

TECHNOLOGY AND EMPLOYEE COLLABORATION IN THE WAKE OF
ORGANIZATIONS' DIGITAL TRANSFORMATION

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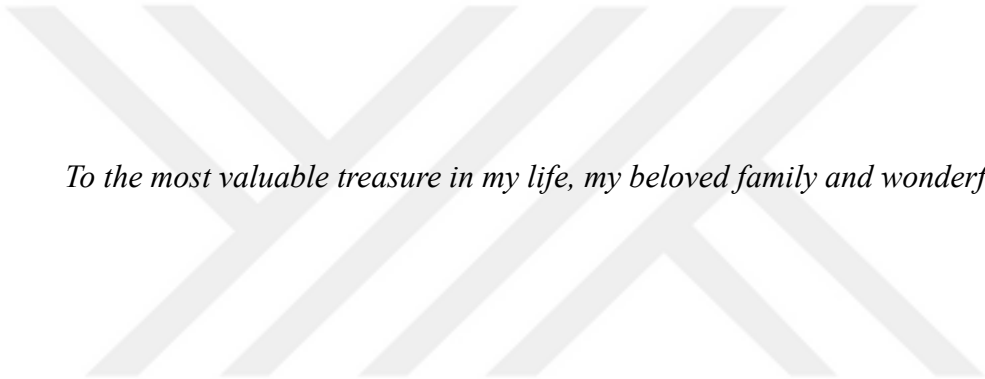
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İMZALANMIŞ SAYFALAR EKLENECEK

STANDARTLARA UYGUN AYRI SAYFADA HAZIRLANDI



To the most valuable treasure in my life, my beloved family and wonderful sons...

ABSTRACT

In this thesis, collaboration of employees with technology, the design of a digital maturity model, the socio-technical design of governance structures, the inclusion of employees in decision-making processes, and the implementation of robotic process automation activities that come to the fore in employee-technology collaboration have been considered. For a holistic and end-to-end handling of the transformation, the digital transformation journey and its critical stages have been defined. In the first stage, a holistic digital maturity model based on a systematic literature review has been designed. This model consists of six main dimensions named digital strategy, digital value, digital processes, digital technology and data, digital work, and digital governance, and twenty-four sub-dimensions. It enables the definition of all critical competencies required by digital transformation regardless of the sector and size of the organizations. In the second stage, after the assessment based on the maturity model has been accomplished, the focus is shifted to how the digital maturity assessment results can be scored and how the targets could be determined to create an effective transformation roadmap. In this context, AHP and TOPSIS methods, which are multi-criteria decision-making techniques, are used in the assessments carried out with the participation of employees. In the third stage, the focus is on robotic process automation that has been designed socio-technically. Then, AHP and TOPSIS methods are used in the selection of a vendor and prioritization of processes, which are critical in the effective deployment and management of this technology.

ÖZET

Tez çalışmasında, dijital dönüşüm, organizasyonlardaki dijital olgunluğun belirlenmesinden değer yaratacak teknolojinin devreye alınmasına kadar bütünsel ve uçtan uca irdelenmiştir. Çalışanların teknoloji ile işbirliği; dijital olgunluk modeli tasarımı, yönetim yapılarının sosyo-teknik olarak kurgulanması, çalışanların karar alma süreçlerine dahil olması ve çalışan-teknoloji işbirliğinde ön plana çıkan robotik süreç otomasyonu çalışmalarının devreye alınması kapsamında ele alınmıştır. Dönüşüme bütünsel ve uçtan uca odaklanılması için öncelikle dijital dönüşüm yolculuğu ve bu yolculuğun kritik aşamaları tanımlanmış, her bir aşamanın model ve yöntemlerle desteklenmesi sağlanmıştır. İlk aşamada, sistematik literatür taramasına dayalı bütünsel dijital olgunluk modeli tasarlanmıştır. Dijital strateji, dijital değer, dijital süreçler, dijital teknoloji ve veri, dijital iş yaşamı ve dijital yönetim adı altında altı ana ve yirmidört alt boyuttan oluşan bu model, organizasyonların sektör ve büyüklük bağımsız dijital dönüşümün gerektirdiği tüm kritik yetkinliklerinin tanımlanmasını sağlamıştır. İkinci aşamada, olgunluk modeline dayalı değerlendirme sonrasında etkili bir dönüşüm yol haritası oluşturmak üzere hem dijital olgunluk değerlendirme sonuçlarının nasıl puanlandırılacağına hem de hedeflerin nasıl belirlenebileceğine odaklanılmıştır. Bu kapsamda çalışanların sürece dahil edilmesiyle gerçekleştirilen değerlendirmelerde çok kriterli karar verme tekniklerinden AHP ve TOPSIS yöntemlerinden yararlanılmıştır. Üçüncü aşamada, çalışanların işlerinin botlara devredildiği robotik süreç otomasyonuna odaklanılmıştır ve bu konudaki yönetimin sosyo-teknik açıdan tasarlanması sağlanmıştır. Daha sonra, bu teknolojinin etkili bir şekilde devreye alınması ve yönetilmesinde kritik olan çözüm sağlayıcı seçiminde ve süreçlerin önceliklendirilmesinde hem organizasyona hem de çalışana nasıl değer yaratılabileceği AHP ve TOPSIS yöntemlerinden yararlanılarak ortaya konmuştur.

