qualitative data, the most commonly used technique in qualitative research (DiCicco-Bloom and Crabtree 2006). According to Bogner et al. (2009), an individual can be considered an expert if the person has profound knowledge in a specific field of action. For this reason, expert interviews are ideally suited as a selected research technique because they provide access to an area where it is difficult to obtain information, which was

the case given the sparse scientific research on LCDPs in this thesis. The expert interviews were conducted using a semi-structured approach. In semi-structured interviews, a series of open and structured questions are defined in advance, which additional questions can supplement during the interviews. Consequently, the interview guidelines in semi-structured interviews are continuously adapted and developed throughout the interviews (DiCicco-Bloom and Crabtree 2006). Through semi-structured expert interviews, it was possible to gain a comprehensive knowledge of LCDPs and their use in industrial companies.

3.1 Sample

Since LCDPs are becoming increasingly popular in the industrial sector (Neurisium 2021), we have focused on industrial companies in this thesis and selected the Microsoft Power Platform as the LCDP to be studied. According to the Gartner Magic Quadrant, the Microsoft Power Platform is one of the leading low-code platforms of 2021. The platform offers various services such as Power Apps, Power Automate, or Power BI, whereby Power Apps is Microsoft's low-code offering. Power Apps is geared towards citizen developers and IT professionals and has managed to keep up with other platforms of leading LCDP vendors such as OutSystems and Mendix. Additionally, Microsoft has customers across all industries and company sizes, therefore, it is estimated that it has more users than any LCDP. However, this is often due to the enterprise's widespread use of Office 365 and Dynamics (Wong et al. 2021). Besides pure industrial companies, I also included IT and consulting companies in the focus of this work to get other perspectives and knowledge.

Therefore, the first step of the sample was to contact potential industrial companies via email and LinkedIn. Two criteria had to be met to be considered as a participant. First, the companies have to use or evaluate the Microsoft Power Platform as a low-code platform, and second, the companies have to be active in the industrial sector. Since Microsoft publishes customer stories on its website, the initial approach consisted of contacting the companies listed there. In addition, we also approached companies in the industrial sector that had published job openings related to the Microsoft Power Platform on various job portals such as StepStone or Indeed during this period. Besides industrial companies, IT consulting firms specializing in low-code were also approached via email and LinkedIn. To be considered a sample company, the IT consulting companies were required to have already implemented projects with industrial companies where the Microsoft Power Platform was used as LCDP. Altogether, 15 enterprises were interested in participating in an expert interview. The companies selected ranged from industrial companies still evaluating the Microsoft Power Platform to industrial companies already using it to IT and consulting firms supporting enterprises in implementing LCDPs or developing solutions for industrial production using the Microsoft Power Platform.

There were several reasons for the selection of these different companies. On the one hand, it allows discovering what industrial companies still in the evaluation phase hope and expect from the introduction of the Microsoft Power Platform. On the other hand, it is also possible to understand how industrial companies are already using the platform today and what facilitating conditions they have used. Additionally, the consulting firms gave an outside perspective and contributed important information and views on the topic through their previous experiences. By selecting these different companies, it is possible to gain a comprehensive picture of the Microsoft Power Platform and its use in industrial companies.

The following table provides an overview of the 15 companies available to participate in an expert interview. Since the data analysis was anonymized, the table only contains information about the industry, the approximate number of employees, and a short description. In addition, interviews were conducted

more frequently with some companies. The number of interviews for each company is thus shown in the table as well.

No.	*Companies*	*Number of Employees*	*Short Description*	*Number of Interviews*
1	Steel	100,000	An industrial company that manufactures steel	1
2	Scaffolding	9,000	Manufacturer of formwork and scaffolding systems	3
3	Automotive	160,000	An industrial company that supplies systems for the automotive and commercial vehicle mobility	2
4	Seal	14,000	Manufacturer of seals for the automotive, aviation, and mechanical engineering	2
5	CarA	120,000	An industrial company that manufactures automobiles and motorcycles	2
6	Consulting	7,000	Consulting and IT services company that supports companies in implementing IT projects	1
7	Construction	11,000	Technology group for construction services	2
8	Metal	8,000	Manufacturer of semi-finished copper and copper alloy products	1
9	Bus	18,000	An industrial company that develops and manufactures buses	1
10	IT Services	25,000	Manufacturer of automation and information solutions for industrial production	1
11	CarB	170,000	An industrial company that develops and manufactures passenger and commercial vehicles	1
12	Plastic	3,000	A plastic manufacturer that processes plastic into semi-finished products and compounds	1
13	CarC	< 100,000	Manufacturer of automobiles and commercial vehicles	1
14	Medicine	8,000	Medical equipment manufacturer	1
15	Injection Molding	7,000	Manufacturer of injection molding machines and automation equipment	1

Table 1: Classification Companies

3.2 Data Collection

The qualitative data was gathered through expert interviews. For this purpose, an interview guideline was developed in advance. As mentioned above, the interviews followed a semi-structured approach, whereby the interview guide consisted of open and structured questions that were continuously adapted throughout the conversations. As a result, new questions were added during the interviews, or existing questions were adjusted based on recent findings. The interviews were conducted over approximately two months, the first one on August 11, 2022, and the last one on October 19, 2022. Most interviews were held online via Microsoft Teams or phone, and only one was conducted in person on-site. The reason for this was the distance in most cases, which is why a face-to-face interview was possible in just one case. The interview duration varied depending on the participants' time, resulting in an average interview duration of 1 hour and 2 minutes, with the shortest interview being 28 minutes long and the longest almost 2 hours.

The original intention was to hold at least two interviews per company to be able to speak with a citizen developer and an IT professional in the best case. However, this was not always possible, as some companies had not yet used the platform in citizen development or no citizen developer was available for a further interview. Therefore a second interview with a citizen developer in five industrial companies was only possible. While most of the interviewees had an IT background, the roles of the interviewees were nevertheless very diverse, ranging from platform developers, IT architects, division managers, and Microsoft Power Platform owners to low-code experts. Although it was impossible to conduct a second interview in all cases, we collected a rich data set due to a large number of interviews. Since no new insights could be gained after the 21st interview, the data collection phase was terminated due to saturation. Saturation is an essential guiding principle in determining sample size in qualitative research and means that no new insights emerged after one more interview (Hennink et al. 2017).

Each interview started with a brief description of the research project, objective, and purpose. Afterward, I introduced myself and asked the participants to introduce themselves by giving me information about their current position and areas of responsibility. After the introduction of the attendees, the conversation turned to the Microsoft Power Platform, its innovations, and facilitating conditions. In doing so, each conversation began with an opening question, followed by follow-up questions depending on how the individual interview developed. During all interviews, I also ensured not to over-formalize the conversation to gain as many insights as possible.

During the data collection phase, we interviewed a total of 21 participants from 15 companies and collected more than 21 hours of interview material. Table two provides an overview of the 21 interviewees. In the ID column, the abbreviation IT indicates an interview with an IT professional, and CD stands for an interview with a citizen developer.

ID	*Companies*	*Interviewee Role*	*Date*	*Duration*
IT01Steel	Steel	Head of Productivity Solutions	August 11, 2022	37 min
IT02Scaffolding	Scaffolding	Project Manager	August 11, 2022	59 min
IT03Automotive	Automotive	Head of IT Process Automation	August 16, 2022	28 min
CD04Scaffolding	Scaffolding	Product Manager	August 16, 2022	1h 2 min
IT05Scaffolding	Scaffolding	Head of Business Intelligence	August 17, 2022	58 min
IT06Seal	Seal	IT Business Consultant	August 29, 2022	57 min
CD07Automotive	Automotive	Power Apps Developer	August 31, 2022	33 min
IT08CarA	CarA	IT Architect	September 01, 2022	1h 51 min
IT09Consulting	Consulting	Low-Code Expert	September 02, 2022	1h 24 min
IT10Construction	Construction	Head of Application Development	September 07, 2022	1h
IT11Metal	Metal	Manager Digital Transformation	September 08, 2022	1h 15 min
IT12Bus	Bus	Development Engineer	September 09, 2022	1h 5 min
IT13Services	IT Services	Data Analytics Solutions Architect	September 09, 2022	1h 5 min
CD14CarA	CarA	Product Owner Power Platform	September 14, 2022	1h 4 min
CD15Construction	Construction	Power Apps Developer	September 21, 2022	1h
IT16CarB	CarB	Product Owner Power Platform	September 23, 2022	59 min
IT17Plastic	Plastic	Head of Cloud Solutions	September 27, 2022	1h
IT18CarC	CarC	Product Owner Power Platform	October 05, 2022	1h 10 min
CD19Seal	Seal	Manager Innovation and Digitalization	October 05, 2022	1h 2 min
IT20Medicine	Medicine	IT Developer	October 17, 2022	1h 3 min
IT21Injection	Injection Molding	Cloud and Infrastructure Engineer	October 19, 2022	1h 10 min

Table 2: Interviewees

3.3 Data Analysis

Due to the consent to data processing provided by the participants in advance, all interviews were recorded for transcription using the Windows Voice Recorder. Thus, after the data collection phase, the recorded interviews could be transcribed using the transcription function of Microsoft Word and subsequently evaluated and analyzed using Microsoft Excel.

Mayring's qualitative content analysis was chosen as an appropriate method to assess the transcribed data. Qualitative content analysis by Mayring is a technique to examine data from communication. The success of this research technique depends heavily on the coding process, in which large amounts of text are divided into a few categories (Hsieh and Shannon 2005). Within the coding process, Mayring

distinguishes between two different types, inductive category formation and deductive category formation. In inductive coding, the categories are derived from the material. Conversely, in deductive coding, the categories are formed before the material analysis, mainly with the help of the existing literature, since other researchers have already established theories beforehand (Schnell et al. 2013). Within the framework of the present work, the inductive approach was chosen as appropriate. One reason for this is the still sparse scientific research on LCDPs currently, which is why it was impossible to derive categories in advance through the literature or already existing theories. In addition, the inductive approach is particularly well suited for qualitative research methods (Mayring 2000).

Figure two illustrates the individual steps of the data analysis. Mayring (2000) served as the basis for the data analysis.

