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Research Paper

[A comparative analysis of policies supporting digital transformation in SMEs between Germany and South Korea]

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List of Abbreviations

SME	Small and Medium Enterprises
IoT	Internet of Things
AI	Artificial Intelligence
ICT	Information and Communication Technology
R&D	Research and Development
GDP	Gross Domestic Product
EU	European Union
OECD	Organization for Economic Co-operation and Development
BMWi	Federal Ministry for Economic Affairs and Energy, Germany
BMWK	Federal Ministry of Economic Affairs and Climate, Germany
UNIDO	United Nations Industrial Development Organization
EISMEA	European Innovation Council and SMEs Executive Agency
MOTIE	Ministry of Trade, Industry, and Energy, South Korea
KOSMO	Korea SMEs and Startups Agency, South Korea
SMIC	Small and Medium Business Administration, South Korea
MSS	Ministry of Science and ICT, South Korea
HTS	High-Tech Strategy
BMBF	Federal Ministry of Education and Research, Germany

List of Abbreviations

COSME	Competitiveness of Small and Medium-sized Enterprises
EIC	European Innovation Council
EEPA	European Enterprise Promotion Awards
EIF	European Investment Fund
EEN	Enterprise Europe Network
TISiM	Cybersecurity for SMEs Transfer Centre

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Abstract

This study explored the digital transformation pathway of small and medium-sized enterprises (SMEs) and the challenges they face. Through a comprehensive literature review, the research explores the concept of digital transformation, its key elements, and the barriers encountered by SMEs. The findings emphasize the crucial role of government assistance in supporting SMEs through tailored policies and initiatives to their specific needs.

The literature review reveals that digital transformation encompasses not only the adoption of new technologies but also the broader organizational and societal impact. The key elements of digital transformation in businesses include a diverse ecosystem of digital technologies, the revolution of data, and the transformation of business models and organizations. However, SMEs encounter challenges such as a skills gap, technology adoption, change management, and the need for innovative strategies.

Multiple studies have shown that government assistance is crucial in facilitating digital transformation for SMEs. Governments can empower SMEs to overcome barriers and embrace digital transformation by recognizing the specific needs of SMEs and tailoring support programs accordingly. Based on an extensive literature review, this research aimed to address three main questions regarding the

digital transformation in SMEs and the corresponding government policies. Firstly, it sought to compare the implementation of policies supporting digital transformation in SMEs between Germany, the EU, and South Korea. Secondly, it aimed to examine the disparities between how the South Korean government promotes digital transformation in SMEs and the barriers perceived by these businesses. Lastly, the research aimed to provide recommendations for businesses and policymakers in South Korea based on a policy analysis and survey conducted among SMEs.

To address these questions, a mixed research methodology was utilized, combining a comparative policy analysis and a survey conducted among SMEs. The comparative policy analysis offered valuable insights into the strategies employed by the German government, the EU, and South Korea in their approaches to digital transformation. Simultaneously, the survey provided crucial perspectives from SMEs, shedding light on the barriers they encounter during their digital transformation journeys. By combining these research methods, a comprehensive understanding of government policies and the challenges faced by SMEs was achieved, enabling the formulation of recommendations for policy development and effective support measures.

The findings from policy analysis reveal that all three entities, Germany, the EU, and South Korea, acknowledge the importance of

digital transformation and supporting SMEs. However, South Korea's primary focus lies in the technological aspect, while Germany and the EU adopt a more comprehensive approach. They recognize that digital transformation needs addressing not only technology but also collaborative initiatives, skill development, and education. This broader perspective reflects their understanding that a holistic approach is necessary to foster an environment conducive to successful digital transformation and promote economic growth.

The survey findings indicate a discrepancy between the current policy focus, primarily centered on technological aspects, and the actual views of SMEs. The survey results emphasize the significance of considering the cost-related challenges encountered by SMEs and the need for financial support. Additionally, addressing the lack of expertise and organizational resistance is crucial to align policies with the real needs and priorities of SMEs. These findings underscore the significance of taking into account the specific needs and challenges confronted by SMEs in South Korea when designing policies and initiatives for digital transformation.

Based on these findings, several recommendations are formulated. Policymakers in South Korea should diversify their policy focus into non-technological aspects, increase financial support, emphasize expertise development through training and partnerships, promote collaboration among businesses, academia, and research

institutions, and support initiatives addressing organizational resistance to change. These recommendations can guide businesses and policymakers in South Korea in creating a supportive ecosystem for SMEs, driving their growth and competitiveness in the digital age. By aligning policies with the challenges faced by SMEs, governments can foster an environment that empowers SMEs to successfully embark on their digital transformation process.

Keywords: [Barriers, Challenges, Digital transformation, Government Policies, SMEs]

1. Introduction

Disruptive new technologies have been the driving force for innovations in existing businesses and nowadays the digital transformation has become a buzzword when we talk about business and innovations. Namely, Google, Netflix and Amazon are said to be the most innovative companies during the recent 10 years and all of them are using digital technologies in their core business activities. Digital transformation involves incorporating digital technology across all aspects of the business process, resulting in significant alterations in the company's operations and its ability to provide value to customers. This process goes beyond just the adoption of technology within the organization, encompassing a comprehensive strategy that impacts the entire company, both internally in terms of work processes, and externally with regard to delivering services to the desired customers accessibly and quickly (Bouarrar et al, 2022).

In response to the changing market environment, digital transformation compels companies to transform their business operations and models. Companies that effectively leverage digital transformation opportunities are likely to come out on top in competitive markets, while those that struggle with the associated challenges may become vulnerable targets for digital disruption. Digital transformation is taking place across all industries and affecting each company in a

distinct manner. Nowadays, nearly all aspects of business operations, such as strategy formulation, marketing initiatives, sales, customer and supplier relationship management, and operational processes, fall within the scope of digital transformation (Cho et al, 2021).

Additionally, it could be argued that digital transformation provides manufacturing companies with opportunities to improve productivity and create new value propositions and business models. Bosch is a prime example of a manufacturing enterprise in Germany that has undergone digital transformation through implementing the "Industry 4.0" system, leveraging data analysis and automated learning to enhance the efficiency of the manufacturing processes. (Binz, 2017). The system includes sensors and data analytics tools that help Bosch identify inefficiencies and improve productivity, making it a leader in the field of digital manufacturing. Moreover, there are several instances of companies that have successfully adapted to the digital environment, resulting in relatively higher market value or position, whereas those that have failed to do so are losing their competitive edge. In particular, General Electric (GE) is a multinational conglomerate that has transformed its business through digital technology. The company has implemented digital tools to improve its manufacturing processes, such as 3D printing, and has also launched several digital products, such as its Predix platform for industrial data analytics (Bilgeri et al, 2017).

However, the emergence of these digital business areas not only created a lot of new business opportunities but also threatens the existing businesses regardless of any industry sector. In today's digital business environment, the boundaries between business sectors are weakening and digital enterprises are able to expand into traditional manufacturing industries. This means that existing manufacturing companies are being exposed to higher competition than before the digital era. For instance, Nokia was a major player in the mobile phone industry but failed to adapt to the rise of smartphones and the shift to the digital ecosystem. The company was slow to embrace touchscreens, app stores, and other key features of modern smartphones, which led to declining market share and its acquisition by Microsoft in 2014 (Panigrahi, 2020).

Given the challenges and opportunities posed by digital transformation, large companies are better equipped to adapt and grow their business with sufficient financial and human resources. However, SMEs lack investment funds and professional workforce to deal with new technologies. Additionally, the requirements of SMEs are different from those of large companies, and they are often pessimistic about the advantages of digital transformation. Hence, SMEs need help specifically tailored to their business features and environment, guiding them step by step through the digital transformation process (Muller and Hopf, 2017).

Drawing inspiration from the growing need for SMEs to adapt to the digital age, this paper aims to examine how governments foster digital transformation in SMEs and what SMEs perceive as actual barriers to digital transformation. To clarify the coverage of the research, the research focuses on SMEs in South Korea's manufacturing industry that are facing more challenges than opportunities, in contrast to their counterparts in the digital and service sectors. The research questions that will be addressed in the paper are as follows:

“ How are Germany and the EU implementing policies to support the digital transformation in SMEs, compared to South Korea? ”

“ What is the difference between the ways the South Korean government promotes digital transformation in SMEs and the barriers to digital transformation that they perceive? ”

“ What recommendations should the researcher make for businesses and policymakers in South Korea, based on the policy analysis and survey outcome of SMEs? ”

To address these questions, the paper will employ two methods: (1) a comparative policy analysis of the EU, Germany, and South Korea, and (2) a survey of 100 SMEs in South Korea.

Firstly, to answer the first question, the paper will perform a comparative policy analysis. It will look at how digital transformation in SMEs is supported within the respective countries of the EU, Germany, and South Korea.

(i) European Commission and European Agency for Small and Medium-sized Enterprises (EISMEA): To fully understand how the European Union (EU) and its member states are supporting digital transformation in SMEs, it's essential to have a more comprehensive view. By examining the SME policies of EISMEA, we can gain valuable insights into the digital transformation strategies being used by various EU member states.

(ii) Germany: This paper suggests that Germany is a model to look to, due to its robust economy - ranking fourth in global GDP in 2022 - and thriving SME sector, which comprises over 90% of all businesses in the country and provides over 80% of training and employment opportunities (BMWi, 2019). A strong SME sector is essential for a healthy economy and represents the diversity of the business ecosystem as a whole. Therefore, the policies and practices implemented by Germany to foster digital transformation in its SMEs serve as an ideal comparative counterpart or benchmark for South Korea to follow.

(iii) South Korea: this study aims to compare the strategies used by the EU and Germany with those of South Korea to analyze, interpret implications and identify key findings for South Korea.

Secondly, the second question focuses on understanding the difference between how the South Korean government promotes digital transformation in SMEs and the perceived barriers to digital transformation. To answer this question, the study will conduct a survey of 100 SMEs in South Korea. The survey will gather feedback and insights from the SMEs themselves about their experiences with digital transformation, including their concerns and needs. This approach will provide a precise representation of the present condition of digital transformation in South Korean SMEs.

Thirdly, based on the findings from the above two approaches, the paper will develop recommendations for policymakers, business owners, and other stakeholders in South Korea who aim to promote successful digital transformation of SMEs. To achieve this, the study employs a mixed-methods approach that includes gathering feedback directly from SMEs. By doing this, the study will generate insights and strategies that are tailored to the specific challenges faced by SMEs in South Korea. Overall, the recommendations will be based on the findings gathered from the two approaches used in the study.

In summary, this paper starts by introducing the concept of digital transformation, discusses what opportunities and challenges exist for the companies of all sectors and sizes, and then narrows its focus to the SMEs in the manufacturing sector to examine the specific barriers to digital transformation. As part of the research methodology, authoritative primary sources, such as government initiatives to support the digital transformation in SMEs in the EU, Germany and South Korea will be analyzed and compared, which are accessible on the official websites of such organizations. Additionally, a survey of 100 SMEs will be conducted to identify their real concerns and needs. The purpose of this research is to compare policy objectives to the real obstacles encountered by SMEs, with the findings based on the comparison of the policy analysis and survey outcomes, and provide recommendations for the businesses and policymakers in South Korea.