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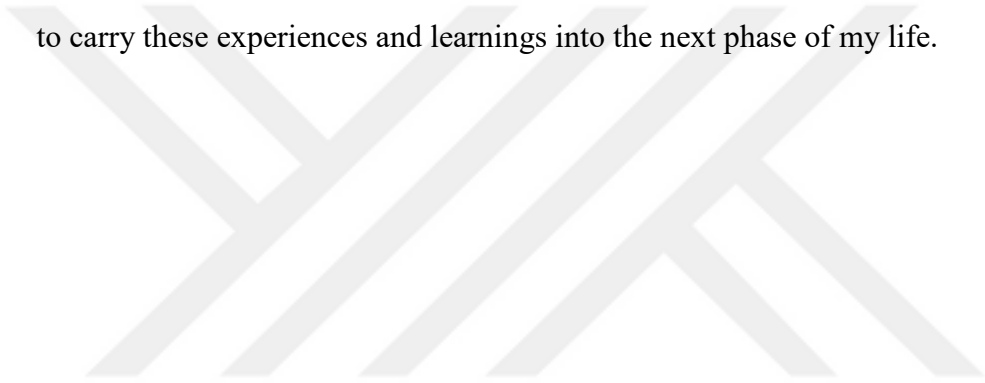


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ABBREVIATIONS

AHP	Analytic Hierarchy Process
AI	Artificial Intelligence
BPM	Business Process Management
CoE	Center of Excellence
CI	Consistency Index
CR	Consistency Ratio
DMA	Digital Maturity Assessment
DMM	Digital Maturity Model
DT	Digital Transformation
E2E	End to End
ERP	Enterprise Resource Planning
FTE	Full Time Equivalent
IoT	Internet of Things
IT	Information Technology
MCDM	Multi Criteria Decision Making
MIS	Management Information System
KPIs	Key Performance Indicators
OT	Operational Technology
RPA	Robotic Process Automation
RI	Random Index
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
VoC	Voice of Customer

CHAPTER 1

INTRODUCTION

Digital transformation (DT) has significantly reshaped the global economy, bringing about various new developments. The World Economic Forum has estimated that, by 2025, DT will have generated up to \$100 trillion in value for businesses and society (World Economic Forum, 2016). By 2030, the DT market is expected to have grown further, with the widespread adoption and development of technologies such as artificial intelligence (AI), machine learning, the Internet of Things (IoT), cloud computing, and Big Data analytics. Additionally, the widespread implementation of 5G technology and the IoT will help companies to accelerate their DT processes (World Economic Forum, 2020). Through numerous industrial revolutions, we have arrived at striking developments that have affected all stakeholders. New advancements, such as the recent introduction of technologies like ChatGPT, will continue to emerge and drive value creation within the realm of technology and technology-human collaboration. This progress highlights the ongoing potential of innovation to shape our lives and transform the way we interact with one another.