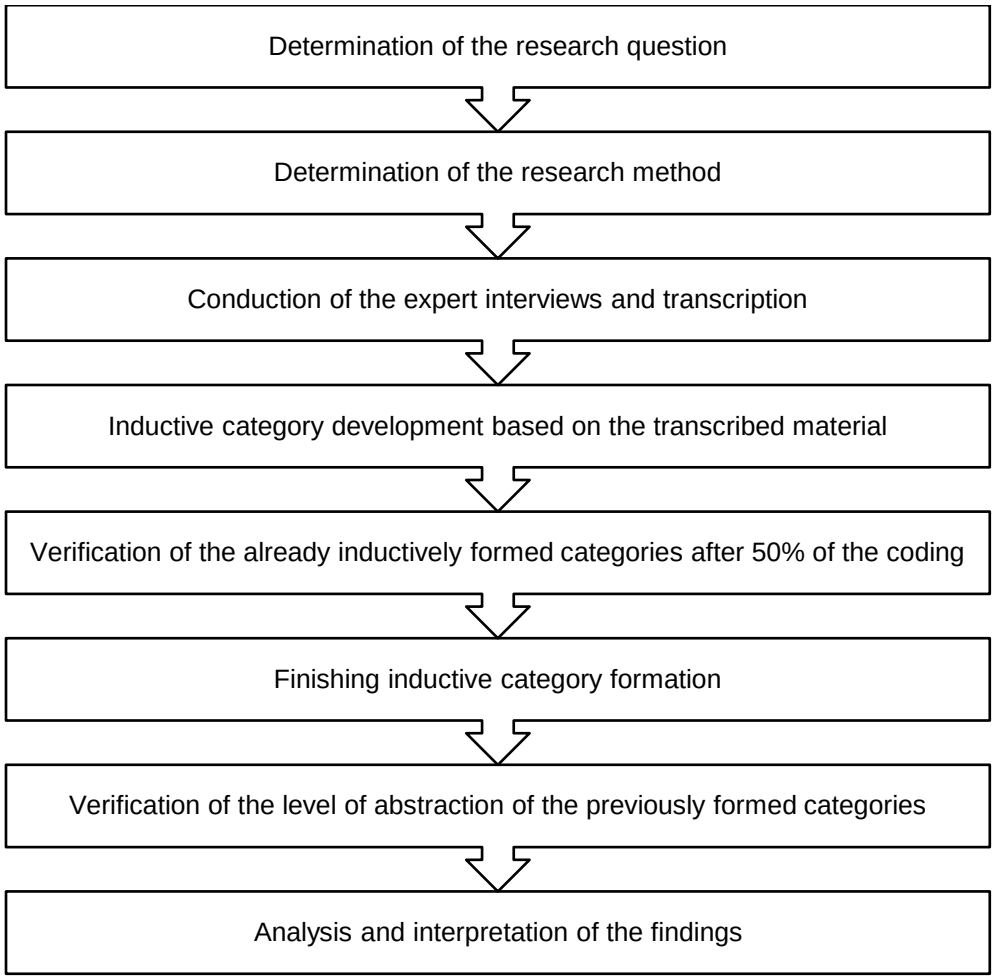

Figure 2: Individual Steps of Data Analysis Based on Mayring (2000)

4 Results

The following chapter will present the results of this thesis. The data collected in the expert interviews were coded and evaluated using the qualitative content analysis based on Mayring (2000). During the data analysis, several patterns were identified and will be presented in the following subsections.

4.1 Types of Innovations

Do LCDPs enable industrial companies to innovate incrementally and radically, and are LCDPs used in incremental innovations to develop and incrementally refine applications and in radical innovations to realize prototypes quickly and with as few resources as possible? The evaluation of the expert interviews revealed several findings.

Almost all industrial companies surveyed use the Microsoft Power Platform for internal innovations. In fact, only IT13Services stated that they use the Power Platform for internal and external innovation and thus was the only company to offer the innovations on the platform to external customers via Power Portals. However, most surveyed companies are skeptical about making applications available to external customers. According to several respondents, the main reason for the dominance of internal use is the stability of the Power Platform. One of the interviewees said the following in this regard:

> *"To be honest, I do not think so for our company because the Power Platform is not powerful enough. If you now invent a cool procedure to calculate something, you would not offer it to the market with the Power App, as the platform is not powerful and reliable enough. If Microsoft changes something, we have a problem because everything runs in the cloud."*
>
> – IT10Construction

Moreover, two main clusters emerged during the interviews regarding the internal use of the Power Platform: industrial companies used the platform for either (1) internal production-related processes or (2) internal back-office solutions. Within the production-related processes, the most significant consistency was in the development of applications for maintenance management. In this regard, industrial companies used the Microsoft Power Platform to digitalize previously manual quality control and maintenance activities. IT01Steel even added that these are the main requirements arising from production. However, other frequently mentioned use cases in this category were applications for occupational safety and health, digital shift handover, and ordering processes within production. Conversely, most companies use the Power Platform in the back office to automate established processes. In addition, the Power Platform was also frequently used to map internal approvals, such as invoices or quotations, and to develop COVID-19 applications. In this regard, the platform enabled companies to track the ever-changing COVID-19 regulations and resume operations in accordance with various laws. Detailed information about the most frequently mentioned innovations is shown in table three.

As seen from the use cases listed above, industrial companies use the platform in the first place for incremental innovations since the underlying process is usually already existing. For instance, at CarA, the previous shift handover between the current and the following shift was highly inefficient and missed digital support. In this case, the preceding shift summarized defects found on the machines during work or other quality issues for the subsequent shift on paper. Often, however, the latter could not read the handwriting of the predecessor or understand what exactly was meant by this note. In addition, individual employees had to stay longer sometimes to pass the problems on to the subsequent shift. Using the Power Platform, CarA has completely digitalized what was previously a manual and inefficient process and created value for the entire group since it is a standardized process in all plants worldwide

(CD14CarA). A further example of incremental innovation is maintenance management. In the past, employees at CarB had to manually carry out quality control of production components using checklists and several other documents. However, through the Power Platform, the previously manual process has now been digitalized and made more efficient. Another significant illustration of incremental innovation was given to us by the company IT Services. The interviewee IT13Services reported that a department in their company was never fully staffed to produce as lean as possible, which meant that this department had never been able to handle the whole work. Using the Power Platform, one employee was able to automate 99.95% of the work there, enabling the department to accomplish all of the work for the first time and even look for more work and new projects. Besides that, all companies emphasized within the interviews that they currently use the Power Platform with a strong focus on incremental improvements and see great potential to digitalize many small daily manual or inefficient tasks. Some companies even go as far as to see the Power Platform only as an enabler of incremental innovations and entirely unsuitable for radical innovations due to its increasing complexity.

Since the Microsoft Power Platform is currently used primarily for internal solutions, none of the interviewees could name an example of a radical innovation they had already developed for external customers or markets. However, two interviewees used the Microsoft Power Platform as part of radical innovation. Thereby, the platform was linked to other systems and thus helped to map part of the innovation. In one case, the front end ran on the Microsoft Power Platform (IT01Steel). In the other one, the aim was to connect the Microsoft Power Platform with an already developed platform to access the data and create individual applications based on that data (IT03Automotive). In addition, one company used the Power Platform for an internal radical innovation, where a new process was created that did not exist within the company. In this context, IT13Services reported on a Power App that the company developed during the COVID-19 pandemic. Since the company is a significant supplier for manufacturing companies, it still had to travel around the globe during that time, complying with changing regulations in the 160 countries where its customers are located. As the company struggled to manage this, an employee thought about how they could track and manage compliance and created half of the template with the Power Platform, which the company expanded, scaled up, and radically deployed to keep up with all the changing laws and policies. Through this application, the employee changed how workflows were managed and added new things that no one had thought of in advance (IT13Services). Besides the radical use cases mentioned above, CarC is creating an internal radical innovation in which the Power Platform will be used to set up a new process for mapping the lifecycle of an IT application. In addition, CarB and Seal can imagine using the Power Platform for internal radical innovations in the future and see the potential for this. Likewise, Metal can imagine using the Power Platform purely as a prototyping tool for radical innovations to create a kind of proof of concept.

Moreover, it has emerged that companies that innovate incrementally and radically with the Microsoft Power Platform follow the approach of structural ambidexterity. In other words, an area of focus requires citizen developers to concentrate on one of the two opposing activities. However, this approach is not strictly followed as employees on the other team always have the option to innovate radically or incrementally. As one of our interviewees said:

> *“We have different types of teams, so we have teams that generally speak on the incremental work, and then we have strategic teams that are looking at the more radical innovation efforts. It is always possible for an individual on the other team to create something radically innovative and vice versa.”*
>
> – IT13Services

Table three provides an overview of the most frequently mentioned innovations industrial companies have implemented with the Microsoft Power Platform. In addition, the table indicates the type of innovation and provides a brief justification.

Companies	***Use Case***	***Innovation***	***Justification***
CarB, CarC, Injection Molding, Metal, Plastic, IT Services	Automation solutions for incoming mail or work processes	Incremental	The processes already existed digitally and have been automated through the LCDP
CarC, Scaffolding	COVID-19 application	Incremental	Many steps have been digitalized (booking rooms, 3G proofs) that would otherwise have required a lot of manual effort
Automotive, CarA	Digital shift handover	Incremental	The shift handover was previously inefficient and missed digital support. The creation of the Power App did not change the process but made it more efficient and professional
CarB, Construction, Injection Molding, Seal, Steel	Maintenance management	Incremental	The process was previously manual and without digital support; the LCDP has made it more efficient but has not fundamentally changed it
Construction, Consulting, Injection Molding, Scaffolding, Medicine	Mapping of internal approvals	Incremental	The processes were previously in place but not transparent. Through the LCDP, everyone in the company can now see where the process progress currently stands
Automotive, CarA, Seal	Occupational safety and health	Incremental	Digitization of SOS inspections and reporting of occupational accidents, but the LCDP has not changed the underlying process
CarA, Construction, Consulting	Order process for service clothing and production parts	Incremental	Previously, the process was manual and without IT support, so production foremen often ordered workwear in the wrong size, or production parts did not arrive on time
Automotive, Steel	Enriching radical innovation with the Power Platform	Part of radical innovation	The logic runs in different systems but links to the LCDP
CarC, IT Services	Application development resulting in a new internal process	Radical	Companies are creating a whole new process that did not exist before, changing how workflows are done, and adding new things

Table 3: Overview of the Most Frequently Mentioned Innovations

Based on the innovations listed above, it is also apparent that industrial companies are not yet using the Power Platform for Industry 4.0 topics. Although the current literature on LCDPs often claims that these platforms represent great innovation potential, particularly for Industry 4.0, the interviews could not confirm this assumption. So far, none of the companies interviewed has used the Microsoft Power Platform in connection with Industry 4.0 technologies. While organizations that already use Microsoft Azure in production can imagine using the Microsoft Power Platforms for Industry 4.0 projects in the future due to the excellent connectivity, none of the companies have reached the point where there are specific use cases or even innovations yet. Nevertheless, the companies agreed that the Power Platform could accelerate the path to Industry 4.0 as the platform allows many minor improvements to be made quickly, contributing to a continuous improvement of the entire value chain.