The rest of this paper is organized as follows. Section 2 presents a comprehensive examination of the concept of digital transformation through a literature review, including its definition, scope, and potential benefits for companies. Then it narrows the focus to the specific challenges faced by SMEs in the manufacturing sector as they undergo digital transformation. It also presents the overview of governmental efforts to foster digital transformation. Section 3 discusses the research methodology that will be used to analyze government policies and survey of SMEs. Section 4 provides the findings of the policy analysis

and survey and compares policy objectives to real obstacles encountered by SMEs. Finally, Section 5 offers recommendations for businesses and policymakers in South Korea based on the findings.

2. Literature Review

2.1 Definition of Digital Transformation

Digital transformation, connected products and services, and the shortening of innovation cycles are topics that are widely discussed in management practice and theory. These concepts have transformed the global economy and played a significant role in shaping business models across all industries (Schallmo et al, 2017). This literature review explores the definitions of digital transformation, the elements of digital technology ecosystem and the global technical trends, examines the challenges and opportunities faced by SMEs in implementing digital transformation, discusses barriers that hinder the application of digital transformation in SMEs, and examines policies proposed by the European Union, Germany, and South Korea to support SMEs in innovating their businesses in the digital era.

While digital transformation has been widely studied recently, there remains ambiguity around the definition, approach, and challenges, particularly within the manufacturing sector (Vial, 2019). Gong and Ribiere (2021) noted that there are various definitions or descriptions of digital transformation, bringing about a buzzword prevalent in academic and practitioner literature. To comprehend the

concept, it is essential to first explore the evolution of the "Digital Transformation” concept.

According to the definitions provided by the OECD (2019), there are several overlapping terms used to describe digital innovation—digitization, digitalization, and digital transformation—specifically in relation to supporting digital transformation initiatives in enterprises.

(i) Digitization: Converting analog data and processes into a format readable by machines. It lays the foundation for digital transformation in SMEs by improving data accessibility and enabling the use of digital tools.

(ii) Digitalization: Utilizing digital technologies, data, and interconnection to drive new or modified activities. SMEs can optimize processes, enhance productivity, and improve customer experiences through digitalization.

(iii) Digital transformation: Involving the comprehensive integration of digitization and digitalization, encompassing the economic and societal aspects. SMEs undergo a strategic reshaping of their processes, culture, and customer interactions to leverage digital technologies and generate new value. It takes a holistic approach to innovation and change, taking into account not just the technical

aspects of digitization and digitalisation but also the wider social, economic, and environmental implications of technology, and can happen in either incremental or disruptive ways driven by digital technology (Boulton, 2020).

Table 1. Understanding digital transformation

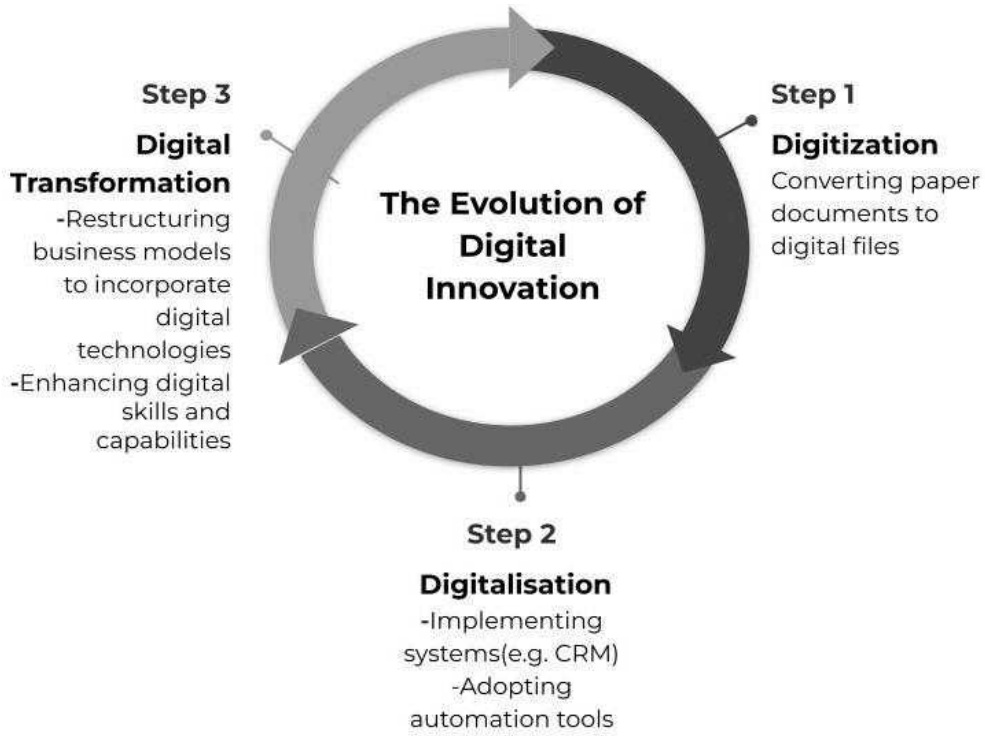
Terms	Digitization	Digitalisation	Digital Transformation
Definition	Transforming analog data and processes into a format interpretable by machines	Utilization of digital technologies and data for new or modified activities	Strategic reshaping of processes, culture and customer interactions to leverage digital technologies and create new value

Source: *OECD (2019), Going Digital: Shaping Policies, Improving Lives*

Although these three terms may appear similar, they represent different aspects of the digital world that are important to understand when implementing technology in various areas of life. Recognizing the distinctions and connections between digitisation, digitalisation, and digital transformation is vital for businesses and individuals to create effective digital strategies.

As shown above, the evolution of digital innovation, from digitization to digitalisation and digital transformation, has brought about significant changes in various aspects of business. For example, digitization has enabled the conversion of paper documents into digital files, making information more accessible and facilitating easier collaboration. On the other hand, digitalization has revolutionized customer engagement by implementing customer relationship management (CRM) systems, streamlining interactions and improving overall customer experience. However, the true power lies in digital transformation, which encompasses a holistic reshaping of processes, culture, and customer interactions. This includes restructuring business models to incorporate digital technologies and enhancing digital skills and capabilities to adapt to the digital era (Barann et al, 2019). Through digital transformation, businesses can leverage the full potential of digital innovation to create new value propositions, drive innovation, and stay competitive in a rapidly evolving digital landscape.

Figure 1. The evolution of digital innovation, and examples of supportive initiatives



Source: *Image created by the author, based on the article titled "supporting digital transformation in SMEs: a procedure model involving publicly funded support units" (Barann et al, 2019)'*

Additionally, other researchers have developed similar terms that indicate the accelerated digital transformation of organizations. According to Ismail et al (2018), Exponential Transformation (ExT) is based on the concept of exponential organizations and their growth, which refers to the rapid and compounded increase in capabilities, impact, and value that is made possible by digital technologies including artificial intelligence(AI), big data, automation, and others. These

technologies have the possibility to disrupt traditional business models, create new opportunities, and accelerate innovation at an unprecedented pace. Exponential organizations (ExOs) are organizations that leverage digital technologies and business models to achieve rapid and exponential growth. They are characterized by their ability to scale at an unprecedented rate, often disrupting traditional industries and business models.

The implementation of ExOs encompasses technological, human and organizational aspect, involving several key elements, including embracing disruptive technologies including AI, big data, and automation, leveraging external resources through crowdsourcing, open innovation, and collaborative platforms, fostering a culture of experimentation, agility, and continuous learning, and implementing organizational structures that are agile, decentralized, and adaptable to changing market dynamics. Monitoring the implementation of ExOs requires a proactive approach to track progress, measure outcomes, and make data-driven decisions to optimize the organization's growth and success in a rapidly changing business landscape (Díaz-Piloneta et al, 2021). ExO and ExT offer a holistic approach that combines cultural, process, and growth-oriented strategies to tackle the challenges of the Fourth Industrial Revolution and drive transformative change within organizations (Derchi, 2021).

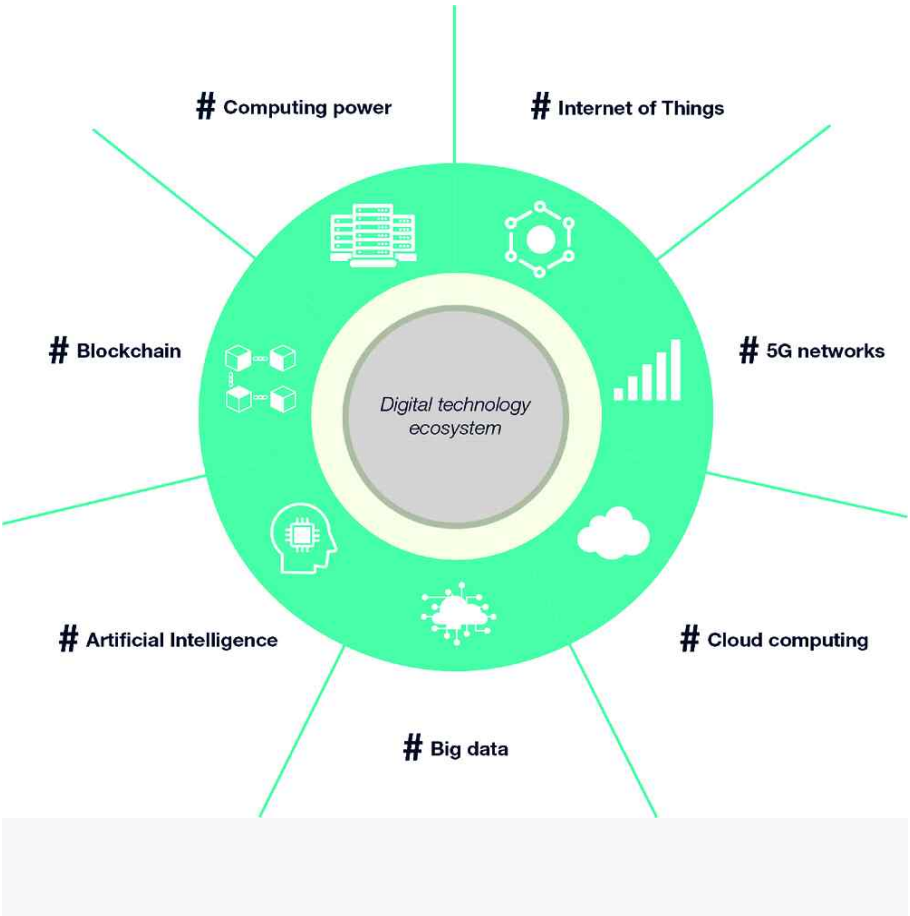
2.2 Elements of Digital Transformation

To better comprehend the concept of digital transformation and its evolution from digitization and digitalization, it is crucial to consider three key elements: (i) an ecosystem of digital technologies, (ii) the data revolution, and (iii) the business and organizational aspects. These elements must be considered for businesses and policymakers to effectively adopt strategies and policies for an effective digital transformation, as highlighted in a report by the OECD in 2019.