The First Industrial Revolution (1760–1840) was marked by a shift from manual labor to mechanized production in the textile and iron industries. Key innovations during this period included the steam engine, the spinning jenny, and the power loom (Landes, 1969). This revolution paved the way for modern industrial societies and led to significant economic growth and urbanization (Mokyr, 1999). The Second Industrial Revolution (1870–1914) was characterized by the spread of

industrialization to other countries, advancements in communication and transportation, and the development of new industries such as steel, chemicals, and electrical power. Innovations during this period included the telegraph, the telephone, the internal combustion engine, and electrical power generation (Chandler, 1992). These advancements accelerated global economic growth and international trade (O'Rourke & Williamson, 1999).

The Third Industrial Revolution (1960s–1990s), also known as the “Digital Revolution,” was marked by the emergence of digital technologies and computerization, which transformed various aspects of society and the economy (Castells, 1996). Innovations during this period included the integrated circuit, personal computer, and the internet, which revolutionized communication, information sharing, and productivity (Brynjolfsson & Hitt, 2000).

The Fourth Industrial Revolution (2010s–present), also known as “Industry 4.0,” is characterized by the convergence of digital, physical, and biological systems, as well as the rise of advanced technologies such as AI, robotics, the IoT, and additive manufacturing (Schwab, 2016). These technologies are expected to further disrupt traditional industries, accelerate innovation, and reshape the global economy (Marr, 2018).

DT, in contrast, is a broader concept that encompasses the integration of digital technologies into all aspects of a business or organization (Matt et al., 2015). This can include areas such as marketing, finance, human resources, and customer service, in addition to manufacturing and industrial processes (Kane et al., 2015). It is focused on leveraging technology to improve business operations, enhance customer experiences, and foster innovation (Bharadwaj et al., 2013). This process often requires organizations to rethink their business models, strategies, and

organizational culture in order to adapt to the rapidly changing digital landscape (Westerman et al., 2014). In summary, Industry 4.0 is a subset of DT that specifically focuses on the manufacturing and industrial sectors, and DT is a more general term that covers the integration of digital technologies across all aspects of a business.

DT has become a critical aspect of modern businesses, institutions, and society as a whole. Implementing DT can be observed at organizations of different types such as companies, governmental organizations, and non-governmental organizations. Companies participate in DT by implementing digital technologies and processes to enhance productivity, innovation, and customer satisfaction (Bharadwaj et al., 2013). This involves adopting cloud computing, data analytics, AI, and other advanced technologies to improve business operations and competitiveness (Matt et al., 2015). Successful DT requires a clear strategy, strong leadership, and a culture that embraces change (Kane et al., 2015).

Governments, educational establishments, and non-profit organizations also participate in DT to better serve their constituents and achieve their goals (Mergel et al., 2019). This involves leveraging digital technologies to enhance public service delivery, streamline processes, and facilitate collaboration (Dunleavy et al., 2005). Institutions need to prioritize digital literacy, invest in infrastructure, and develop policies to support DT (Bertot et al., 2016).

DT has significant implications for society, as it impacts the way people live, work, and interact (Bughin et al., 2017). Society participates in DT by embracing digital technologies such as smartphones, social media, and e-commerce platforms. This leads to changes in communication, consumer behavior, and the labor market (Lasi et al., 2014). To ensure inclusive participation in DT, society must address the

digital divide, ensure digital literacy, and consider the ethical implications of digital technologies (Dreyfus & Dreyfus, 2004).

Employees are vital stakeholders in DT, responsible for executing and adapting to new digital strategies and technologies (Fitzgerald et al., 2013). To ensure employee engagement, organizations must invest in training, the development of digital skills, and the promotion of a culture that encourages innovation and collaboration (Vial, 2019).

Customers are essential stakeholders in DT, as their preferences, behaviors, and expectations shape the way that organizations design and deliver products and services (Lemon & Verhoef, 2016). Engaging customers in DT involves leveraging digital channels to collect feedback, co-create solutions, and personalize experiences (Nguyen et al., 2015). Suppliers are critical stakeholders, providing the necessary resources and technologies for organizations to achieve their digital goals (Pagani & Pardo, 2017). Engaging suppliers in DT involves collaborating on innovation, sharing data, and integrating supply chain processes through digital platforms (Kiel et al., 2017). Investors play a vital role in DT, as they provide the necessary capital and strategic guidance for organizations to implement digital initiatives (Kane et al., 2015). Engaging investors in DT involves communicating the strategic vision, demonstrating the potential return on investment, and addressing the risks associated with DT projects (Ross et al., 2017).