Furthermore, new insights emerged on how industrial companies use the Power Platform for experimenting and testing. Firstly, all the companies surveyed use the Power Platform as a prototyping tool. However, it is not decisive whether it is incremental or radical innovation. Whenever new ideas emerge, or a new use case arises, they are often evaluated and tested by a proof of concept in the first step. All interviewees emphasize the enormous time savings when creating a prototype with the Microsoft Power Platform in this context. As put by one of our interviewees:

> *"I have set up an app within ten minutes. I can put something together so quickly and dirty without having to place the pixel correctly. I propose a design and go into the race with it, so I have to say this is a beautiful possibility."*
>
> – CD19Seal

In addition, companies often use the platform purely as a prototyping tool, so the requirements, pitfalls, and benefits are known, and it is easier to explain to the management why the company should spend money on more professional development. Likewise, some companies emphasized that the Power Platform enables them to pursue a fail-fast strategy since prototypes can be created quickly, and misdevelopment can be detected promptly. As a result, companies often set up a prototype on the Power Platform to see if the idea is going in the right direction. However, several organizations also felt that a prototype on the Power Platform would not provide a basis for comparison if the implementation later took place in another system. Therefore, some companies are hesitant to experiment with new ideas on the Power Platform if it is unclear whether the later implementation will also take place on it.

During the interviews, it also emerged that citizen developers, in particular, do not distinguish between a prototype and a finished application. Since most citizen developers do not master structured software development, a prototype is developed and tested in most cases. However, they do not consciously design this as a prototype. Instead, the prototype is developed more agilely based on feedback and improvement requests from other colleagues until the desired end product is ready. As a result, developers on these platforms do not create throwaway prototypes but can build directly on them and reuse them further. As one of our interviewees explained:

> *"That is how our apps always start. We make the first shot and then build on that. So the first version is usually relatively straightforward, then we show it to the production department, for instance, and they say, that is good, but I still need this and that, and then we keep working on it until it fits."*
>
> – CD07Automotive

Furthermore, some companies also use the Power Platform as a prototyping tool within the IT departments to quickly coordinate IT projects developed for users from the business departments and to uncover misunderstandings earlier, especially in the initial stages of a project. In this regard, the IT Services company even goes so far as to use the Power Platform as a prototyping tool for live development. In this case, a business employee with a specific use case converses with a business analyst. During

the meeting, where specific vital points are discussed, a further IT professional develops a prototype via the Power Platform, which is shown directly to the business employee at the end of the meeting so that the employee can provide direct feedback (IT13Services). In this regard, the interviewee also adds the following:

> *"They can take that, and they can immediately do something with it, and it is not going to be 100% of what they want, but it might be 60%, it might be 70% of what they want, and in the rare occasion where it is like 80/90% sometimes that is it, sometimes they are done, and the engagement to spin up a new application was 60 minutes. That is transformative in how we work; it is not 18 months to deliver an IT solution, which is the current timeline; it is 60 minutes, which is so different."*
>
> – IT13Services

4.2 Types of Companies

As discussed in the literature review, LCDPs are particularly well suited to empower non-IT employees, so-called citizen developers, to develop applications through low technical complexity and drag-and-drop interfaces. Therefore, citizen developers seem to be the perfect target group to use LCDPs for application development, making them the driving force behind digital innovations. Nevertheless, new insights emerged regarding usage patterns and innovation potential.

First, new insights arose regarding usage patterns: We found (1) companies that are currently evaluating the Power Platform and are not yet actively using it, (2) companies that are already actively using the Power Platform but only within IT, and (3) companies that use the platform precisely as expected, as an LCDP for citizen developers. More specifically, one company is currently evaluating the Microsoft Power Platform and is not actively using it. Since the company uses Office 365, certain Microsoft Power Platform services are already available to employees with an Office account because of the license. However, employees are still hesitant to use them, according to interviewee IT12Bus. In this context, the interviewee sees it a great challenge to get people excited about the new possibilities since employees often prefer to continue working with their usual tools despite the new options. Nevertheless, the interviewee mentions the Power Platform's great potential for professionalizing inefficient manual processes. Therefore, the company is still trying to find the right strategy to bring the Power Platform closer to its employees and make it public (IT12Bus).

Furthermore, two companies surveyed already actively use the Power Platform, but only within IT. One of the companies uses the Power Platform purely as an IT tool, as the company believes the citizen developer framework does not work for them. As mentioned, employees can still access individual Power Platform services because of the Office 365 license. However, in this company, the applications created in citizen development are regularly deleted by IT because the business departments are not empowered to develop applications. Therefore, the employees within this company must approach the IT departments with specific use cases, which are prioritized in a backlog and implemented with the Power Platform (IT17Plastic). The second company has just recently introduced the Power Platform and is mainly using it within IT for the time being. However, they plan to raise the framework for citizen developers in the long term. The main reason the company is still primarily using the platform in IT is the uncertainty as to whether the citizen development concept will work. The interviewee sees it as a great challenge to train the citizen developers on the platform since all of these employees have to do another full-time job and have limited time to deal with the platform in depth. Moreover, the interviewee also sees the platform as very complex, so employees without IT knowledge will have difficulties developing simple applications independently (IT11Metal).

Nevertheless, all other companies used the platform precisely as expected, as an LCDP for citizen developers. While the individual reasons for companies to adopt the citizen developer concept varied, the main reason was the same across all companies; empowering business departments to develop applications quickly and not always depend on IT departments. Other reasons were to decrease friction losses in communication between business and IT departments, faster and cheaper development of applications, lack of IT capacity, and more minor use cases that do not have a high priority within IT can be implemented. In addition, some companies wanted to tackle shadow IT by using these platforms.

Table four provides an overview of the three usage patterns that emerged during the interviews and the main reasons companies are currently using the Power Platform in this way.

Companies	***The Main Reason for the Usage Pattern***
Companies evaluating and not yet actively using the Microsoft Power Platform:	
Bus	The Power Platform could currently not yet be made public within the company
Companies using the Microsoft Power Platform within IT:	
Metal	The Power Platform was introduced recently and is used primarily in IT for the first time
Plastic	Concerns that the citizen development concept will work due to lack of knowledge in the business departments
Companies using the Microsoft Power Platform in citizen development:	
Automotive	Enable business departments to create small applications independently without relying on the IT department
CarA	
CarB	
CarC	
Construction	
Injection Molding	
IT Services	
Medicine	
Scaffolding	
Seal	
Steel	

Table 4: Overview of Usage Patterns

As described in the previous subsection, most companies use the Power Platform to digitalize smaller processes or to develop minor applications. Almost all companies surveyed avoid developing critical applications on the Power Platform that require, for instance, offline capabilities or a 24/7 runtime. As the interviews showed, these companies use the Power Platform in the citizen development framework in nearly all cases. In particular, it became apparent that these companies mainly focus on digitalizing smaller manual processes or work steps since it would not be directly production-critical if something

did not work or a problem occurred. Once these organizations classify applications as mission-critical, citizen developers are no longer empowered to develop these applications on the Microsoft Power Platform. However, when applications grow over time in terms of consumption, usage, and popularity and become too complex or critical, they will either be taken over by the IT departments or an IT support model will be implemented. Conversely, companies that use it purely as an IT tool see no issues developing critical applications on the Power Platform. Therefore, the more stringent the non-functional requirements are in citizen development, the more necessary it is to move from low-code to high-code. This statement also came up during the conversation with the low-code expert (IT09Consulting) and could be confirmed within the interviews.

Moreover, the interviews also showed that companies that use the Power Platform in citizen development develop significantly more applications in a shorter time than companies that only use it within IT. Although citizen developers primarily improve existing manual activities or develop minor applications and do not radically innovate, the sum of these improvements adds value to the entire company at all levels. Even if an application has reached a certain level of complexity and has to be taken over by IT, the citizen developers have still been able to build up new knowledge and capabilities that they can incorporate into the development of the following application. As one of the interviewees said:

> *"We have so many learnings - now we are really in the innovation area - we have been able to gather so many experiences: what is possible, what can be done with it, how I implement something, also purely methodically not only from the programming. All this can flow back into a more professional topic implementation."*
>
> – IT03Automotive

On the opposite, it became evident that companies that use the platform as a pure IT tool do not benefit from the speed of these platforms. In these companies, employees still have to submit their use cases to the IT departments, where they are prioritized in a backlog and subsequently implemented. Initially, this does not change anything for the business departments, as they still depend on IT professionals until they realize their use cases. Consequently, they cannot benefit from rapid innovations enabled through LCDPs.

4.3 Facilitating Conditions

Do different facilitating conditions apply to radical innovations than incremental innovations, and are there facilitating conditions that are the same for both types of innovations? The evaluation of the expert interviews revealed several findings.