First of all, it is crucial to clearly understand an ecosystem of digital technologies, and recognize the potential opportunities and challenges that can arise from their implementation. There are seven major components of digital technologies that underpin the digital transformation, as visualized in Figure 1. An ecosystem of digital technologies is an interconnected and robust system that surpasses the capabilities of its individual components. The synergy among these components create new opportunities that were previously unimaginable. A few of these technologies are already ingrained in our daily lives, while others are still undergoing development. All of these technologies have the potential to contribute to the growth and well-being of businesses and society, and their benefits are worth exploring. Combining different technologies can present unique opportunities and challenges, and the greatest potential often lies in

integrating them within a single digital technology ecosystem (Kim et al, 2021). An example of this is how cloud computing relies on reliable, fast internet connection speed, which is very important for big data analysis (Al-Ruithe et al, 2018). Similarly, the billions of devices and sensors that make up the Internet of Things(IoT) generate vast amounts of data that is to be used to inform sophisticated algorithms and machine learning, which in turn enable the use of AI in various fields and can transform AI into a valuable resource (Liu et al, 2021). Ignat (2017) also highlights the increasing importance of digital technologies including AI, IoT, big data analytics, and cloud computing in various industries and emphasizes the transformative power of digitalization and the need for businesses to embrace it in order to succeed in the current global economy.

Figure 2. “An ecosystem of interdependent digital technologies”



Source: *OECD (2019), Going Digital: Shaping Policies, Improving Lives*

Second, it is also vital to comprehend the ongoing data revolution and how it impacts individuals, the economy, and society overall through data and data flows. The digital technology ecosystem heavily relies on data, which have become an essential foundation for digital transformation and a valuable resource for decision-making and production. Big data plays a crucial role in enabling digital transformation and the development of sustainable societies. Pappas et

al (2018) noted that by gathering data from various sources, sharing it with different stakeholders, and analyzing it in various ways, we can accomplish digital transformation and promote sustainable development.

Lastly but not least, other than the technological aspects previously examined, there are properties of digital transformation that transcend the technologies, such as how they are influencing the development of new business models (Kotarba, 2018, Schallmo et al, 2017) and the implications for public policy (Kim et al, 2021). Bleicher and Stanley (2019) highlights the importance of digitalization in driving innovation in business models and argues that companies must adopt digital technologies to stay competitive and create new value for customers. It also emphasizes the need for companies to have a culture of innovation and agility in order to successfully implement new business models. Digital innovation causes disruptive changes in the entire business processes and can be discussed on three levels: digitalizing the operating model and optimizing processes, digitally rethinking business models by leveraging digital technologies to adapt, improve or extend the existing business models, and creating a completely new digital business model. It is not only a tool for improving existing business models, but also a catalyst for creating new ones that can transform entire industries. Therefore, digital transformation is not just about adopting technologies, but also about changing how an organization operates (Barann et al, 2019).

2.3 Barriers to Digital Transformation in SMEs

Given that digital transformation is a complicated process that needs careful planning, execution, and continuous learning and adaptation to stay ahead of the curve, it is crucial to develop a thorough strategy that aligns with organizational goals, invest in the right technologies and tools, prioritize employee training and skills development, foster a culture of innovation, and measure progress (Gurbaxani and Dunkle, 2019). Digital transformation has become an essential aspect of recent business operations, with enterprises of all sizes looking to capitalize on the opportunities offered by technology. However, while larger companies may have the resources and expertise needed to adapt to the barriers and opportunities faced by digital transformation, SMEs may struggle to recognize beneficial projects for digital transformation and navigate the challenges that come with it (Eller et al, 2020). To address this issue, SMEs need special guidance that is different from larger companies and tailored to their peculiar business environment and requirements (Barann et al, 2019; Herberle et al, 2017).

In light of these specific challenges and struggle of SMEs, this study narrowed down the focus to SMEs, especially in the manufacturing sector in South Korea, based on the following backgrounds: (1) Due to the fact that digital transformation shares

similarities with Industry 4.0 and smart factories, the manufacturing sector is often considered a key area to study in order to better understand digital transformation (Savastano et al, 2019; Vogelsang et al 2018) and (2) South Korea is a top innovative digital economy globally, having been ranked first in 2020 and third in 2019 in the "National Industrial Digitalization Ranking" by BloombergNEF (2020). This ranking is determined by assessing a country's national policies and initiatives, and Korea was particularly recognized for prioritizing digital transformation through the Smart Manufacturing Promotion Strategy and the Korean New Deal Policy (Kim et al, 2021).

Multiple authors have discussed the challenges faced by SMEs in the manufacturing sector. According to recent research (Abdallah, 2021), the key challenges of the digital transformation process fall into four categories: "(i) Skills Gap, (ii) Adoption of New Technologies, (iii) Change Management Process, and (iv) Innovation Strategies and Procedures".

To begin with, the manufacturing industry is facing a skills gap in terms of digital transformation, as organizations lack the necessary digital skills to follow the rapidly evolving digital world (El Hamdi et al., 2020; Horvath et al., 2018). Studies have shown a significant skills gap between what is necessary and what is available (Peillon & Dubruc, 2019), and companies often do not invest enough in training and development. Furthermore, workers fear that technology will replace

their jobs, making them resistant to digital transformation (Heavin & Power, 2018).

Next, SMEs in the manufacturing industry face challenges when adopting new technologies, including the need for an innovation culture (Ananyin et al, 2018) that is willing to take risks and make long-term investments, because they are, in general, conservative. They generally invest in low risk and short term projects due to lack of resources, and little investment in new technologies (Cozmiuc & Petrisor, 2018). In addition to this, cyber attacks pose a significant threat to businesses in the digital world, and these attacks are constantly evolving (Heikkila et al., 2016). The cost of converting data from old systems to new systems is also a challenge (Castelo-Branco et al., 2019), as old systems become outdated and require significant investments to update or replace. Manufacturing firms must weigh the costs and benefits of updating their old systems versus investing in new technologies.

Third, digital transformation involves incorporating disruptive technologies (Hausberg et al., 2019), which can be difficult to apply and use in practice. One of the most complex obstacles faced by manufacturing companies in this process is restructuring the organization (Heavin & Power, 2018). However, restructuring any organization is a challenging and demanding process that needs significant effort to overcome resistance to change from employees (El Hamdi et al., 2020). This resistance stems from the fact that current

employees are accustomed to working with old systems and structures, and may not be willing to leave their safe space (Kunii & Hasegawa, 2019). Therefore, managing the change process is important to change the existing situation, and implement the necessary modifications.

Fourth, innovation plays a crucial role for successful digital transformation initiatives in the manufacturing sector. However, many organizations lack a clear innovation strategy, as pointed out by Tokody (2018). Vogelsang et al (2019a) identified the barriers that hinder the implementation of digital transformation in the manufacturing industry. The barriers include a lack of knowledge about digital technology, resistance to change, inadequate infrastructure, difficulty in integrating new technologies into existing systems, lack of data quality and security, and insufficient funding. It also emphasizes the importance of addressing these barriers and implementing strategies to overcome these obstacles through education and training programs, collaboration and partnerships, and investment in research and development.

In addition to the four categories mentioned earlier, the barriers can be grouped into more intuitive and easily understood categories: (i) technological, (ii) human, and (iii) organizational factors, based on multiple sources. Muller and Hoft (2017) stated that for the successful digital transformation, human and organizational aspects need to be considered as well as the technological aspect and all these three aspects should be analyzed and integrated into the digital

transformation roadmap of companies. There is a view among researchers that either technological factors, such as lack of technology and security measures, or the human factor, like unskilled workforce, are the primary barrier to the successful digital transformation of SMEs (Rupeika-Apoga et al, 2022). Also, Toytari et al. (2017) found that changing people's mindsets and beliefs can be the most challenging, while Vogelsang et al. (2019) emphasized the importance of people's IT capabilities.

2.4 The significance of government assistance in facilitating the digital transformation of SMEs

As mentioned previously, there has been extensive research conducted on the challenges that SMEs encounter in the process of digital transformation. However, we don't know much about what kind of support SMEs require to overcome these challenges. In a recent study by Rupeika-Apoga et al (2022), various types of public support were identified, that can help SMEs address the barriers to digital transformation: *"upgrading skills, upgrading safety, expanding the potential workforce, conducting in-house research, mentoring, reduced taxes and fees, and direct public financial support"*. To obtain a comprehensive understanding of the actual requirements of SMEs, it is necessary to review other studies that examine the governmental role to support digital transformation among SMEs.

Chen et al. (2021) identified four crucial roles that governments can play in facilitating the digital transformation in SMEs: (i) applying digital tools, (ii) mobile/digital payment system(specific to small service businesses), (iii) training and education for digital capability of employees, and (iv) collaborative ecosystem with . Firstly, SMEs often face challenges due to insufficient funding and lack of digital expertise to develop their own digital platforms. They may not have the financial means to outsource these services from external providers. In such cases, governments can provide support in building their own digital platforms to facilitate their digital transformation. These platforms can enable SMEs to digitize their operations both internally and externally. Governments can also promote the adoption of diverse digital tools among SMEs.

The following role of the government to support digital transformation is to promote the use of mobile and digital payment systems, particularly among small service businesses, as these businesses often face unique challenges in developing and implementing such systems. Digital payment systems are crucial in the digital business ecosystem, but often require a certain scale of merchants and customers to be viable. Large companies like Alibaba with Alipay have the resources to drive adoption and reach the necessary scale. However, small service businesses lack these resources and cannot create a business ecosystem for digital payments

on their own. Therefore, they require government assistance in creating a mobile or digital payment system, developing the business ecosystem, and promoting its use. Additionally, small businesses need government support in integrating websites and payment systems to enhance convenience for customers and improve transaction intentions. The government also plays a role in promoting safety regulations, establishing digital transaction regulations, and enforcing security standards and certification for digital payments. Conducting security certification and implementing safety measures will build trust and confidence among customers, leading to increased transaction volume.

Moreover, the government can assist SMEs in enhancing their digital capability by providing training or education to the workforce. Digital training can increase the digital knowledge and improve their organization's digital capability. Digital capability is crucial for successful digital transformation and adequate knowledge of digital technologies will enable SMEs to develop a digital vision and drive digital innovation, which is essential for the development of new digital products. The government can support them in developing a digital learning and training system to train their employees. This system could reduce the cost of hiring and training new employees.