To address the various aspects of DT, including its socio-technical dimensions and capabilities, it is essential to approach DT as a journey. This journey should involve adopting an inclusive digital maturity model (DMM), its assessment capabilities, creating the right roadmap, and ensuring that the targeted outcomes are achieved. By considering DT as a journey, organizations can better align their

strategic goals and objectives with the evolving digital landscape. A comprehensive DMM serves as a reference point for evaluating the organization's current digital capabilities, technology adoption, workforce skills, and customer experience (World Economic Forum, 2018). Integrating socio-technical considerations into the model allows organizations to identify areas of improvement, prioritize initiatives, and track progress over time, fostering a sustainable, competitive, and socially responsible environment.

In parallel to the views in the literature, DT as a journey encompassing all its dimensions, including socio-cultural and technical aspects, capabilities, and an inclusive reference model, is crucial for organizations looking to navigate the complex landscape of DT. By creating the right roadmap and ensuring the achievement of targeted outcomes, organizations can foster a sustainable and socially responsible business environment.

1.1 Research Definition

Based on the research gaps in the literature, the thesis is conducted in five stages to comprehensively address DT from a business perspective. It investigates when, how, and with what methodologies and approaches collaboration with employees can be achieved in the process (Figure 1).

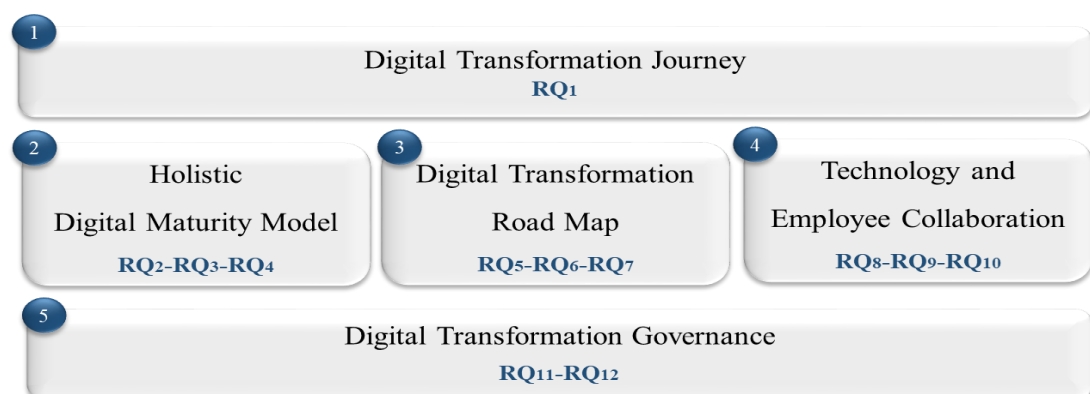


Figure 1. Stages of thesis

The first stage of the thesis aims to clarify what DT is, how to achieve a successful transformation, and how to maximize value for all stakeholders. This stage then concludes by defining the DT journey and revealing the importance of the subsequent stages and the interplay between them. Additionally, a comprehensive literature study on DT is conducted to identify the gaps in the literature by asking the following research question:

RQ1: How should one begin and sustain a DT?

In the second stage, a comprehensive literature study is conducted to examine the reference models and ensure that all dimensions and stakeholders are taken into account in the DT journey to achieve the targeted results. These guiding research questions are defined as follows:

RQ2: What is the importance of a DMM in DT?

RQ3: What is the scope of the DMM considered in terms of dimensions and sub-dimensions?

RQ4: How should a holistic and generic model be designed?

The third stage of the thesis defines the methodology used for the analysis of the assessment results obtained by the DMM and explains how to create an effective DT roadmap. It deals with how targets can be determined on the basis of the dimensions and sub-dimensions of the DMM and DT phases (digitization, digitalization, and DT). To this end, the following research questions are formulated:

RQ5: How are the dimensions and sub-dimensions weighed in DMMs?