Firstly, new findings emerged about the facilitating conditions depending on the type of innovation. In this context, the interviews did not confirm that different conditions exist depending on the kind of innovation. In companies that used the Power Platform for incremental and radical innovations, the facilitating conditions for both innovations were consistently the same. However, different conditions are being applied depending on the type of application developed and the user group affected by the application. For this reason, nearly all companies have set up different environments on the Power Platform, with more or fewer options available to the developers. By doing this, the companies try to encapsulate the critical and more complex applications in a different environment, where they can be treated with special attention by the IT departments. In this regard, it has become evident that most companies have established three platform settings, which gradually increase technical usability and bandwidth. At the lowest level, citizen developers can develop applications for their productivity. Since these applications do not affect others within the company, there are almost no restrictions except that most connectors are not enabled, or the app creators cannot share the application with other users. In the following environment,

applications can be shared with others, and more connectors are enabled, but everything is still mostly limited to the Office 365 landscape. Usually, this level also has a test environment where a small user group can extensively test the applications before sharing. On the highest level, more connectors are enabled, including those outsides of the Office 365 landscape, allowing connecting to other systems and creating more complex and critical applications. However, in this environment, citizen developers must observe considerably more IT security rules and company processes; therefore, it became apparent that a citizen developer alone can no longer develop an application without IT support. Usually, this level also has a test and quality assurance environment.

Additionally, to ensure that industrial companies can monitor these environments and coordinate the topic of LCDPs within the company, most organizations have established a center of excellence within the company in addition to these environments. In this context, the center of excellence describes a department within the company that defines the facilitating conditions, takes care of the licensing aspects, empowers the citizen developers, and monitors to ensure that no critical applications arise in the business departments. It became apparent that these departments are the central point of contact for all matters relating to the Microsoft Power Platform and are, therefore, primarily responsible for successfully implementing it in the company and acting as a bridge between IT departments and business units. In addition, organizations that had established a center of excellence could maintain a better overview of the applications created in the business departments and intervene promptly if the applications became critical over time or if employees wanted to develop critical applications from the outset.

Moreover, new insights arose regarding the governance strategy pursued by the companies. Most industrial companies follow a lean governance approach, and only three reported that they established strict governance. All companies with an authoritarian governance culture require employees to submit a use case description, which goes through an approval process and must be explicitly approved by a governance unit before the implementation. This use case description captures different data depending on the organization. Nevertheless, this must include at least the application's title, benefit, and maintainer in all companies. In contrast, organizations that take a lean governance approach only define the basic framework and leave employees free to develop applications independently without submitting a use case description or meeting other requirements in advance. However, regardless of the governance structure, all organizations using the Power Platform in citizen development have restricted connectors. In most cases, only Office 365 connectors can be used without restriction due to privacy concerns. Should employees require additional connectors, they must be reviewed and approved separately by the center of excellence, making most applications on the Power Platform autarkic, as there is no interface to other systems. In this regard, it became evident that companies that use the Power Platform only within IT have significantly fewer governance measures than those that use it predominantly in citizen development.

In this context, it has also become apparent that companies that follow a strict governance approach prevent fast innovations. Since the use case first has to go through an approval process or employees must undergo mandatory training, a lot of speed is lost, although this is one of the main advantages of using LCDPs within the company. Even if this use case is a minor incremental improvement, the citizen developers must have the use case agreed upon and approved in advance. In this regard, one interviewee who takes a strict governance approach within the company said the following:

> *“That contradicts the idea that we want to generate rapid innovations, which is more in line with the idea that we want to keep things under control, which is the impression I get from the questions.”*
>
> – IT11Metal

Conversely, companies that take a lean governance approach want to benefit from the speed that LCDPs enable. Consequently, these companies empower citizen developers and thus offer many training and learning paths, but all are based on complete voluntarism and are not mandatory. As put by one of our interviewees:

> *"We do enablement, which means we rely on our responsibility for telemetry. We have deliberately said that we do not do schools in advance or as a prerequisite because this would counter the actual goal of a low-code platform. Low-code platforms are supposed to achieve results quickly, and if I first have to apply for something and then have to attend a training session, and none takes place, then I have already lost so much speed that I do not even need to start. We have not done that, but we offer a lot."*
>
> – IT16CarB

However, it is not the case that industrial companies that pursue a lean governance approach do not establish any rules at all. A minimum standard is in place at all companies, and special attention is paid to compliance with data protection and security regulations. For this, citizen developers often have to accept terms and conditions or other agreements that regulate what data may be processed, how they may use the platforms, and what rights and obligations go along with this. Nevertheless, these companies focus on keeping things as simple as possible to not overburden the citizen developers with too much bureaucracy and requirements. Otherwise, this drive for innovation is nipped in the bud, and employees return to their traditional paper-based working methods. Through this lean governance strategy, companies try to empower the citizen developers and take them by the hand whenever they feel things are getting critical or employees need support, thus exercising governance indirectly. Several interviewees also mentioned this during the interviews and the difficulty of finding a healthy balance between both:

> *"That is always very important to us, as far as this governance aspect is concerned, not to overburden them with too many requirements and bureaucracy. We want to use, capture and channel the drive for innovation and not nip it in the bud with five forms and ten mandatory pieces of training."*
>
> – CD04Scaffolding
>
> *"You have to find that fine line between keeping it under control and steering it in the right direction, but not overdoing it, and keeping people in line, so they are still motivated to do it. So put as few obstacles as possible, but as many as necessary."*
>
> – IT10Construction

Moreover, it became apparent that all organizations that follow a lean governance approach first introduced the Power Platform and then established a meaningful framework over time. Companies with a lean governance strategy use an iterative process and try to get as much adoption as possible in the first step and therefore set the hurdles for the citizen developer as low as possible. Nevertheless, over time the companies need to increase the resources in governance. Almost all enterprises with a lean governance strategy stated that they are still developing and adapting the guidelines and governance and will be busy with this for quite a while. In contrast, it turns out that companies with strict governance first define the rules and afterward introduce the Power Platform in the business departments.

As mentioned earlier, few companies currently use the Power Platform for radical innovation or can imagine using it for future purposes. In most cases, the Power Platform was only part of a radical innovation or was used for application development leading to a new internal process. The interviews confirmed this finding. However, it also emerged that this perception varies depending on the facilitating conditions. In particular, companies that pursue a lean governance approach and allow citizen developers to participate in continuous improvement without imposing significant restrictions on them see the

potential for radical innovations or have already developed radical innovations with the Power Platform. Conversely, companies that follow a strict governance approach try to absorb all possible risks in advance, giving employees almost no opportunity to experiment with the platform and thus, if necessary, to innovate radically.

Furthermore, it was mentioned in the theory section that despite the critical voices against LCDPs, acceptance within the IT departments and the business units is high. Therefore, an initial assumption was that LCDPs must be perceived as valuable by the company's employees and customers, and organizations can only successfully introduce these platforms if this is the case. However, it became apparent during the interviews that the acceptance of the Power Platform differs significantly between IT employees and citizen developers. All citizen developers with whom a conversation could be held were consistently positive, especially when IT had already disappointed them. Additionally, management always had a high level of acceptance towards these platforms. Conversely, the response of the IT employees was largely negative. Many IT professionals perceive the Power Platform as a threat or do not see these low-code platforms as real IT. This pattern of IT opinion is particularly evident in companies that follow a lean governance approach and use the Power Platform within citizen development. In this context, the low-code expert mentioned that low-code is the digitalization of IT, as LCDPs lower the barriers to entry and many people perceive this as a threat (IT09Consulting). During the interviews, it was possible to confirm this statement, as in companies with strict governance or where this platform is used purely as an IT tool, the acceptance of IT employees is significantly higher since IT is still the gatekeeper and has a high degree of control and authority.

In addition, the interviews showed that companies that use the Microsoft Power Platform as part of the citizen development concept and with a lean governance strategy do not tend to have less shadow IT. On the contrary, most interviewees believe this only shifts shadow IT from Excel and Access databases to the Power Platform but does not eliminate it. Nevertheless, many interviewees emphasize that this is the first time companies have provided business employees with a standardized and secure platform that legalizes shadow IT. In addition, for the first time, companies have an approach to see what they have done. Therefore, these companies have absolute transparency about which solutions have already been created and can see whether citizen developers may have made any critical applications that should be handed over to IT responsibility. Shadow IT has always existed, but until now, it took place under the radar with Excel, Access databases, and other tools where IT departments could not monitor it. The Power Platform now gives companies a whole new way to deal with it, and it also offers potential for further innovation in the enterprise, as one of our interviewees pointed out:

> *“For the first time, the Power Platform gives us an approach to see what has been implemented in Power Apps and Automates. That does not go down like with Office when some intern does something with Excel. Here, via the platform approach, I can see it exactly [...], and if this can now be made available in a transparent manner […], then I would also have the chance to see what great solutions are available in the group area before I perhaps start programming something myself or I allow myself to be inspired about solutions and come up with new ideas simply by leafing through them.”*
>
> – IT03Automotive

Consequently, to ensure that the innovations in the company become transparent, many companies have set up a use case store in which the applications developed within the business units can be published. However, this use case store was introduced for different reasons depending on the governance strategy of the respective company. During the interviews, it became apparent that organizations that follow a lean governance approach want to utilize this use case store to make the solutions within the company transparent. As a result, employees can check whether someone else has developed

something similar before they develop an application themselves or get inspiration from existing applications. In this context, it is essential to mention that these companies are not trying to prevent redundant solutions. On the contrary, several interviewees even emphasized that they are not interested in eliminating redundant solutions. One interviewee cited the example of Charles Darwin's selection theory, whereby redundant solutions can be used to determine which solution is the better one and thus, if necessary, prevail (IT03Automotive). Conversely, it became evident that companies with strict governance are setting up use case stores to prevent a proliferation of applications and redundant solutions. Frequently, the citizen developers are obligated to publish their applications within the store, whereas in companies with a lean governance approach, it is voluntary and only recommended.