The ultimate way in which the government can assist SMEs is by supporting the creation of a collaborative ecosystem that facilitates networking and collaboration with other companies. Collaborative

systems are beneficial to SMEs as they help to build connections and foster collaborative innovation. Through collaboration, SMEs can overcome challenges such as limited resources, lack of manpower, and knowledge gaps.

2.5 An overview of the measures taken by governments to promote the digital transformation of SMEs

The European Union (EU) emphasizes securing and enhancing the competitiveness of businesses through digital transformation, fostering market inclusiveness for SMEs and startups, as well as reducing regional disparities in digital transformation and economic strength. In light of this, the EU aims for an integrated and balanced approach to digital transformation. This direction is reflected in the Digital Single Market Strategy initiated by the EU as part of the Europe 2020 Project in 2015, as well as in the strategic goals and directions for industrial digitization in the European Union's Digitising European Industry initiative in 2016 (Hallward-Driemeier et al, 2020).

Kalpaka et al (2020) highlighted the importance of Digital Innovation Hubs of the EU as policy instruments to foster digitalisation of SMEs. It is a one-stop service center aimed at increasing accessibility to relevant technologies in the pre-investment experimentation phase for businesses, particularly SMEs, in order to enhance their competitiveness in terms of business, production

processes, and products/services in the context of the comprehensive digital transformation in Europe. Its main services include providing new digital technology demonstration facilities that encompass software and hardware, digital technology education such as bootcamps and training, investment matchmaking services and networking services through connections with incubation and acceleration programs.

Germany has been at the forefront of driving a manufacturing-focused digital transformation strategy since it introduced the Industry 4.0 initiative in 2011. It aims to establish a global manufacturing ecosystem led by Germany, enhancing the competitiveness of domestic companies and promoting global standards through this initiative. SMEs play a significant role in the German economy, and recognizing the importance of this in the context of the Industry 4.0 ecosystem strategy, policy efforts such as Mittelstand 4.0 are being made to promote the digital transformation of SMEs. Germany emphasizes SMEs because in the era of the Fourth Industrial Revolution, which focuses on the ecosystem strategy rather than individual company units, there is a concern that if the SME sector, which plays a significant role in the national economy in terms of its contribution and proportion, does not properly respond, it may lag behind in the overall industrial digital transformation (Cho et al, 2021)

The South Korean government has implemented various policies to foster digital transformation in SMEs. In 2014, taking reference from

Germany's Industry 4.0 initiative, the government pursued the "Manufacturing Innovation 3.0 Strategy" with the goal of promoting smart factories, targeting 10,000 smart factories in SMEs. In March 2018, the government launched the "Smart Factory Expansion and Enhancement Strategy" to transform about 20,000 manufacturing SMEs into smart factories. Subsequently in December 2018, the "SMEs Smart Manufacturing Innovation Strategy" was introduced to complement existing policies and address improvement tasks based on on-site feedback. The strategies aim to increase government support, improve coordination, and foster people-centered workplaces. The policies also aim to spread the benefits of smart factories throughout the manufacturing industry and ensure tangible benefits for workers through workplace innovation (Oah and Kim, 2021).

3. Methods

In today's rapidly evolving digital landscape, governments worldwide are increasingly recognizing the importance of digital transformation in SMEs for economic growth, competitiveness, and innovation. This study seeks to investigate how governments foster digital transformation in SMEs and identify the barriers perceived by these businesses. Specifically, the research focuses on comparing the approaches of Germany, the EU, and South Korea in implementing policies to support digital transformation in SMEs. Furthermore, the study aims to understand the differences between the strategies employed by the South Korean government to promote digital transformation in SMEs and the obstacles perceived by these businesses. The final purpose of this study is to develop recommendations for policymakers in South Korea in ways to promote the digital transformation in SMEs.

3.1 Research Setting

To address the research questions, the study employs two main research methods: (i)a comparative policy analysis and (ii)a survey of over 100 SMEs in South Korea.

The comparative policy analysis involves examining policy documents and related information from Germany, the EU, and South Korea. The researcher conducted searches on Google and retrieved relevant documents and information from official government websites such as BMWi (Federal Ministry for Economic Affairs and Energy) and BMWK (Federal Ministry of Transport and Digital Infrastructure) in Germany, UNIDO (United Nations Industrial Development Organization), EISMEA (European Innovation Council and SMEs Executive Agency), MOTIE (Ministry of Trade, Industry, and Energy), KOSMO (Korea SMEs and Startups Agency), SMIC (Small and Medium Business Administration), MSS (Ministry of Science and ICT), among others. This analysis allows for a comparison of the policies and initiatives implemented in each region to support digital transformation in SMEs.

The second research methodology involves conducting a survey among SMEs in South Korea. The survey aims to gather additional insights and perspectives from these businesses regarding digital transformation and the barriers they perceive. The researcher likely designed a questionnaire and distributed it on Google Forms to over 100 SMEs in South Korea from 8 to 26 May, 2023 for the duration of three weeks. Total 105 responses were collected, which served as valuable data on the challenges faced by SMEs in adopting digital transformation, their awareness of government policies, and their perspectives on potential improvements.

Finally, based on the findings from the policy analysis and survey outcomes, the study will provide recommendations for businesses and policymakers in South Korea. These recommendations are expected to offer insights on how SMEs can overcome barriers to digital transformation and how policymakers can improve their support for these businesses in their digital transformation efforts.

3.2 Research Method(I): A Comparative Policy Analysis

A comparative policy analysis was conducted to compare the policies among South Korea, Germany and the EU. This analysis aimed to identify similarities and differences of the policies deployed by these entities and thereby draw meaningful recommendations for the South Korean policymakers about effective approaches for fostering digital transformation in SMEs.

3.2.1 Data Analysis

The comparative policy analysis employed a qualitative content analysis on policy documents and government website information. The objective was to identify commonalities and distinctions among Germany, the EU, and South Korea. The process of content analysis involved carefully reviewing and analyzing the policy documents and government website information, extracting relevant information, and

categorizing it based on themes and patterns. This approach provided findings necessary to draw recommendations for the South Korean policymakers.

3.2.2 Data Sources: Policies Under Comparison

1) Germany’s Policies

The policies, implemented in Germany, serve as a comparative benchmark for the South Korean government because Germany has a very strong SME sector and has developed strategies and policies specific to SMEs for a longer period than any other country. In this sense, a strong SME sector in Germany makes it an ideal comparative counterpart or benchmark for South Korean policymakers. Also, the selection of Germany as the comparative benchmark was based on its relevance, similar objectives, and potential to offer meaningful information into digital transformation support for SMEs. Through the literature review, the study gained a basic understanding of Industry 4.0 and Mittelstand 4.0, which represent Germany's policies to promote digital transformation and SMEs, respectively.

For this analysis, the research identified and reviewed nine relevant documents and information officially released by “the Federal Ministry of Education and Research(BMBF), the Federal Ministry of

Economic Affairs and Energy (BMWi) and the Federal Ministry of Economic Affairs and Climate Change (BMWK)" as follows:

Policy documents

- BMBF (2006): High-Tech Strategy
- BMWi (2014): SMEs-Digital: ICT-Application in the Business.
- BMWi (2015): Promotion Initiative Mittelstand 4.0 - Digital Production and Work Processes.
- BMWi (2016): Digital Strategy 2025
- BMWi (2019a): SMEs Digital Strategies for the digital transformation.
- BMWi (2019b): The German SME Strategy.

Government website information

- BMWK (n.d.): "The German Mittelstand as a mode for success"
- BMWK (n.d.): Industry 4.0.
- BMWK (2021): What is Mittelstand-Digital?

Based on the provided information and relevant literature, an analysis was conducted to establish a foundational understanding of the commonalities and differences in the approaches of Germany, the EU, and South Korea towards digital transformation and SME support. The primary objective was to draw meaningful implications for the South Korean government based on these findings.

1-1) “Industry 4.0 / Platform Industry 4.0”:

The policy analysis focused on the examination of policy documents and relevant literature, specifically exploring Germany's Industry 4.0 and Platform Industry 4.0 initiatives. Industry 4.0 refers to “the fourth industrial revolution characterized by the integration of advanced technologies” to enhance competitiveness and innovation in the manufacturing sector (BMWK, n.d.). Germany has been at the forefront of promoting Industry 4.0, with a strong focus on automation, digitization, and the development of smart factories.

The study considered the evolution of German policies, starting with the "High-Tech Strategy" (HTS) initiated in 2006 by the Federal Ministry of Education and Research (BMBF) (UNIDO, 2018). The HTS aimed to establish Germany as a global research and innovation hub, addressing key areas such as “climate and energy, health and food, mobility, security, and communication”. In 2011, the term "Industry 4.0" was introduced publicly at the Hannover Trade Fair by the "Promotion Group: Communication" as a way to identify future projects (UNIDO, 2018).

Germany's commitment to Industry 4.0 has been demonstrated through substantial investments in research and development, deployment of advanced technologies, and the establishment of a national platform called Platform Industrie 4.0. This platform serves as a

coordination mechanism and promotes collaboration among stakeholders (BMWK, n.d.). Key technologies involved in German Industry 4.0 include the IoT, big data analysis, AI, robotics, and 3D printing. These technologies enable the creation of highly connected and automated smart factories with streamlined data collection, analysis, and the decision-making process (BMWK, n.d.).

Throughout the policy analysis, the focus was on identifying the strategies, initiatives, and support mechanisms employed by the German government to drive digital transformation in SMEs and advance the manufacturing sector. The analysis considered funding for research and development, tax incentives, and the establishment of coordination platforms as key elements of Germany's policy framework. While examining Germany's policies and initiatives, the study strived to present valuable findings and lessons that can inform the South Korean government's approach to digital transformation promotion in SMEs. The findings of the analysis will be presented and interpreted in the subsequent section, contributing to the overall understanding of effective strategies for fostering digital transformation in SMEs.

1-2) Mittelstand 4.0 and Mittelstand Digital:

In this analysis, the focus extends beyond Germany's Industry 4.0 to explore the initiatives and support mechanisms specifically directed towards SMEs, which is translated into Mittelstand in German.

Mittelstand refers to SMEs, which play a significant role in the German economy, employing around two-thirds of the country's workforce (BMWK, n.d.).

Mittelstand 4.0 initiative is to help SMEs adopt and integrate Industry 4.0 technologies into their businesses. It recognizes the challenges faced by SMEs in adopting new technologies and digital transformation, such as limited financial resources, lack of expertise, digital infrastructure gaps, data security concerns, and shortage of skilled workers. To address these challenges, the German government has established initiatives and funding programs aimed at supporting SMEs to adopt technologies used in Industry 4.0 (BMWK, n.d.). The Mittelstand 4.0 initiative aims to assist SMEs in staying competitive in the increasingly digital and globalized economy by enabling them to benefit from the advantages offered by Industry 4.0, such as increased efficiency, flexibility, and innovation. The success of the Mittelstand, driven by SMEs, is pivotal to the overall success of the German economy (BMWK, n.d.). As part of this initiative, “Mittelstand 4.0 Competence Centers and Agencies” have been established throughout Germany. Currently, there are 26 locations of Mittelstand 4.0 Competence Centers providing practical guidance and support for SMEs’ digital transformation (BMWK, n.d.).