RQ6: How are the targets of the dimensions and sub-dimensions set on the basis of the DT phases?

RQ7: How are the priorities and development areas determined according to the assessment results obtained by the DMM?

In the fourth stage, the technologies that most affect employees in DT are investigated, and the impact of RPA technology on the employees is discussed in response to the following research questions (on process selection and implementation):

RQ8: What technologies affect employees in DT?

RQ9: Where should this technology be implemented, and which process should be used to create optimal value for both the company and the employees?

RQ10: How can the opinions of the employees be taken into consideration during the RPA implementation?

The research questions in the fifth and final stage focus on the governance timeline that ensures the successful management and sustainability of the DT journey.

RQ11: How can the governance and sustainability of DT be ensured?

RQ12: What critical success factors and capabilities should be defined and managed?

In summary, the above-mentioned five stages help to explore how DT should be managed end-to-end by focusing on not only the technology implementation, but also the necessary capabilities, as well as the model and methodology designs that address its impact on employees in particular.

1.2 Scope of the thesis

In the first chapter of the thesis, the evolution of DT and the significance and impacts of this transformation for all stakeholders are primarily summarized. In this way, attention has been drawn to how digital transformation can influence stakeholders such as society and employees. Subsequently, the research questions that were focused on and the scope of the thesis study have been presented.

In the second chapter, a systematic literature review study, supported by both subject-based and bibliometric analyses, has been conducted towards the possible answers to research questions, which are prominent in DT. In this context, firstly, all areas of DT are focused on, and the shortcomings and needs regarding how to define the end-to-end digital transformation journey are identified. On the other hand, digital maturity models and their dimensions and sub-dimensions are examined to ensure that the transformation is handled multi-dimensionally and comprehensively.

In the third chapter, several design issues that are related to how DT can be handled and initiated in an organization are discussed. In this context, the DT journey process, which reveals how the DT process can be managed end-to-end, has been defined. In addition, a holistic DMM has been designed that can be applied to all organizations regardless of industry and size, covering all capabilities of DT, and revealing the impact and interaction areas of employees within DT. In the fourth chapter, a methodological approach has been developed on how to handle digital maturity assessment results in parallel with different priorities and targets with the participation of employees. In this context, it has been presented with analyses on how scoring based on dimension weights, setting goals based on strategies, and how the roadmap can be generated.

In the fifth chapter, the implementation of RPA technology found in the DT roadmaps of all companies has been handled from a socio-technical perspective. In this framework, firstly, the design of the governance and capabilities of RPA technology has been made. Then, a methodological approach has been developed using Multi-Criteria Decision Making (MCDM) techniques on how employees can be involved in critical decision-making processes such as vendor selection and process selection.

In the sixth and final chapter, the study outcomes are summarized with regard to how they can be made sustainable within the scope of DT governance. The research's contribution to the literature, its limitations, and insights for future studies are provided as well.

In summary, this thesis deals with the end-to-end digital transformation process and systematically presents the integration that needs to be achieved with the employees in this process, as Figure 2 illustrates.