Another facilitating condition that emerged during the interviews was that organizations that have consciously opted for LCDPs and the concept of citizen development because they see potential in it had established digitization units within the company. Since IT cannot provide support for applications developed in the business units, the citizen developers in all companies are responsible for their applications themselves. Many companies have even abolished a help desk and do not bother if problems arise during use. As a result, citizen developers must take care of further developments or bug fixes. However, many business employees have a significant time problem doing this during their actual work, so they often are reluctant to develop apps that affect a larger group of users. Those companies that have recognized this problem but still want to push the topic of LCDPs have countered this through digitization centers. Employees can submit their use cases in these digitization centers, which citizen developers develop for the business units. For this purpose, these companies have hired employees as citizen developers whose main task is to create applications with the Power Platform for a specific department. In this context, the findings showed that companies with established digitization units also develop larger applications in the citizen developer concept that are not business-critical but affect many users. In addition, this time problem was a frequent topic in the interviews and a reason why one company has not yet rolled out Microsoft Power Platform in the business units (IT11Metal). However, only enterprises that have not set up separate divisions for this purpose and therefore see the additional workload on employees raised this concern.

Moreover, the findings showed that companies have also established versatile support measures for citizen developers. As mentioned above, IT does not want to offer support for the applications developed in the business units or provide centralized application development. Nevertheless, to support the business departments, companies have often established communities where citizen developers can exchange information and help each other in the case of problems or questions. Furthermore, organizations have often implemented show-and-tell or walk-in sessions, where citizen developers are regularly allowed to ask specific Power Platform questions to a team of experts. Often, these companies develop FAQs based on these questions, publish them on the intranet, or further adapt the learning materials. These multifaceted support measures enable citizen developers to create applications without IT support and build in-depth knowledge and skills.

A further facilitating condition that emerged was a clear communication concept. Companies that have established a communication and marketing strategy to make the Microsoft Power Platform known within the company have a significantly higher acceptance among citizen developers. In doing so, these organizations have designed and created their branding, vision, name, color, and form languages to anchor the topic within the business from the lowest level to the boardroom. Frequently, these companies have also set up a separate website on the intranet where various teaching materials and information are available for the citizen developers. In addition, these companies reported that they are currently almost overwhelmed with inquiries and that this communication concept, particularly, has helped them succeed. Through the communication concept, the departments have understood the

added value of these platforms and want to participate actively in the change. In this context, an interviewee whose company did not establish a communication strategy at the time for cost reasons also told us that they are still paying the price for it today. Due to the lack of communication, two years later, the topic has not fully arrived or become anchored in the company and among the employees. Given the lack of communication, the organization missed out on getting employees excited about the topic and paying attention to it at a crucial moment (IT21Injection).

Almost all enterprises see the Power Platform as a powerful tool. Still, many companies emphasize that a cultural change within the company is required to place the platform successfully. Employees must be curious and have the urge to improve things by constantly asking if something can be changed or improved. Radical innovations can emerge when organizations make this change and thus establish the Power Platform culturally. As one of our interview partners said:

> *"I believe that low-code, especially when it is culturally established, is a powerful tool for trying out visions and creating prototypes. Everything that has to do with digitization is then taken to the next level, and you say, hey, we could imagine this very differently, and it could look like this and this."*
>
> – IT16CarB

Most companies interviewed during this thesis were German, and only two interviews were conducted with foreign companies, of whom one came from the United States and the other from Austria. Thereby it turned out that the US company is much further ahead than the German and Austrian companies in innovations through the Power Platform. In particular, the US company has to comply with much looser data protection rules than the German and Austrian companies since here, the works council and other management bodies have to agree to an application in almost all of these companies interviewed. In addition, the US company recognized the potential of the Power Platform at an early stage and thus was an early adopter. Consequently, the company already has over 20,000 Power Apps developers, which means that the company develops almost all applications via the Power Platform. No German or Austrian company surveyed had this magnitude of citizen developers.

Subsequently, table five provides an overview of the most successful facilitating conditions identified during data analysis.

Companies	*Facilitating Condition*	*Justification*
Automotive, CarA, CarB, CarC, Construction, Injection Molding, IT Services, Metal, Scaffolding, Seal, Steel	Center of excellence	Establish a center of excellence in the company that describes the team dealing with the Power Platform and its associated processes and acts as a central point of contact
Automotive, CarA, CarB, Construction, Seal, Steel	Communication concept	Establish a communication concept to successfully anchor the Power Platform in the company from the lowest level to the board of directors
CarA, CarB, CarC, Construction, Injection Molding, IT Services, Metal, Plastic, Scaffolding, Seal, Steel	Different environments	Establish different environments, increasing in terms of technical usability and the number of available connectors
Automotive, Construction, IT Services, Steel	Digitization centers	Since citizen developers are responsible for the applications they create, companies should set up digitization units that focus on developing applications for the business departments to address the employees' time problems
Automotive, CarB, Construction, Injection molding, IT services, Medicine, Plastic, Scaffolding, Seal, Steel	Lean governance	There is only a minimum standard and guardrails set. The citizen developers are primarily free in what they do to enable rapid innovation
Automotive, Bus, CarA, CarB, CarC, Construction, Injection Molding, IT Services, Scaffolding, Seal, Steel	Supporting measures	Since IT departments cannot offer support due to the shortage of skilled workers, companies should build support activities such as communities, training, or Q&A sessions to empower business departments to develop skills to help each other in the event of a question or problem
Automotive, CarA, CarC, Construction, IT Services	Use case store	Build a use case store to make the applications transparently available to everyone within the company

Table 5: Overview of the Most Successful Facilitating Conditions Identified During Data Analysis

5 Discussion

In the previous finding section, I described the types of innovations that industrial companies have developed with LCDPs, usage patterns, and facilitating conditions they have introduced. The overall objective of this work was to investigate the conditions under which LCDPs are used in the industrial sector, whether industrial companies use these platforms for the development of incremental or radical innovations, and which facilitating conditions must exist in each case. The following chapter will now summarize the research findings to answer the guiding research question of this thesis. Likewise, we revise the initial assumptions based on our results and propose hypotheses for future research. Subsequently, this chapter will discuss the implications for theory and practice and outline this study's limitations. The chapter will conclude with recommendations for future research approaches.

First, the research showed that LCDPs enable industrial companies to innovate incrementally and radically. However, it also became apparent that most companies use these platforms predominantly for incremental innovations to digitalize and optimize analog or management-intensive processes within the production or the back office. In addition, it became clear that most companies innovate internally and do not make their applications available to external customers or markets. About a third of the companies surveyed see no potential to use LCDPs for radical innovations in the future, and only three respondents said they could imagine using these platforms for this purpose. So far, industrial companies have not used LCDPs for radical innovations to quickly develop working prototypes on which new possibilities can be explored. Companies that have already radically innovated either utilized the platform as part of radical innovation or created an entirely new internal process. However, they consciously decided to use the LCDP as the target solution, as most believe it is better to know the target solution before prototyping. Beyond that, all companies use the LCDP as a prototyping tool, although not for radical innovations but for incremental innovations. Since most companies only innovate incrementally, they primarily use the platform to test ideas in advance by making the prototype available to a small group of users and developing it further based on feedback and change requests until a finished application emerges. Furthermore, the findings revealed that LCDPs are not only used in the concept of citizen development but also as a pure IT tool. Through these respective usage patterns, it has become evident that companies that use these platforms in citizen development develop more applications in a shorter time than those that use them purely within IT.

Moreover, the research findings showed that companies set up different facilitating conditions. However, these conditions differed not by the innovation type but based on the criticality or complexity of the applications. Minor applications that citizen developers create for themselves or a smaller user group are subject to different conditions than applications that are more critical or complex and thus affect a larger user group. Therefore, companies have created different environments on these platforms, which are gradually increasing in terms of technical usability and the number of available connectors. In addition, it has become apparent that most industrial companies pursue a lean governance strategy and apply as few governance measures as possible. Most companies take this lightweight approach to ensure citizen developers do not get overwhelmed by too many requirements and revert to traditional means. These companies want to create rapid innovations through minor requirements and not nip the innovation drive of citizen developers in the bud through the bureaucracy. While companies with strict governance have also innovated, it has become evident that they are losing speed since use cases often have to go through an approval process before citizen developers can develop an application. Additionally, in all companies that make the platform available to the business departments, the citizen developers are responsible for their applications themselves, which means that the IT department does not support them. Since many citizen developers perform application development in addition to their

primary tasks, they have time constraints. Organizations that have recognized this time problem but still want to drive the topic forward have counteracted this by setting up central digitization units in which employees are responsible exclusively for app development within the business units. In addition, many companies have built supporting measures like communities or training courses to enable citizen developers to gain competencies on these platforms and help each other in the case of questions or problems. Likewise, many companies have established a center of excellence and created a use case store to make applications transparent. However, the reasons for this were different depending on the governance strategy. While companies with lightweight governance try to empower citizen developers and increase the innovation potential for incremental innovations, companies with a strict governance structure try to keep the risks as low as possible, keeping the innovation potential comparatively low. A reflection of this is that companies with lean governance, in particular, can imagine using LCDPs in the future to innovate radically or have already innovated radically with them. Moreover, it turned out that a communication concept is essential to anchor the platform in the company successfully. Companies that communicate their vision from the lowest level up to the board have achieved a higher level of acceptance in the business departments and a more incredible rush of citizen developers who want to participate in application development in the company than those that make the platform available silently and secretly.

To summarize, LCDPs theoretically empower industrial companies to innovate incrementally and radically, thus enabling organizational ambidexterity. However, companies use these platforms mainly to digitalize internal analog processes for incremental innovations. Here, industrial companies also see the primary potential use of these platforms to digitalize previously manual, inefficient activities. Therefore industrial companies currently achieve predominantly organizational ambidexterity for internal innovations through these platforms and use them primarily for exploiting and less for exploring. Among the reasons for the current mainly incremental use could be that in most companies, the topic of LCDPs is still relatively young, and these companies, therefore, do not yet fully assess and exploit the innovation potential for radical innovations of these platforms. In addition, it usually takes a long time for radical ideas and innovations to emerge. Since most companies have only introduced these platforms within the last two years, too little time may have passed. As a reflection of this, the US company that introduced the LCDP as an early adopter was the most advanced in radical innovation. Furthermore, companies that innovate incrementally and radically follow the approach of structural ambidexterity. From these findings, we can derive the first hypothesis:

H1: LCDP use facilitates the development of incremental and radical innovations.