Additionally, the German government has implemented the Mittelstand Digital initiative to actively support the digital transformation

of SMEs. A report published by BMWi (2019) outlines digital strategies that can facilitate successful digital transformation in SMEs. These strategies include developing a digital roadmap, investing in digital infrastructure, fostering digital skills and culture, utilizing data analytics, and embracing digital business models. The aim of these strategies is to help SMEs remain competitive in a rapidly evolving digital landscape by guiding them to analyze their current digital capabilities, invest in digital infrastructure, develop digital skills among employees, leverage data analytics for informed decision-making, and explore new digital business models to expand revenue and reach new customers. Within the Mittelstand Digital framework, three pillars have been established: Mittelstand-Digital Innovation Hubs, Digital Now investment grant program, and the Cybersecurity for SMEs Initiative with the Cybersecurity for SMEs Transfer Centre (TISiM) (BMWK, 2021). The nationwide network of Mittelstand-Digital Innovation Hubs provides expert knowledge, workshops, training, networking, and information events related to digitalization, supporting SMEs and skilled crafts throughout Germany. The Digital Now initiative offers financial support for digital technology and skills investments. The Cybersecurity for SMEs Initiative offers tailored services to enhance IT security, including a dedicated point of contact and support to improve cybersecurity practices for SMEs. Importantly, all of these services are provided free of charge (BMWK, 2021).

Through the comprehensive examination of the Mittelstand 4.0 and Mittelstand Digital initiatives, this policy analysis seeks to uncover fundamental understandings regarding the strategies and support mechanisms utilized by the German government in driving digital transformation among SMEs. The findings obtained from this analysis will then be used to conduct a comparative assessment with the digital transformation promotion policy of the South Korean government, ultimately enabling a deeper understanding of effective approaches for fostering digital transformation within the SME sector.

2) European Union(EU)'s Policies

The EU has recognized the importance of digital transformation and have formulated comprehensive strategies to drive innovation and support SMEs through "the European Commission, and European Innovation Council and Small and Medium-sized Enterprises Agency (EISMEA)". To obtain a comprehensive understanding of how the EU supports SMEs in achieving digital transformation and overcoming barriers, the study retrieved relevant policy documents and information from the official websites of "the European Commission and the EISMEA". These sources provided the policies, programs, and initiatives implemented by the EU to foster digital transformation of SMEs.

First, the research identified and examined a recent policy document announced by the European Commission:

- European Commission,(2021): “2030 Digital Compass, the European way for the Digital Decade”**.**

It includes the strategies, programs, and initiatives for supporting businesses in their digital transformation process, emphasizing the importance of skills and education, infrastructure, innovation and entrepreneurship, and digitization of public services. This data allowed for a broad understanding about the EU's priorities and approaches to foster digital transformation in businesses and society.

Second, the information on the EISMEA website contained more detailed information about the programs specifically tailored to support SMEs. The following programs provided meaningful data for comparison with the other entities:

- Competitiveness of Small and Medium-sized Enterprises (COSME)
- European Innovation Council (EIC)
- European Enterprise Promotion Awards (EEPA)
- European Investment Fund (EIF)
- Enterprise Europe Network (EEN)
- Single Market Program

- Horizon Europe program
- European Green Deal
- Digital Europe Program

2-1) “2030 Digital Compass: the European way for the Digital Decade, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions”.

Examining the European Commission's policies within the context of Germany's membership in the EU will contribute to a comprehensive understanding of the strategies and approaches employed by both Germany and other EU member states to promote innovation and facilitate digital transformation among businesses and society. The European Commission (2021) has outlined ambitious goals and strategies for Europe's digital transformation by 2030. It emphasizes four key areas that Europe should prioritize to build an inclusive, sustainable, and prosperous digital future.

(i) The first area focuses on skills and education, emphasizing the necessity of investing in digital skills and education to ensure that all Europeans are equipped with the knowledge and competencies needed to thrive in the digital economy. This includes initiatives to promote digital literacy, provide skills training, and encourage the participation of women and underrepresented groups in technology-related careers.

(ii) The second area centers around infrastructure, advocating for the development of a reliable and high-speed digital infrastructure capable of meeting the growing demand for digital services across Europe. This includes investments in next-generation networks, such as 5G, and efforts to improve broadband coverage and connectivity in rural areas.

(iii) The third area emphasizes the importance of promoting innovation and entrepreneurship in the digital economy, particularly in emerging technologies including AI, blockchain, and quantum computing. This involves supporting startups and SMEs, as well as strengthening Europe's position as a global leader in digital transformation.

(iv) The fourth and final area highlights the digitization of public services to enhance accessibility, efficiency, and responsiveness to citizens' needs. This includes initiatives to integrate digital technologies into healthcare, education, and government services, as well as ensuring user-centric design principles in the delivery of public services.

This policy serves as a clear roadmap for policymakers, businesses, and citizens in the EU to collaborate in building an inclusive, sustainable, and prosperous digital future for Europe.

2-2) EISMEA Programme:

The European Commission implements SME policies through the EISMEA, which is an agency dedicated to supporting and promoting SMEs in the EU. EISMEA implements various programs and initiatives aimed at achieving its objectives. EISMEAs official website provided detailed information on the EISMEA Programme (2021) which is structured around four strategic pillars:

(i) Strengthening entrepreneurship and innovation ecosystem: Under this pillar, “the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME)” program provides SMEs with access to finance, markets, and business support services. Additionally, the European Innovation Council (EIC) offers financing and assistance to creative SMEs and startups, helping them bring their concepts to the market. Furthermore, the European Enterprise Promotion Awards (EEPA) acknowledge and reward the most innovative and successful entrepreneurship support initiatives in Europe.

(ii) Enhancing access to finance and markets: This pillar focuses on improving SMEs' access to finance and markets. The European Investment Fund (EIF) provides financing and guarantees to SMEs through financial intermediaries such as banks and venture capital funds. The Single Market Program facilitates SMEs in accessing new markets and expanding their business within the EU. Moreover, the

Enterprise Europe Network (EEN) offers information and support services to SMEs seeking to engage in cross-border business.

(iii) Facilitating the transition towards a sustainable economy: This pillar seeks to facilitate the transition of SMEs to a sustainable and digital economy. The Horizon Europe program provides funding for research and development projects in fields like sustainable energy, digitalization, and circular economy. The European Green Deal offers funding and support for SMEs to adopt more sustainable business models. Additionally, the Digital Europe Program assists SMEs in adopting and utilizing digital technologies to enhance their competitiveness.

(iv) Supporting the internationalization of SMEs: The fourth strategic pillar focuses on supporting the internationalization of SMEs. The Access2Markets portal provides information and guidance on exporting to countries outside the EU. EU Trade Agreements facilitate access to new markets through trade agreements with countries outside the EU. The Export Helpdesk offers information on tariffs, taxes, and regulations pertaining to the export of goods from the EU.

Reviewing the programs and initiatives implemented by EISMEA under these strategic pillars helped to have a comprehensive understanding of how the EU supports SMEs in achieving innovation and digital transformation.

3) The South Korean Policies

In recent years, the South Korean government has prioritized digital transformation as a key innovator of economic growth and competitiveness. Through various policies and initiatives, South Korea aims to harness technology and innovation to propel its industries forward. The study identified and examined three policy documents and one government agency website information as to promoting digital transformation in SMEs:

Policy documents

- Smart Manufacturing Innovation Strategy
- Korean Digital New Deal Policy
- Smart Manufacturing 2.0 Strategy

Government agency website information

- Korea Smart Manufacturing Office (KOSMO) / Smart Manufacturing Innovation Centers

3-1) Smart Manufacturing Innovation Strategy:

The “Smart Manufacturing Innovation Strategy” is a national initiative by the South Korean government to drive the digital transformation of the manufacturing sector. It aims to establish smart factories that integrate the entire production process using ICT

technology, enabling the production of customized products (MOTIE, 2014). The strategy began with the 'Manufacturing Innovation 3.0 Strategy' in 2014 and later introduced the 'SMEs Smart Manufacturing Innovation Strategy' with a goal to set up 30,000 Smart Factories by 2022 (South Korea Joint Press Release, 2018).

The strategy focuses on three main pillars: building smart manufacturing infrastructure, supporting smart manufacturing technology development, and promoting the smart manufacturing industry. By prioritizing infrastructure development, the government aims to create a robust technological foundation for digital transformation. This includes leveraging technologies like 5G, AI, and big data to enhance efficiency and promote innovation in the manufacturing sector.

To drive innovation, the government emphasizes supporting R&D activities related to smart manufacturing technology. By expanding R&D support and fostering collaboration between industry and research institutions, the strategy aims to accelerate the application of cutting-edge technologies in the manufacturing sector.

Additionally, the strategy aims to make a favorable business environment for the smart manufacturing industry. Efforts to improve investment environments, facilitate global market expansion, and

enhance the competitiveness of companies in this sector are crucial components of the policy.

In short, the Smart Manufacturing Innovation Strategy of the South Korean government is a comprehensive method to promote innovation and efficiency in the manufacturing industry. Through infrastructure development, technology support, and industry promotion, the strategy aims to create an ecosystem that fosters the growth of the smart manufacturing industry in South Korea.

3-2) Korean Digital New Deal Plan:

The Korean government introduced the 'Korean New Deal' in 2020 as a national development strategy to deal with the economic downturn caused by COVID-19. The 'Digital New Deal' is a key component of this strategy, aiming to enhance digital transformation and increase the utilization of data across all industries. Key projects include establishing a national data-based infrastructure, developing an AI-based intelligent national governance system, digitizing educational infrastructure, fostering non-face-to-face industries, and promoting the digitization of social indirect capital like smart healthcare (South Korea Joint Press Release, 2020).

The Digital New Deal policy centers around four pillars: digital infrastructure, digital industry, digital innovation, and digital inclusion.

(i) To build a strong digital infrastructure, the government plans to invest in 5G, AI, and other emerging technologies, expand broadband access, and create a digital data highway.

(ii) The digital industry pillar focuses on supporting the growth of digital businesses and startups through financial assistance, tax incentives, and the establishment of a digital platform for businesses. The aim is to create an environment conducive to the growth of the digital industry.

(iii) To drive digital innovation, the government plans to invest in research and development, including the establishment of a national research institute for AI. Collaboration between industry, academia, and research institutions will be encouraged to foster innovation.

(iv) The digital inclusion pillar aims to bridge the digital divide and ensure that everyone can benefit from digital transformation. The government plans to expand digital education, provide support for digital job training, and establish a universal basic digital income.

In short, the Korean Digital New Deal is a comprehensive plan that recognizes the importance of digital transformation and data utilization for economic growth and societal advancement. Through investments in digital infrastructure, support for digital industries, promotion of digital innovation, and efforts to achieve digital inclusion,

the government aims to position South Korea as a leading digital economy.