Beyond that, it became apparent that the industrial companies have set up different facilitating conditions to introduce the platform successfully. These conditions differed not by the type of innovation but by the criticality and complexity of the applications. Therefore, companies have created different environments on the platform in which the developers are guided safely by various restrictions as more or fewer connectors are enabled depending on the environment. In this way, companies try to encapsulate critical applications in a different environment, where IT departments can treat them with special attention. Organizations that have developed more applications in less time have adopted a lean governance strategy and the citizen development concept in addition to the different platform settings. In doing so, these companies have achieved rapid innovations through few restrictions, which is one of the main advantages of LCDPs. In this context, it has also been shown that companies adopting the platform in citizen development with a lean governance strategy are willing to take more risks and innovate radically, if necessary because employees can experiment with these platforms and explore new opportunities. However, acceptance within the IT department is significantly lower in these companies, meaning that

lightweight governance in the citizen development concept negatively impacts adoption in IT. From these findings, further hypotheses can now be derived:

H2: When citizen developers use LCDPs, more innovations are created.
H3: Strict governance rules are established for critical applications.
H4: Strict governance rules inhibit the speed of innovation.
H5: Strict governance structure negatively impacts the potential for radical innovation.
H6: Lean governance structure positively influences LCDPs use by citizen developers.
H7: Lean governance structure negatively impacts adoption within IT departments.

In addition, to facilitate the introduction of the platform, the companies have established a center of excellence that acts as a central point of contact and a bridge between business users and IT. Further, they built a use case store to make the applications transparent and increase the innovation potential for incremental innovation. Likewise, companies have handed over app development to the responsibility of citizen developers, simultaneously set up digitization units to counteract citizen developers' time problems, and built support measures to enable business departments to build competencies. Companies that have achieved a high level of acceptance in the departments and a high rush of citizen developers have also developed a communication strategy to make this vision known and anchored in the organization from the lowest level to the board of directors. These findings lead to further hypotheses:

H8: Center of excellence positively affects the usage of LCDPs.
H9: Use case stores positively impact the development of incremental innovation.
H10: Digitization units facilitate the usage of LCDPs by citizen developers.
H11: Communication concepts positively affect the usage of LCDPs by citizen developers.

Based on the theoretical background and the new insights gained through the data analysis, it was possible to revise the initial assumptions from which the hypotheses mentioned above resulted. In the following figure, the hypotheses are depicted.

General	Governance-Related	Facilitating Conditions
H1: LCDP use facilitates the development of incremental and radical innovations H2: When citizen developers use LCDPs, more innovations are created	H3: Strict governance rules are established for critical applications H4: Strict governance rules inhibit the speed of innovation H5: Strict governance structure negatively impacts the potential for radical innovation H6: Lean governance structure positively influences LCDPs use by citizen developers H7: Lean governance structure negatively impacts adoption within IT departments	H8: Center of excellence positively affects the usage of LCDPs H9: Use case store positively impacts the development of incremental innovation H10: Digitization units facilitate the usage of LCDP by citizen developers H11: Communication concepts positively affect the usage of LCDP by citizen developers

Figure 3: Derived Hypothesis for Future Research

5.1 Implications for Theory

This work investigated the facilitating conditions under which LCDPs are used in the industrial sector and whether they use these platforms to develop incremental or radical innovations. By conducting 21 expert interviews from 15 companies with more than 21 hours of interview material, it was possible to gain several new insights from which main implications for theory now emerge and are outlined subsequently.

First, the data shows that LCDPs theoretically enable industrial firms to innovate radically and incrementally. However, most industrial companies use these platforms mainly for incremental innovations and rarely for radical innovations. In this context, it became apparent that industrial companies primarily use these platforms to optimize inefficient day-to-day processes or work steps in production and the office that previously had little or no digital support. Krejci et al. (2021) argued in their scientific research that LCDPs are better suited for incremental innovations than radical ones. While this research has also shown that companies primarily use these platforms for incremental innovations, it has also become apparent that in cases where radical innovations would be possible, companies often use strict governance mechanisms that stand in the way of radical innovations. Future research should look into that.

Furthermore, the data shows that LCDPs are used predominantly for internal innovations. In particular, there was no use case in the German and Austrian companies where something developed on the Power Platform was made available to external customers or markets. One of the main reasons for this was the stability of the Power Platform. Since Microsoft does not promise a defined availability and everything runs in the cloud, companies fear that changes from Microsoft could also affect external applications. This result was unexpected since Richardson and Rymer (2014) repeatedly point out that LCDPs are particularly well suited for creating customer-oriented applications and quickly adapting to changing customer behavior. However, our data proves otherwise, considering the selected companies and the Microsoft Power Platform as the LCDP to be studied.

Additionally, in contrast to vendor reports from Workerbase (2019) and Neurisium (2021), our research shows that industrial companies are not yet using LCDPs for Industry 4.0 topics. Due to the excellent connectivity, many companies that already use Microsoft Azure in production can well imagine using the Power Platform for these purposes in the future. Still, none of these companies have implemented specific use cases yet. Conversely, industrial companies with SAP-heavy production or ancient machines find it difficult to imagine future use of the platform for Industry 4.0 projects. In addition, the data shows that industrial companies are not yet using the Power Platform to explore new opportunities through prototyping. Although Richardson and Rymer (2014) highlight that LCDPs provide a perfect environment for testing and experimenting with new ideas, our data shows that the platforms are not currently being used for exploration in industrial companies. Since only a few companies are innovating radically, and only a few can imagine doing so in the future, there is relatively limited data available. Regardless, our data shows that the companies that have already radically innovated with the Power Platform have connected the platform with other systems so that the platform has mapped part of the innovation or created a new internal process with an application developed on the Power Platform. In both cases, the companies did not use the Power Platform for experimenting. Instead, they consciously decided to implement the application on the Power Platform or connect it to other systems. That was also a general attitude of the companies. Typically, they want to define the target solution and then create a prototype based on that decision. Several companies believe that a prototype on an LCDP is not a basis for comparison if this prototype is implemented in a completely different system later. That may also be why industrial companies have not yet used the platform to explore new possibilities.

Conversely, our data shows that industrial companies use LCDPs as a prototyping tool for incremental innovations. Since most companies only innovate incrementally, they use them to make applications available in an initial, rather rudimentary version, further developed iteratively based on change requests. In this context, it has become visible that citizen developers do not distinguish between a prototype and a finished application. In most cases, citizen developers iteratively develop a prototype until they achieve the desired result. Occasionally, the platforms are used purely as a prototyping tool to make the requirements and benefits known so that professional development in existing systems is easier to justify or to prevent friction between IT and business departments. Also, all the companies emphasized that these platforms enable them to create working prototypes quickly and with few resources. Some respondents were able to develop a working prototype within ten minutes. Due to this fast prototyping, companies can take a fail-fast approach, as the effort to create this prototype is relatively low. These findings partially align with previous research where Krejci et al. (2021) and Richardson and Rymer (2016) highlight the potential of LCDPs to reach working prototypes quickly. However, this research has also shown that citizen developers do not distinguish between a prototype and a fully developed application but rather create an initial rudimentary version that is iteratively refined and that the platforms are used more for exploitation than exploration as a prototyping tool.

Although LCDPs are particularly suitable for business employees, our data revealed that companies also use LCDPs as pure IT tools. Even if it is a myth that LCDPs are only for citizen developers (Richardson and Rymer 2016), it appears to be the most logical choice to use these platforms within business departments. Most companies from our data collection also use the Power Platform as intended in citizen development. Still, the data shows that some companies use it the other way around. Through the discovered usage behavior, it turned out that companies that use the LCDP as a pure IT tool create critical and complex applications but also fewer applications in a more extended period. These findings partially align with previous research where Rymer (2017) highlights that IT departments can create large and complex applications through LCDPs. However, this research has also shown that companies using the platform as a pure IT tool develop fewer applications and do not benefit equally from the speed, as the business departments still have to communicate use cases to the IT departments, which are then prioritized in a backlog.

Furthermore, this work has shown under which conditions industrial companies use LCDPs and the differences that arise from the respective strategy. Companies do not introduce different conditions depending on the type of innovation but instead on the application's criticality. For this, almost all companies have set up different environments on the platform where citizen developers have more or fewer options available. In the process, the companies have also introduced a center of excellence that acts as a bridge between business and IT departments and positively affects the platform's usage. Moreover, the work revealed that companies following a lean governance strategy could innovate faster and develop more applications in a shorter period since the citizen developers have few constraints or do not have to fulfill conditions in advance compared to companies following a strict approach. In this context, it emerged that a lightweight governance structure is favorable for radical innovations, as companies are willing to take more risks and do not cover all eventualities. Furthermore, it showed that companies that have established a communication concept enjoy higher acceptance than companies that have not done so. Likewise, companies were able to counteract the time problem of citizen developers by setting up digitization units, which led to high engagement in the departments and increased the potential for incremental innovation by establishing a use case store to make applications available within the company transparently.

Finally, the work shows that employee acceptance of LCDP deployment varies. In particular, the data revealed that companies that use these platforms within the citizen development concept and follow a

lean governance strategy have lower IT acceptance than companies with strict governance. We were surprised by this result, as Mendix Technology (2021) and Outsystems (2019) repeatedly emphasize a high acceptance of LCDPs among IT professionals. However, our data indicates that when companies use LCDPs in citizen development and exercise low governance, acceptance within IT decreases. One reason may be that IT professionals in these organizations relinquish more control and authority than in companies implementing the platform with strict governance.

5.2 Implications for Practice

Moreover, from the findings outlined above, four main implications for practice could be derived, which are presented in the following. The aim is to provide recommendations for companies planning to implement LCDPs in the future or are currently in the process of doing so.

First, to keep pace with digital transformation, companies need to adopt LCDPs. Our data has shown that a critical advantage of LCDPs is creating working prototypes or even completing applications quickly. Consequently, companies can adapt rapidly and flexibly to the accompanying changes. In this framework, LCDPs seem to be particularly well suited for creating incremental innovations. Based on our data, LCDPs can be used to digitalize and automate many previously inefficient manual activities within the enterprise. The time saved can then be used for other projects and tasks, creating value for the entire company. Almost every company has at least one paper-based internal process that can be digitalized through an LCDP (Bratincevic et al. 2021). Our research confirmed this result and showed that in all the companies we surveyed, far more than one paper-based process was causing inefficiencies. Even in huge companies, there was enormous potential for digitalizing small manual activities that could be leveraged by LCDPs and create value for the entire company.

Second, to fully exploit the innovation potential of LCDPs, companies should deploy an LCDP with a focus on citizen developers. Our results have shown that companies that use these platforms in citizen development can develop more applications in a shorter period than companies using them as pure IT tools. Since the business departments precisely know the problems that prevent them from working more effectively but have not had a tool yet, they have often operated shadow IT through oversized Excel lists or Access databases. With LCDPs, business departments have a tool that increases the potential for innovation within the company since everything that previously happened under the radar on computers or a piece of paper is now recorded securely and transparently on a central, standardized platform. Although the data suggests that this probably will not make shadow IT less of a problem, it will at least make it more transparent. In addition, if an employee leaves the company, the knowledge will remain, and the process does not simply disappear as it did before with Excel or Access databases.

On the other hand, our findings show that companies in citizen development largely avoid creating business-critical applications for which a business employee has to take full responsibility. Applications made in citizen development are predominantly smaller applications or process automation that do not paralyze the entire company in the event of an error. However, it is often the case that applications created in the business department are initially classified as non-critical and then grow over time in terms of consumption, usage, and popularity. As a result, IT departments must continuously monitor the non-functional requirements of the applications and set up a center of excellence within the company that is dedicated to this monitoring and acting as a bridge between the business and IT departments. When applications reach a point where they are deemed critical, IT departments must take responsibility and establish an IT support model or perform some refactoring into other systems. Therefore, if companies

plan to use LCDPs to develop business-critical applications primarily, our data suggests that these platforms are better used within IT and should be made available to business departments in a limited way only.

Third, companies that introduce an LCDP should take care not to set the conditions too strictly. Our data has shown that organizations that have implemented only the minimum amount of governance benefit far better from the speed of these platforms and also used these platforms for radical innovations than companies that have covered all eventualities in advance down to the smallest detail. When businesses only set the minimum governance framework and otherwise do a lot of enablement through communities, training, and question sessions, many innovative ideas might emerge quickly. In addition, companies should also establish digitalization departments within the organization, in which employees focus primarily on application development for the business units. Our data suggests that employees quickly reach their limits during their activities and then put application development aside because they do not have the time to deal with it. Companies could counteract this problem by hiring employees who only deal with application development and thus carry out centralized order development for the business departments. As a result, enterprises could profit sustainably from the speed made possible by LCDPs and develop larger applications in the business domain.

Fourth, companies should establish a communication strategy. Our findings show that businesses that have developed a communication concept anchored from the lowest level up to the board of directors have achieved a higher level of acceptance within the organization and a higher number of citizen developers who want to participate in application development. Therefore, companies should develop their branding, vision, slogans, and website on the intranet and create new roles for employees specially trained on the LCDP. When enterprises succeed in sustainably anchoring the topic, this can lead to a cultural change, as employees are genuinely interested in improving or doing something new and want to change their current way of working.

5.3 Limitations

Finally, although this thesis provides a comprehensive first look at the use of LCDPs in the industrial sector and what innovations these platforms enable, I also recognize certain limitations that this thesis contains and outline them below.

One limitation was the current lack of scientific articles on LCDPs. Especially in the context of digital innovations, almost no scientific research was available. In addition, the data collection was limited to 21 interviews conducted mainly with industrial companies, all of which use Microsoft Power Platform as their LCDP. Due to the focus of this work on industrial companies and the selection of the Microsoft Power Platform as the LCDP to be studied, only one of many LCDPs in a given area could be investigated, limiting the generalizability of the findings and may contain underlying biases (Oppong 2013). However, compensation for this was attempted by including consulting firms and companies that were not yet actively using the Microsoft Power Platform in the data collection, which thus provided an outside perspective and could contribute further information and knowledge on the topic. In addition, there was no fixed sample size from the beginning; instead, data collection was terminated as no new insights emerged after the 21st interview, and thus saturation was reached (Alsaawi 2014).

Furthermore, the varying lengths of the interviews, which allowed the gathering of more information in some interviews than others, and the unbalanced ratio between IT professionals and citizen developers may be considered limitations that could have led to a bias in the results. In addition, participants were not randomly selected for this work but were consciously chosen based on various criteria, which could have led to a bias within the selection process (Oppong 2013).

Additionally, the data was collected using expert interviews written down for data analysis afterward. Another limitation that may have biased the results could be the translation of the interviews from German to English. Since most conducted interviews were in German and this paper was written in English, the data and quotes had to be translated into English. Through this translation process, it cannot be completely ruled out that formulations have been misrepresented. Moreover, the researcher analyzed and interpreted the interviewees' statements during the data analysis, which may also not entirely exclude the possibility of misunderstandings (Alsaawi 2014). Another limitation of this work could have been the data analysis process, which involved inductively forming categories from the data material since other researchers may have developed different codes or taken different approaches to analyze the data.

5.4 Future Research

Given the lack of scientific research on LCDPs in the context of digital innovation, further research should be dedicated to this topic. Therefore, a future research approach could validate the present research results by selecting another LCDP as the platform to be investigated. Furthermore, this work has shown that most industrial companies use LCDPs for internal and incremental innovations, therefore, a future research approach could also examine the potential of LCDPs for external and radical innovations. Likewise, the present work has focused on industrial companies only. However, more and more industries will use LCDPs in the future (Mendix Technology 2021). Therefore a fruitful future research approach could include other industries in the sample list and investigate the use of LCDPs in these sectors.

Beyond that, another interesting approach for future research emerged during the interviews. As mentioned in the findings chapter, LCDPs support agile development, but these platforms bring a new dynamic into this process. In a typical Scrum framework, a product owner defines the requirements, and then a development team of five to nine people implements those requirements. Due to the fact that LCDPs now allow requirements and changes to be implemented at such a high speed, the previous Scrum framework is difficult to apply to LCDP projects and leads to problems. On the one hand, the number of developers needed within these low-code projects is lower than before. On the other hand, the product owner can no longer keep up with the requirements definition since the development team can implement the requirements much faster than the product owner can define them. Hence the question about the roles within the Scrum framework when developing with LCDPs arises. A future research approach could thus investigate the Scrum roles in LCDP projects and how these must be lived differently in the future when developing projects with LCDPs.

6 Conclusion

This work aimed to investigate the conditions under which LCDPs are used in the industrial sector, meaning whether industrial companies use LCDPs to develop incremental or radical innovations and which facilitating conditions they must meet to unfold this potential in each case. The guiding research question of this work was:

- How do LCDPs enable digital innovation in the industry?

To obtain an answer to the guiding research question, I conducted a literature review on the relevant topics related to the research question on the one hand and qualitative research through expert interviews on the other. In the theoretical background of this thesis, it was pointed out what digital innovations are and the necessity that companies today have to innovate incrementally and radically. Likewise, it was presented how companies can simultaneously pursue these two fundamentally contradictory activities through organizational ambidexterity. Moreover, the paper outlined how LCDPs can help involve business employees in the development process of digital innovations allowing companies to pursue both types of innovation simultaneously, which was previously difficult to achieve due to the shortage of IT professionals. Afterward, a semi-structured interview guide was created based on this theoretical framework, continuously adapted and expanded during the interviews. For the expert interviews, I focused on industrial companies that use the Microsoft Power Platform as an LCDP or plan to do so in the future, as well as consulting firms that have already implemented LCDP projects and thus have expertise in this area. The results of the qualitative research have shown that LCDPs can promote organizational ambidexterity and help industrial companies pursue incremental and radical innovation simultaneously. However, the findings also show that industrial companies use LCDPs primarily to digitalize production-related or internal back-office processes for incremental innovations. Therefore, industrial companies currently achieve predominantly organizational ambidexterity for internal innovations through these platforms and use them primarily for exploitation rather than exploration. In addition, the number of companies already using LCDPs for radical innovations was still low at four. If companies have already used these platforms for radical innovations, they either used them as part of radical innovation or created an entirely new internal process by developing an application. However, it has also become clear that most companies do not see any potential for radical innovation and will only use it for incremental innovations in the future. Thereby, it also emerged that the companies do not currently use the platform as a prototyping tool for experimenting and exploration to generate radical innovations but only as a prototyping tool to test incremental innovations and develop them iteratively or to make requirements and benefits visible. The work also showed that companies use LCDPs in citizen development and as pure IT tools. In this regard, the study revealed that companies that use LCDPs as part of the recommended citizen development framework developed significantly more applications in a shorter period than companies that use it the other way around. The usage pattern also showed that most applications developed in citizen development are limited to small, non-critical applications. Otherwise, the citizen developers would have to take full responsibility for business-critical applications, which they cannot ensure due to their lack of experience and knowledge. In contrast, companies that use it purely as an IT tool developed more critical applications.

The study further showed that industrial companies had introduced different facilitating conditions to establish the LCDP within the company successfully. These conditions did not differ based on the innovation type, not even for companies that innovate radically, but mainly in the criticality of the application. Since LCDPs provide several connectors to other systems, many companies have set up environments in which more or fewer connectors are enabled. This encapsulation allows IT departments to keep a closer eye on more critical applications and to take responsibility if necessary. In addition, it also became

evident that most companies currently only exercise a minimum of governance and give employees as few guidelines as possible so that adoption is high and the innovation potential for incremental and radical innovations in the company can evolve. In this context, the study showed that these companies could benefit from the speed of LCDPs due to the few requirements that citizen developers must meet to create applications. However, the work also shows that some companies have adopted LCDPs with rigorous specifications. In this case, employees often have to undergo training as a prerequisite, or use cases have to be approved, thus losing speed. In this context, it has also emerged that overly strict governance minimizes the potential for radical innovation, as employees have almost no opportunity to experiment with these platforms or explore new possibilities. Beyond that, many companies rely on the enablement of citizen developers by building supporting measures like communities, learning portals, and question-and-answer sessions. Through these measures, citizen developers can build up knowledge so that the IT departments do not have to continuously deal with the requests and can focus on their core business instead. In addition, it has been shown that facilitating conditions lie in setting up digitalization units to counteract the time problem of citizen developers and a use case store to make the applications transparent and to increase the innovation potential for incremental innovations. Likewise, there is a need for a center of excellence that acts as a central point of contact and defines the conditions, as well as a communication concept to achieve greater acceptance within the organization and to inspire a more significant number of citizen developers for application development.