3-3) Smart Manufacturing 2.0: Based on AI and Data:

The Ministry of SMEs and Startups (MSS) announced the Smart Manufacturing 2.0 strategy in 2020, which focuses on AI and data-based manufacturing innovation (MSS, 2020). This strategy builds upon the previous promotion of smart factories by transitioning to a more qualitative advancement.

3-4) KOSMO and Smart Manufacturing Innovation Center:

The KOSMO, established in 2019 as part of the Smart Manufacturing Innovation Strategy, plays a vital role in supporting manufacturing innovation R&D and the establishment of 30,000 smart factories by 2022 (KOSMO, 2018). KOSMO operates Smart Manufacturing Innovation Centers in regional Technoparks across the country. These centers provide practical business support programs, including digital transformation initiatives. However, there is currently no dedicated regional center for SMEs, which may limit specialized support for SMEs' digital transformation needs.

The Smart Manufacturing Innovation Center (SMIC) contributes to the digital transformation of manufacturing through R&D of digital

technologies based on standard specifications. SMIC operates a model factory and testbed to showcase achievements and evaluate advanced technologies such as digital twin, AI, specialized 5G networks, and industrial IoT (SMIC, 2023). It also provides testbeds for process automation, core component evaluation systems, and processing-specialized testbeds based on international standard interoperability specifications.

Key technologies in the Smart Manufacturing 2.0 strategy include AI, big data analytics, 3D printing, robotics, and the IoT. These technologies are leveraged for data collection, analysis, optimization of production processes, and product quality inspections.

The strategy not only aims to innovate production processes but also includes various support policies such as personnel training and technology development. Additionally, the government is strengthening cooperation between the government and companies while promoting research and development collaboration among industry, academia, and research institutions.

In short, the Smart Manufacturing 2.0 strategy of the South Korean government focuses on harnessing AI and data to drive manufacturing innovation and enhance the quality of smart factories. By establishing an AI-based Manufacturing Platform, promoting AI-based Smart Factories, and creating a My Manufacturing Data System, the

strategy aims to further advance the digital transformation of the manufacturing sector.

3.3 Research Method(II): Survey among 105 SMEs in South Korea

To understand the difference between the South Korean government's promotion of digital transformation in SMEs and the perceived barriers, a survey was conducted and 105 responses from SMEs in South Korea were gathered. The survey aimed to gather feedback and insights from the SMEs regarding their experiences, concerns, and needs related to digital transformation. This approach provided a representation of the current state of digital transformation in South Korean SMEs.

3.3.1 Data Analysis

The collected data from the survey was analyzed using both quantitative and qualitative methods to gain insights into the differences between the South Korean government's promotion of digital transformation in SMEs and the perceived barriers.

For the quantitative analysis, the multiple-choice and checkbox questions were examined to calculate percentages and frequencies. This analysis provided a quantitative overview of the participants' responses and allowed for comparisons between different options and categories. The analysis included determining the distribution of

respondents across different demographic factors, such as country of work, years of work in SMEs, industry, company size, and department. It also involved assessing the percentage of respondents who selected each option for major business problems, perception of digital transformation, current use of digital technologies, challenges in adopting or using digital technologies, perception of public (government) support, preferred types of public support, participation in digital transformation programs, and satisfaction levels with those programs.

The qualitative analysis focused on the open-ended questions, including the short answer responses and the paragraph suggestion. Thematic analysis was employed to identify common themes, patterns, and insights within the qualitative data. This involved coding and categorizing the responses to extract meaningful information and capture the participants' perspectives, concerns, and suggestions. The qualitative analysis allowed for a deeper understanding of the participants' experiences and provided qualitative evidence to support the quantitative findings.

The quantitative and qualitative findings were integrated to provide a comprehensive analysis of the survey data. The quantitative analysis offered numerical summaries and statistical trends, while the qualitative analysis provided rich descriptions and detailed explanations. By combining these approaches, a holistic understanding of the

similarities, differences, and relationships between the variables under investigation was achieved.

3.3.2 Data Sources

1) Participants

The target audience of this survey specifically consisted of SMEs that are either implementing or interested in digital transformation. The aim was to gather insights and feedback from SMEs in South Korea, focusing on their experiences, challenges, and perceptions related to digital transformation.

To ensure a targeted approach and access to the desired audience, the survey distribution was facilitated with the help of three organizations: the Free Trade Zone Agency, Smart Green Industrial Complex, and Korea IT Business Women's Association. These organizations are based in South Korea and consist of SMEs operating in various sectors.

The involvement of these organizations offered several advantages. Firstly, it provided a means to reach out to a diverse range of SMEs in terms of size and business operations. Since each organization consists of SMEs from different sectors, the survey could capture insights from various industries, including manufacturing, service, and others. This balanced representation allowed for a more

comprehensive understanding of the challenges and perspectives of SMEs involved in digital transformation.

Secondly, the collaboration with these organizations facilitated targeted access to SMEs in South Korea. By leveraging the existing networks and resources of these organizations, the survey could be disseminated directly to SMEs who are actively engaged in or interested in digital transformation initiatives. This approach increased the likelihood of receiving responses from the intended target audience, ensuring the relevance and validity of the data collected.

In short, the involvement of the Free Trade Zone Agency, Smart Green Industrial Complex, and Korea IT Business Women's Association in distributing the survey to their member SMEs in South Korea provided a focused and balanced representation of SMEs implementing or interested in digital transformation. This targeted approach enhanced the survey's effectiveness in gathering valuable insights and perspectives from the specific audience of interest.

2) Questions

The survey consisted of 15 questions and included multiple-choice options, checkboxes, short answer responses, and a linear scale rating. The multiple-choice and checkbox questions allowed for quantitative analysis by providing structured and categorized data that could be analyzed using statistical techniques. The short answer

responses and the open-ended paragraph suggestion provided qualitative data that could be analyzed thematically.

The survey questions were designed to collect data on the demographics, perspectives, challenges, and preferences of SMEs in South Korea regarding digital transformation and government support. The analysis of collected data helped identify trends, areas of improvement, and potential recommendations for businesses and policymakers in South Korea.

2-1) Questions related to demographics:

The first set of questions focused on demographic information, such as acknowledging voluntary participation and age, country of work, and years of work in SMEs. The analysis determined the percentage of respondents in each category, allowing for a clear understanding of the demographic composition of the sample.

- Participant Profile: The survey consisted of 105 SMEs in South Korea, with participants aged 18 or above who voluntarily took part. The majority of respondents (62.8%) had extensive work experience in SMEs, with more than 10 years of experience.

2-2) Questions related to perspectives:

The next set of questions explored the perspectives of the participants, including their industry, company size (number of

employees), and department. By analyzing the distribution of respondents across these variables, patterns and trends within different perspectives could be identified.

- Industry Representation: The manufacturing sector was the most represented industry among the respondents, accounting for 63.8% of participants. The service sector followed with a representation of 23.4%.

- Business Size: Small-scale businesses with less than 50 employees constituted 46.8% of the respondents, while 36.2% worked in companies with 50 to 150 employees.

- Common Departments: Among the respondents, the most common department was R&D, with 36.2% reporting their affiliation to it. Support services and operations management were the next most common departments, representing 34% and 22.3% of respondents, respectively.

2-3) Questions related to challenges:

The subsequent questions are the most critical part representing the challenges faced by the SMEs in relation to digital transformation. The analysis involved calculating the percentage of respondents who selected each option for major business problems, their perception of digital transformation, current use of digital technologies, and challenges encountered in adopting or using digital technologies. This quantitative analysis shed light on the prevalent challenges.

- Business Problems: The survey revealed that the most commonly reported business problems by SMEs were increased cost or decreased profit, as identified by 56.4% of respondents. Another significant problem reported by 50% of participants was the lack of technology or expertise.

- Perception of Digital Transformation: A vast majority of respondents (94.7%) expressed their belief in the potential of digital transformation to address their business problems.

- Digital Technology Adoption: The survey indicated that SMEs in South Korea have adopted a range of digital technologies. The most commonly adopted technology was software solutions, reported by 63.8% of respondents, followed by robotics and automation, which were adopted by 27.7% of participants.

- Challenges in Technology Adoption: SMEs identified several challenges in adopting digital technologies. The main hurdles reported were a lack of budget (68.1%) and expertise (62.8%). Organizational resistance to change (29.8%) and security concerns (14.9%) were also mentioned as significant barriers.

2-4) Questions related to preferences:

The final set of questions focused on the preferences of participants regarding public (government) support for successful digital transformation. The analysis included determining the percentage of respondents who believed public support was helpful, the preferred types of public support, the participation rate in government-supported programs, the distribution of respondents across different program types, and the satisfaction levels of participants in those programs using a scale of one to five. This analysis offered information on the preferences and satisfaction levels of SMEs regarding government support.

- Government-supported Programs: A significant proportion of respondents (69.1%) reported participating in government-supported digital transformation programs.and perceptions among the surveyed SMEs.

- Perception of Public Support: The survey revealed a positive perception of public support among the respondents, with 89.4% of SMEs believing that it could help address the challenges of digital transformation.

- Preferred Types of Public Support: Among the various types of public support, respondents showed a preference for public funds (57.4%) and R&D support (16%). Additionally, consulting services (11.7%) and training/education of employees (14.9%) were also mentioned as preferred types of support.

3.3 Limitations

It is important to acknowledge certain limitations of data analysis. Firstly, the survey sample was limited to the SMEs associated with the three organizations involved in the distribution of the survey. This may introduce some selection bias and limit the generalizability of the findings to the broader population of South Korean SMEs. Additionally, the reliance on self-reported responses introduces the possibility of respondent bias or inaccuracies. Despite these limitations, the data analysis still contributes meaningful perspectives about the target audience of SMEs implementing or interested in digital transformation in South Korea.

The combination of quantitative and qualitative analysis methods allowed for a comprehensive examination of the survey data, delivering important discoveries about the differences between the South Korean government's promotion of digital transformation in SMEs and the perceived barriers. These findings contribute to the existing knowledge and understanding of digital transformation in South Korean SMEs and can inform future strategies and policies aimed at promoting successful digital transformation initiatives in this context.

4. Findings

This research aims to tackle three main questions. The first question is answered by conducting a comparative policy analysis, which employs a qualitative method to examine the policies of Germany, the EU, and South Korea regarding digital transformation and SME support. The second question was addressed through a survey conducted among SMEs, utilizing a combination of qualitative and quantitative methods to explore the barriers they face in digital transformation. The third question will be approached by incorporating the findings from the policy analysis and survey outcomes.