This qualitative research showed how industrial companies currently use LCDPs and what facilitating conditions these companies have introduced. It has become clear that industrial companies have recognized these platforms' strengths but have not yet fully exploited its potential. A significant advantage of LCDPs is that they can bring rapid innovation. However, if companies slow down this speed by imposing too strict requirements and approval processes, an essential advantage of these solutions is nipped in the bud. In addition, most companies currently use the platform only for internal innovations. As a result, a vital benefit of these platforms remains untapped: the ability to adapt quickly to continuously changing customer requirements. In this context, the industrial sector may not even be the target group for creating digital solutions for customers since their unique selling proposition is usually not primarily IT solutions but manufacturing products in which IT can be one component. Therefore, the result could be different in other industries under certain circumstances. Nevertheless, to ensure that LCDPs are used sustainably in this industry and bring innovations to light, industrial companies must pay more attention to the facilitating conditions and attach even more importance to this topic. This study has shown that the facilitating conditions are essential for companies to bring innovations to light with these platforms, if not the most necessary prerequisite for innovations to flourish.

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Appendix

Appendix 1: Interview Guideline

Fragen zur Person:

1. Können Sie mir etwas über sich und Ihre Tätigkeiten im Unternehmen berichten?

Einsatz der Microsoft Power Platform:

1. Können Sie mir sagen, seit wann Sie die Microsoft Power Platform nutzen, und was der Hauptgrund dafür war?
2. Welche Lösungen haben Sie bereits mit der Microsoft Power Platform entwickelt? Können Sie mir hier von einem Ihrer Highlights berichten, vorzugsweise mit einem Fokus auf die Produktion?

   <u>Falls berichtetes Projekt inkrementell ist:</u>
   a. Wie haben Sie die Plattform genutzt, um diese Innovation zu entwickeln?
   b. Bleibt die entwickelte Anwendung auf der Microsoft Power Platform oder wird diese zu einem späteren Zeitpunkt in Ihre Bestandssysteme migriert?
      i. Welche Strukturen werden bei einer Migration beachtet und wer entscheidet darüber?
   c. Nutzen Sie die Microsoft Power Platform derzeit auch für radikale Lösungen?
      i. Falls nein, warum nutzen Sie die Microsoft Power Platform derzeit nicht für radikale Lösungen?
      ii. Falls ja, können Sie mir auch hier von einem Ihrer Highlights berichten?

   <u>Falls berichtetes Projekt radikal ist:</u>
   a. Wie haben Sie die Plattform genutzt, um diese Innovation zu entwickeln?
   b. Haben Sie in diesem Projekt auch die Microsoft Power Platform eingesetzt, um schnell zu Prototypen zu gelangen?
      i. Falls ja, wie sind Sie dabei vorgegangen?
   c. Nutzen Sie die Microsoft Power Platform derzeit auch für inkrementelle Lösungen?
      i. Falls nein, warum nutzen Sie die Microsoft Power Platform derzeit nicht für inkrementelle Lösungen?
      ii. Falls ja, können Sie mir auch hier von einem Ihrer Highlights berichten?

   <u>Falls beide Arten von Innovationen auf der Microsoft Power Platform entwickelt werden:</u>
   a. Würden Sie sagen, dass die Microsoft Power Platform Ihnen dabei geholfen hat, beide Arten von Innovationen gleichzeitig zu entwickeln?
      i. Falls ja, würden Sie mir die Gründe erläutern?
   b. Nutzen Sie die Microsoft Power Platform häufiger, um bestehende Lösungen zu verbessern (inkrementell) oder um völlig neue Lösungen zu entwickeln (radikal)?
   c. Haben Sie eine strukturelle Trennung bei der Entwicklung radikaler und inkrementeller Innovationen?

3. Nutzen Sie die Power Platform momentan überwiegend für interne Innovationen oder entwickeln Sie auf der Power Platform auch Anwendungen für externe Kunden?

Kontext Industrie 4.0 und Microsoft Power Platform

1. Gab es bereits Projekte, bei denen Sie die Microsoft Power Platform im Zusammenhang mit Industrie 4.0 Technologien eingesetzt haben?

   Wenn Microsoft Power Platform mit Industrie 4.0 eingesetzt wird:
   a. Würden Sie sagen, dass die Microsoft Power Platform Ihrem Unternehmen dabei hilft, den Weg in die Industrie 4.0 zu beschleunigen?
      i. Falls ja, würden Sie mir die Gründe erläutern?
   b. Würden Sie sagen, dass die Microsoft Power Platform es Ihnen ermöglicht, weniger IT-Spezialisten zu benötigen?

   Wenn Microsoft Power Platform nicht mit Industrie 4.0 eingesetzt wird:
   a. Können Sie mir sagen, warum Sie die Microsoft Power Platform aktuell nicht im Zusammenhang mit Industrie 4.0 Technologien einsetzen?
      i. Könnte das zukünftig der Fall sein, dass Sie die Power Platform in diesem Zusammenhang einsetzen?

Rahmenbedingungen für erfolgreiche Microsoft Power Platform Einführung

1. Wie wurde die Microsoft Power Platform in Ihrem Unternehmen eingeführt - Gab es hierbei besondere Rahmenbedingungen, die beachtet werden mussten?
   a. Was war Ihrer Meinung nach die wichtigste Rahmenbedingung für die erfolgreiche Einführung der Microsoft Power Platform in Ihrem Unternehmen?
   b. Gibt es bestimmte Regeln, welche die Mitarbeiter bei der Entwicklung von Anwendungen auf dieser Plattform beachten müssen?
      i. Haben Sie verschiedene Umgebungen auf der Power Platform etabliert?
         1. Falls ja, würden Sie mir die Gründe dafür erläutern?
         2. Wie unterscheiden sich die verschiedenen Umgebungen?
      ii. Wie regeln Sie die Governance auf der Power Platform?
         1. Haben Sie für die Microsoft Power Platform ein Center of Excellence im Unternehmen aufgebaut?
         2. Müssen Citizen Developer vor der Anwendungsentwicklung Verträge unterzeichnen oder AGBs akzeptieren?
         3. Gibt es verpflichtende Schulungen oder andere Vorgaben?
      iii. Würden Sie sagen, dass die Governance für alle Innovationsarten gleich ist (inkrementell/radikal)?
   c. Wie gehen Sie in Ihrem Unternehmen bei der Problemlösung vor?
      i. Wenn Mitarbeiter in bestehenden Prozessen ein Verbesserungspotenzial sehen, dürfen diese dann die Microsoft Power Platform nutzen, um den Prozess zu verbessern?
      ii. Müssen hier im Vorfeld Genehmigungen eingeholt oder Vorgaben erfüllt werden?
      iii. Hilft Ihnen die Microsoft Power Platform bei der Erreichung von kontinuierlicher Verbesserung?
   d. Haben Sie einen Use-Case Store im Unternehmen etabliert, in denen die Anwendungen allen Mitarbeitern transparent zur Verfügung gestellt werden?
      i. Aus welchem Grund haben Sie diesen Use-Case Store aufgebaut?
      ii. Sind die Mitarbeiter verpflichtet, ihre Anwendungen dort freizugeben?

e. Haben Sie Unterstützende Maßnahmen für die Citizen Developer im Unternehmen etabliert?
    i. Falls ja, können Sie mir von diesen berichten?
f. Haben Sie ein Kommunikationskonzept für die Einführung der Power Platform im Unternehmen aufgebaut?
    i. Falls ja, wie spiegelt sich das Kommunikationskonzept wieder?
    ii. Wie hat Ihr Unternehmen durch dieses Kommunikationskonzept profitiert?
g. Sind die Citizen Developer für ihre entwickelten Anwendungen selbst verantwortlich?
    i. Stehen die Citizen Developer hierbei in einem Zeitkonflikt diese Aufgaben während ihren Hauptaufgaben zusätzlich zu erledigen?
    ii. Falls ja, haben Sie hierfür Maßnahmen im Unternehmen etabliert, um diesem Zeitproblem entgegenzuwirken?
h. Beziehen Sie die Endnutzer der Anwendung durch die Power Platform stärker in den Feedbackprozess mit ein?
    i. Falls ja, können Sie mir von dem Vorgehen berichten?
    ii. Würden Sie sagen, dass sich dadurch die Mitarbeiterzufriedenheit sowie der Mitarbeiterwert insgesamt verbessert hat?
    iii. Gibt es bei diesem Vorgehen Unterschiede je nach Art der entwickelten Anwendung (inkrementell/radikal)?
i. Wie denken die Mitarbeiter über den Einsatz der Microsoft Power Platform?
    i. Würden Sie sagen, dass es in dieser Hinsicht Unterschiede zwischen IT-Mitarbeitern und Nicht-IT Mitarbeitern gibt?
j. Testen Sie neue Ideen und Konzepte auf der Microsoft Power Platform im Vorfeld in Form von Kleingruppen mit unterschiedlichen Teilnehmern durch Prototypen?
    i. Würden Sie sagen, dass die Anwendungsentwicklung mit der Power Platform viel Trial and Error ist?
k. Wie würden Sie den Umgang mit Risiken in Ihrem Unternehmen beschreiben?
    i. Was tun Sie, wenn sich ein auf der Microsoft Power Platform entwickelter Prototyp oder eine Anwendung als unbrauchbar erweist?

Declaration on Oath

Declaration

I hereby confirm that the attached bachelor thesis is my own work and that it has not been used for other examination purposes; I have named all the sources and auxiliary material used, and I have marked appropriately quotations used verbatim or which I have given the gist of. I tolerate the check using anti-plagiarism software.

Ulm, 05.12.2022 _____ _____

Place, Date Signature