4.1 How are Germany and the EU implementing policies to support digital transformation in SMEs, compared to South Korea?

Germany has a long-standing focus on promoting digital transformation and supporting SMEs. It has developed comprehensive strategies such as Industry 4.0 and Mittelstand 4.0. Industry 4.0 aims to create a new level of automation and digitization in manufacturing and other industries through the integration of advanced technologies. The German government has invested heavily in research and development, funding, and the establishment of a national platform (Platform Industrie 4.0) to coordinate efforts and promote collaboration. Mittelstand 4.0

specifically targets SMEs, which constitute a significant portion of the German economy. The government has established initiatives and funding programs to support SMEs in adopting Industry 4.0 technologies. The focus is on improving their competitiveness through increased efficiency, flexibility, and innovation. Germany's policies serve as a benchmark for other countries in terms of promoting digital transformation and supporting SMEs.

The EU, including Germany as a member state, has set ambitious goals for digital transformation and supports SMEs through various programs and initiatives. The European Commission's strategies for Europe's digital transformation emphasize investing in digital skills and education, developing reliable digital infrastructure, promoting innovation and entrepreneurship, and digitizing public services. The EU implements SME policies through the European Agency for SMEs (EISMEA), which supports and promotes SMEs in the EU. Programs such as COSME, the European Innovation Council (EIC), and the European Enterprise Promotion Awards provide access to finance, markets, and business support services. The EU focuses on improving SMEs' access to finance, enhancing their internationalization efforts, and facilitating the transition to a sustainable and digital economy. The EU's policies aim to create a more inclusive, sustainable, and prosperous digital future for Europe.

South Korea has its own smart manufacturing innovation strategy, which is comparable to Germany's Industry 4.0 policy. The Smart Manufacturing Innovation Strategy aims to modernize the manufacturing sector through the adoption of digital technology, particularly the realization of smart factories. South Korea's policy focuses on building smart manufacturing infrastructure, supporting smart manufacturing technology development, and promoting the smart manufacturing industry. The government recognizes the importance of having a robust technological foundation, investing in research and development, and creating a favorable business environment for companies in the smart manufacturing sector. The goal is to achieve digital transformation in the manufacturing industry and enhance competitiveness. South Korea's policy aligns with the global trend of digital transformation and highlights the country's commitment to innovation and efficiency in the manufacturing sector.

Based on the comparative analysis of the policies among Germany, the European Union (EU), and South Korea, the following findings are identified:

Commonalities

1) **Focus on Digital Transformation**: All three entities prioritize digital transformation as a key driver for economic growth and competitiveness. Germany's Industry 4.0, the EU's digital

transformation strategy, and South Korea's Smart Manufacturing Innovation Strategy all aim to leverage advanced technologies and digitization to enhance various sectors, particularly manufacturing.

2) **Emphasis on SME Support**: Germany, the EU, and South Korea recognize the importance of supporting small and medium-sized enterprises (SMEs) in their digital transformation journeys. Germany's Mittelstand 4.0 and the EU's initiatives such as COSME and the EIC provide funding, access to finance, and business support services to SMEs. South Korea's policy also focuses on creating a favorable environment for SMEs in the smart manufacturing sector.

3) **Infrastructure Development:** South Korea and the EU recognize the significance of robust digital infrastructure. South Korea's Smart Manufacturing Innovation Strategy includes a focus on building smart manufacturing infrastructure, while the EU's strategy emphasizes the development of reliable digital infrastructure as a foundation for digital transformation.

DIstinctions

4) **Collaborative Efforts**: The EU and Germany both exhibit a strong focus on collaboration and coordination. Germany's Platform Industrie 4.0 and the EU's EISMEA serve as platforms

for stakeholders to exchange knowledge, share best practices, and promote collaboration in the digital transformation and SME domains.

5) **Skill Development and Education**: The EU and Germany specifically emphasize the development of digital skills and education. The EU's strategy highlights the importance of investing in digital skills, while Germany's policies consider upskilling and reskilling the workforce to meet the demands of digital transformation.

The findings highlight a common understanding among Germany, the EU, and South Korea regarding the significance of digital transformation and SME support. It is evident that all three entities—Germany, the EU, and South Korea—acknowledge the importance of digital transformation and support for SMEs. However, there are some distinctions in their policy approaches.

South Korea's focus on the technological aspect reflects its emphasis on innovation and advanced technologies. The Smart Manufacturing Innovation Strategy demonstrates this focus by prioritizing the development of smart manufacturing infrastructure and promoting the adoption of cutting-edge technologies. South Korea recognizes that technological advancements are key drivers of economic growth and competitiveness in the digital era.

On the other hand, Germany and the EU demonstrate a broader perspective by expanding their policy efforts beyond the technological aspect. While they also prioritize digital transformation, they recognize that it is not solely about adopting advanced technologies, but also about addressing various other factors that contribute to successful digitalization.

Germany's policies, such as the Mittelstand 4.0 initiative and Platform Industrie 4.0, highlight the importance of collaboration and coordination among stakeholders. These platforms serve as avenues for knowledge sharing, best practice exchange, and fostering partnerships among industry, academia, and government. Germany recognizes that collaborative efforts are essential for promoting innovation, driving digital transformation, and achieving sustainable growth.

Similarly, the EU places emphasis on collaborative efforts through initiatives like the European Innovation Council (EIC) and the Europe Enterprise Network (EEN). These initiatives aim to foster collaboration, support entrepreneurship, and facilitate access to funding and expertise for innovative SMEs across Europe. The EU recognizes that collaboration and networking play a vital role in enabling SMEs to thrive in the digital economy.

Furthermore, Germany and the EU both prioritize skill development and education as crucial components of their policies. They recognize the need to equip the workforce with digital skills and promote lifelong learning to address the challenges and opportunities brought about by digital transformation. By investing in education and upskilling programs, Germany and the EU aim to ensure that individuals and businesses can adapt to technological advancements and seize the benefits they offer.

In summary, while all three entities acknowledge the significance of digital transformation and SME support, South Korea primarily focuses on the technological aspect, whereas Germany and the EU broaden their policy efforts to encompass collaborative initiatives and skill development and education. This reflects their recognition that digital transformation requires a holistic approach that goes beyond technology, incorporating various aspects such as collaboration, skills, and education to create a conducive environment for successful digital transformation and economic growth.

4.2 What is the difference between the ways the South Korean government promotes digital transformation in SMEs and the barriers to digital transformation perceived by SMEs?

The policy analysis reveals that South Korea's focus is primarily on the technological aspects of digital transformation, with a strong emphasis on promoting smart manufacturing infrastructure and technologies. However, recent policy developments indicate an increasing awareness of the importance of soft and non-technological aspects, such as fostering collaborative environments among businesses, academia, and research institutions.

On the other hand, the survey results shed light on the actual challenges faced by SMEs in their digital transformation journey. The key business problems and obstacles identified by SMEs are predominantly related to costs, including increased expenses and decreased profitability, as well as a lack of budget. These findings highlight the financial constraints that SMEs encounter and their pressing need for resources to support their digital transformation efforts.

Interestingly, the preferred type of public support identified by SMEs is public funds, which aligns with their cost-related challenges. This indicates that SMEs perceive financial assistance from the

government as crucial for overcoming the hurdles they face in adopting digital technologies.

Additionally, the survey highlights two other significant challenges that SMEs perceive, namely a lack of expertise and organizational resistance. These challenges go beyond the technological aspects and underscore the importance of addressing non-technological factors in digital transformation initiatives. SMEs recognize the need for developing expertise and tackling resistance to change within their organizations to successfully embark on digital transformation.

These findings reveal an inconsistency between the current policy focus, which predominantly centers on technological aspects, and the actual perception of SMEs. The survey emphasizes the significance of considering the cost-related challenges that SMEs encounter and the need for financial support. Moreover, addressing the lack of expertise and organizational resistance is vital to align policies with the real needs and priorities of SMEs.

These findings highlight the importance of considering the specific needs and challenges faced by SMEs in South Korea when formulating policies and initiatives for digital transformation. It is crucial for the government to align its approach with the actual barriers perceived by SMEs, such as addressing cost-related issues, providing expertise development opportunities, and overcoming organizational

resistance to change. By tailoring policies to these specific challenges and preferences, the government can better support SMEs in their digital transformation efforts and foster a conducive environment for their growth and success.

4.3 Based on the policy analysis and survey outcomes of SMEs, what recommendations should be made for businesses and policymakers in South Korea?

Based on the policy analysis and survey outcomes of SMEs, several recommendations can be made for businesses and policymakers in South Korea:

1) **Diversify policy focus**: Policymakers should consider expanding the focus of digital transformation policies beyond purely technological aspects. While technological advancements are crucial, it is equally important to address non-technological factors, such as collaboration, skills development, and organizational change management, to ensure comprehensive support for SMEs.

2) **Increase financial support**: Recognizing the cost-related challenges faced by SMEs, policymakers should explore ways to increase financial support, including public funds, grants, and subsidies. Providing accessible and targeted funding options can

help SMEs overcome financial barriers and facilitate their adoption of digital technologies.

3) **Enhance expertise development**: To address the perceived lack of expertise, policymakers should prioritize initiatives that promote skill development and provide training opportunities for SMEs. Collaborations with academic institutions and industry associations can facilitate the transfer of knowledge and best practices, enabling SMEs to build the necessary capabilities for successful digital transformation.

4) **Foster collaboration**: Encouraging collaborative environments among businesses, academia, and research institutions can enhance innovation and knowledge-sharing within the ecosystem. Policymakers should facilitate platforms and networks that promote collaboration, allowing SMEs to access resources, expertise, and potential partnerships that can accelerate their digital transformation journey.

5) **Address organizational resistance**: Policymakers should support initiatives that help SMEs tackle organizational resistance to change. This can include providing change management guidance, promoting a culture of innovation and adaptability, and offering resources for training and re-skilling employees to ensure a smooth transition to digital processes.

To align policy initiatives with SMEs needs, policymakers should regularly assess and evaluate the needs and challenges faced by SMEs in digital transformation. Engaging in dialogue with SMEs through surveys, focus groups, and consultations can help ensure that policies and initiatives are effectively addressing the specific requirements and priorities of SMEs.

5. Conclusions, Limitations, and Recommendations

This study explored the digital transformation journey of SMEs and the challenges they face. The digital transformation journey for SMEs is fraught with various challenges that can hinder their progress. In order to gain a comprehensive understanding of the landscape surrounding digital transformation and SMEs, this research delved into multiple aspects in the literature review.

Firstly, the research explored the concept of digital transformation, providing a holistic definition that encompasses digitization, digitalization, and digital transformation. Digitization involves the conversion of analog data into digital formats, while digitalization focuses on leveraging digital technology and data to optimize processes and enhance efficiency. Digital transformation goes beyond these technical aspects and also considers the broader social, economic, and environmental impacts of digital technology on organizations and society as a whole.

Moreover, the research examined the key elements of digital transformation. It highlighted the significance of an ecosystem of digital technologies, which includes various tools, platforms, and systems that enable digital transformation efforts. Additionally, the revolution of data emerged as a critical element, emphasizing the importance of harnessing and leveraging data to drive insights and decision-making.

The impact on business models and organizations was another crucial aspect, as digital transformation often necessitates reimagining traditional business structures and embracing agile, customer-centric approaches.

However, SMEs encounter several challenges on their digital transformation journey. One common obstacle is the presence of a skills gap, where SMEs may lack the necessary expertise and knowledge to effectively implement digital technologies and navigate the complexities of digital transformation. Additionally, the adoption of new technologies can be daunting for SMEs, requiring significant investments and careful consideration of the right solutions for their specific needs. Change management also poses a challenge, as organizations must deal with internal resistance to change and successfully integrate digital processes into their existing workflows.

Furthermore, innovation strategies may need to be revised or developed to ensure that SMEs can adapt to the rapidly evolving digital landscape.

That being said, multiple studies have shown that government assistance plays a vital role in facilitating digital transformation for SMEs. Policymakers can provide support in various forms, such as skills upgrading programs to bridge the skills gap, providing mentoring programs for guidance and expertise, offering research support to encourage innovation, facilitating workforce expansion through training initiatives, implementing safety measures to address data privacy and security concerns, and offering tax incentives and financial assistance to alleviate the financial burden associated with digital transformation.

By understanding the specific needs of SMEs and tailoring support programs accordingly, governments can create an enabling environment that empowers SMEs to successfully embark on their digital transformation journeys.

Through the above comprehensive literature review on digital transformation, encompassing its concept, definition, key elements, and barriers faced by SMEs, this study highlights the crucial role of government assistance in providing various forms of support to empower SMEs. It is evident that recognizing the specific challenges faced by SMEs and offering tailored assistance is of utmost importance for governments to facilitate SMEs in overcoming barriers and embracing digital transformation. By doing so, governments can drive the growth, competitiveness, and resilience of SMEs in the digital age.

Therefore, building upon these understandings gained from the comprehensive literature review, this research aimed to address three key questions pertaining to digital transformation in SMEs and the corresponding government policies:

(i)How are Germany and the EU implementing policies to support the digital transformation in SMEs, compared to South Korea?,

(ii)What is the difference between the ways the South Korean government promotes digital transformation in SMEs and the barriers to digital transformation that they perceive?,

(iii)What recommendations should the researcher make for businesses and policymakers in South Korea, based on the policy analysis and survey outcome of SMEs?.

To answer these questions, a mixed research methodology was employed, consisting of a comparative policy analysis and a survey conducted among SMEs. Through the comparative policy analysis, valuable insights were obtained into the strategies implemented by the German government, the EU, and South Korea in their approach to digital transformation. Simultaneously, the survey provided essential perspectives from SMEs, shedding light on the perceived barriers they face throughout their digital transformation journey.

The combination of these research methods yielded a comprehensive understanding of the policies employed by governments and the challenges experienced by SMEs, enabling the formulation of recommendations for policy development and effective support measures.

As the first methodology, the comparative analysis highlighted commonalities among the three entities, such as the recognition of digital transformation as a driver for economic growth and competitiveness, the emphasis on supporting SMEs, and the importance of infrastructure development. However, distinctions were also observed, with South Korea primarily prioritizing technological aspects particularly in the manufacturing sector, while Germany and the EU adopted a more holistic approach by addressing multiple factors beyond the technological factors, such as collaborative network, skills development and education that contribute to creating a conducive environment for successful digital transformation and economic growth.

Secondly, complementing the policy analysis, the survey results unveiled the challenges faced by SMEs, such as cost-related issues, lack of expertise, and organizational resistance to change. These outcomes highlighted the misalignment between the current policy focus and the actual needs and priorities of SMEs, emphasizing the importance of incorporating these factors into policy formulation.

These research findings emphasize the significance of tailored government support and a holistic approach to digital transformation, encompassing both technological and non-technological factors, which can enable governments to build a conducive environment for successful transition to digital transformation in SMEs, driving their growth and competitiveness in the digital era. Based upon these findings, several recommendations are formulated:

1) **Policymakers in South Korea should diversify their policy focus** to include non-technological factors and consider fostering collaboration, skills development, and change management within the organizations. Digital transformation is not solely about adopting new technologies. It also involves addressing non-technological aspects such as organizational culture, skill gaps, and change management.

By broadening the policy focus to include these factors, policymakers can create an environment where organizations are encouraged to collaborate, develop relevant skills, and effectively manage the changes associated with digital transformation. This comprehensive approach will support a more holistic and successful implementation of digital transformation initiatives.

2) **Increasing financial support through accessible funding options** can help SMEs overcome cost-related barriers. SMEs often face financial constraints when investing in digital transformation. By providing accessible funding options, such as grants, loans, or subsidies, policymakers can alleviate the financial burden on SMEs.

This financial support will enable SMEs to invest in the necessary digital technologies, tools, and infrastructure, ultimately overcoming the cost-related barriers that may hinder their digital transformation efforts.

3) **Emphasizing expertise development through skill training and partnerships** with academic institutions can address the perceived lack of expertise. SMEs may lack the necessary knowledge and expertise to effectively implement and leverage digital technologies. Policymakers can address this challenge by promoting skill development programs tailored to the needs of SMEs. This can involve offering training courses, workshops, or certifications focused on digital skills and technologies.

Additionally, fostering partnerships between SMEs and academic institutions can facilitate knowledge transfer and

collaborative research, further enhancing the expertise available to SMEs and bridging the perceived lack of expertise.

4) Promoting collaboration among businesses, academia, and research institutions will foster a conducive environment for innovation and knowledge-sharing. Collaboration is a key driver of innovation and growth in the digital era. Policymakers should encourage and facilitate collaboration among SMEs, academia, and research institutions. This can be achieved through initiatives such as innovation hubs, industry-academia partnerships, or collaborative projects.

By fostering an environment where ideas, knowledge, and resources are shared, policymakers can enable SMEs to tap into a broader ecosystem of expertise and innovation, driving their digital transformation journey.

5) Supporting initiatives that address organizational resistance to change, such as change management guidance and resources for employee training, can facilitate a smooth transition to digital processes. Organizational resistance to change is a common challenge in digital transformation. Policymakers should

support initiatives that provide guidance and resources for change management within SMEs. This can include developing frameworks, guidelines, or best practices for managing organizational change, as well as offering training programs or resources to help employees adapt to digital processes.

By addressing and overcoming resistance to change, SMEs can more effectively embrace digital transformation and integrate digital processes into their operations.

In conclusion, this study strived to bridge the gap between the policies and the actual concerns of SMEs and developed five recommendations based on the findings obtained from a mixed research methods: a comparative policy analysis and a survey among SMEs. The recommendations suggest that South Korean policymakers should broaden their focus to include non-technological factors, provide accessible funding options for SMEs, promote expertise development through skill training and partnerships with academic institutions, foster collaboration among businesses and research institutions, and support initiatives that address organizational resistance to change for a successful digital transformation. The recommendations can be a helpful tool for businesses and policymakers in South Korea to create an enabling

environment for SMEs to overcome barriers and embark on their digital transformation journey. This will contribute to the growth and competitiveness of SMEs and position South Korea as a leading player in the digital era.

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The Survey Questions

1. I have read the above and acknowledge that my participation in this survey is voluntary, that my responses will be kept anonymous and that I am 18 years old and above.

Multiple choice: 2 options

- Yes (100%)
- No

2. Which country do you work in?

Multiple choice: 4 options

- South Korea (100%)
- Germany
- Europe
- Other

3. How long have you been working in SMEs?

Multiple choice: 4 options

- Less than 1 year (6.4%)

- 1 year or more but less than 5 years (23.4%)
- 5 years or more but less than 10 years (7.4%)
- 10 years or more (62.8%)

4. Which industry do you work in?

Multiple choice: 3 options

- Manufacturing (63.8%)
- Service (23.4%)
- Other (12.8%)

4-1. If you've chosen other, please specify.

Short answer

5. How many employees are there in your company?

Multiple choice: 4 options

- Less than 50 (46.8%)
- 50 or more but less than 150 (36.2%)
- 150 or more but less than 300 (8.5%)
- 300 or more (8.5%)

6. In which department are you working?

Multiple choice: 4 options

- Operations Management(e.g. Production, Quality Control) (22.3%)
- R&D(e.g. Engineering, Sustainability) (36.2%)
- Support Services(e.g. HR) (34%)
- Finance and Accounting (7.4%)

7. What are the major business problems your company encounters currently? (You can choose more than 1)

Checkboxes: 5 options

- Increased Cost or Decreased Profit (56.4%)
- Lack of Customers or Marketing Channels (27.7%)
- Lack of Technology or Expertise (50%)
- Inefficient Business Processes(e.g. Reduced productivity) (31.9%)
- Other (2.1%)

7-1. If you've chosen other, please specify.

Short answer

8. Do you think Digital Transformation(Using Digital Technologies) can help solve your business problems?

Multiple choice: 2 options

- Yes (94.7%)
- No (5.3%)

9. What kind of digital technologies does your company use currently? (You can choose more than 1)

Checkboxes: 9 options

- Software Solution (e.g. Accounting, ERP, CRM, MES)) (63.8%)
- Data Analysis (23.4%)
- Cloud Computing (19.1%)
- Internet of Things (9.6%)
- Robotics and Automation (27.7%)
- Artificial Intelligence (AI) and Machine Learning (13.8%)
- 3D Printing (6.4%)
- Blockchain (2.1%)
- Other (3.2%)
- Not using any of the above (13.8%)

9-1. If you've chosen other, please specify.

Short answer

10. What kind of challenges does your company encounter when adopting or using digital technologies?

Multiple choice: 5 options

- Lack of Budget (68.1%)
- Lack of Expertise in the field (62.8%)
- Organizational Resistance to Change (29.8%)
- Security (14.9%)
- Other (1.1%)

10-1, If you've chosen 'other', please specify.

Short answer

11. Do you think Public(Government) Support is helpful for tackling the above challenges?

Multiple choice: 2 options

- Yes (89.4%)
- No (10.6%)

12. What kind of Public(Government) Support do you think is the most helpful for SMEs?

Multiple choice: 4 options

- Public Funds (57.4%)
- R&D (16%)
- Consulting(e.g. Businesses, Technologies) (11.7%)
- Training or Education of Employees (14.9%)

13. Have you(your company) ever taken part in any Digital Transformation Programs supported by the Government?

Multiple choice: 2 options

- Yes (69.1%)
- No (30.9%)

13-1. If you've chosen yes, what kind of programs did you participate in? (You can choose more than 1)

Checkboxes: 4 options

- Public Funds (28.4%)
- R&D (55.2%)

- Consulting(e.g. Businesses, Technologies) (9%)
- Training or Education of Employees (7.5%)

13-2. How satisfied were you with the program?

Linear scale

- Very unsatisfied (0%)
- Unsatisfied (4.3%)
- Medium (40%)
- Satisfied (35.7%)
- Very satisfied (20%)

14. Please specify if you want to suggest a Public Supported Program.

Paragraph