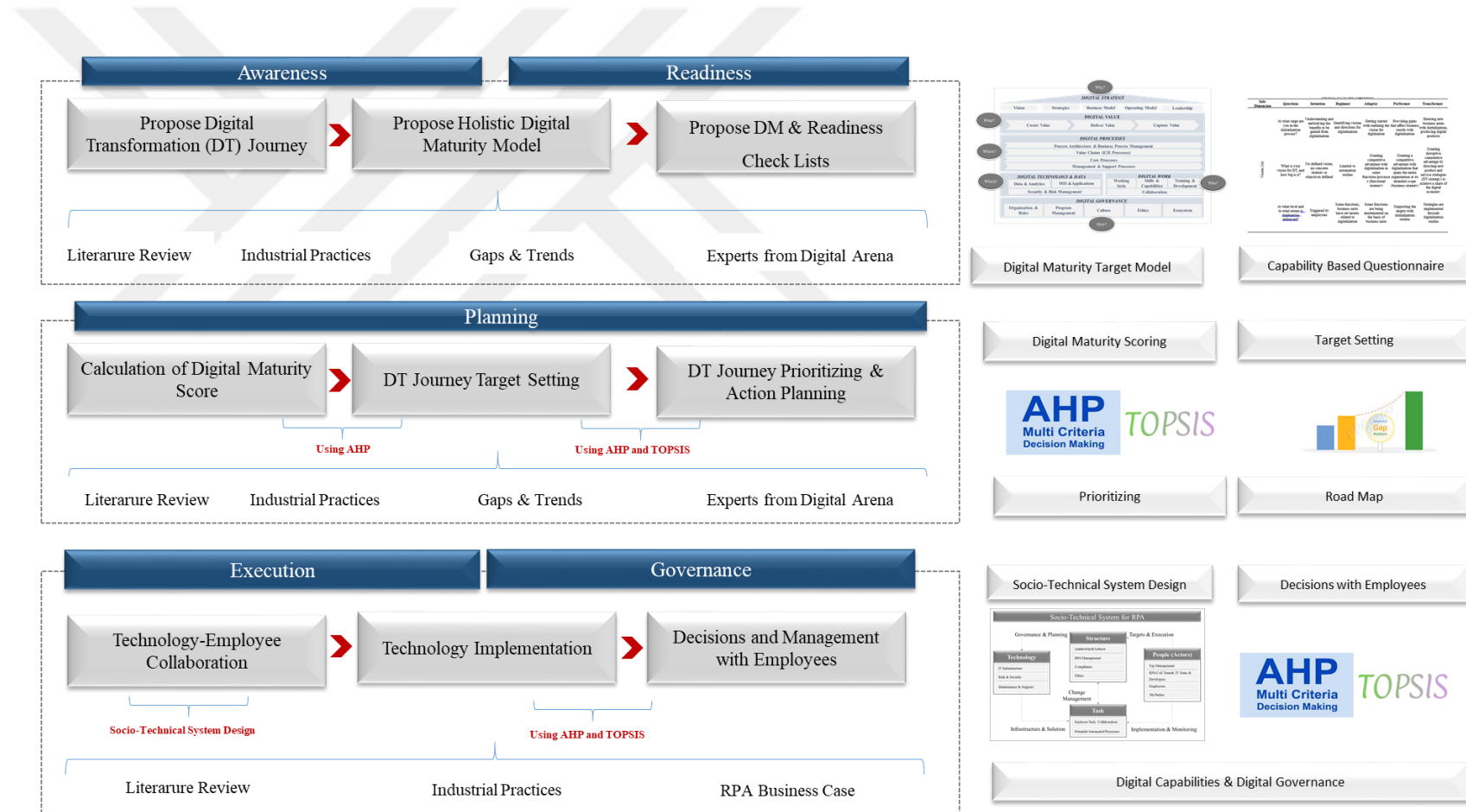


Figure 2. Thesis road map, scope and outputs

CHAPTER 2

LITERATURE REVIEW

The literature review is conducted in two parts where the first part includes a systematic literature review to provide answers to the research questions one through six (Aras & Büyüközkan, 2023)¹. The second part performs a classical literature review related to research questions seven through twelve.

2.1 Systematic Literature Review

The systematic literature review study is carried out by combining two methods, which is the first in its field. With the first of these methods, PRISMA, it is guaranteed that the review process is carried out according to the standard. Within the scope of bibliometric analysis, which is used as the second method, the distribution of scientific publications, the interaction and relations of these publications with each other were revealed using the Biblioshiny tool. The four primary steps of a systematic literature review consist of identification, eligibility, inclusion, and analysis (Figure 3).

The first step consists of a comprehensive literature search using a variety of concepts to identify all studies pertaining to the DMM in the context of DT. On the basis of the keywords listed in Table 1, over 10,000 publications were located. These keywords indicate how relevant these publications are to the notion of DM.

Table 1. DT and DM related keywords

“Digital Maturity”	“Digital Readiness”
“Digital Transformation” AND “Digital Maturity”	“Digital Readiness Model”
“Digital Transformation Maturity”	“Digital Readiness Assessment”
“Digital Maturity Assessment”	“Stages of Digital Transformation”
“Digital Transformation Assessment”	“Digital Maturity Levels”
“Digital Transformation Capability Maturity Model”	“Phases of Digital Transformation”

¹ This systematic literature review was published.

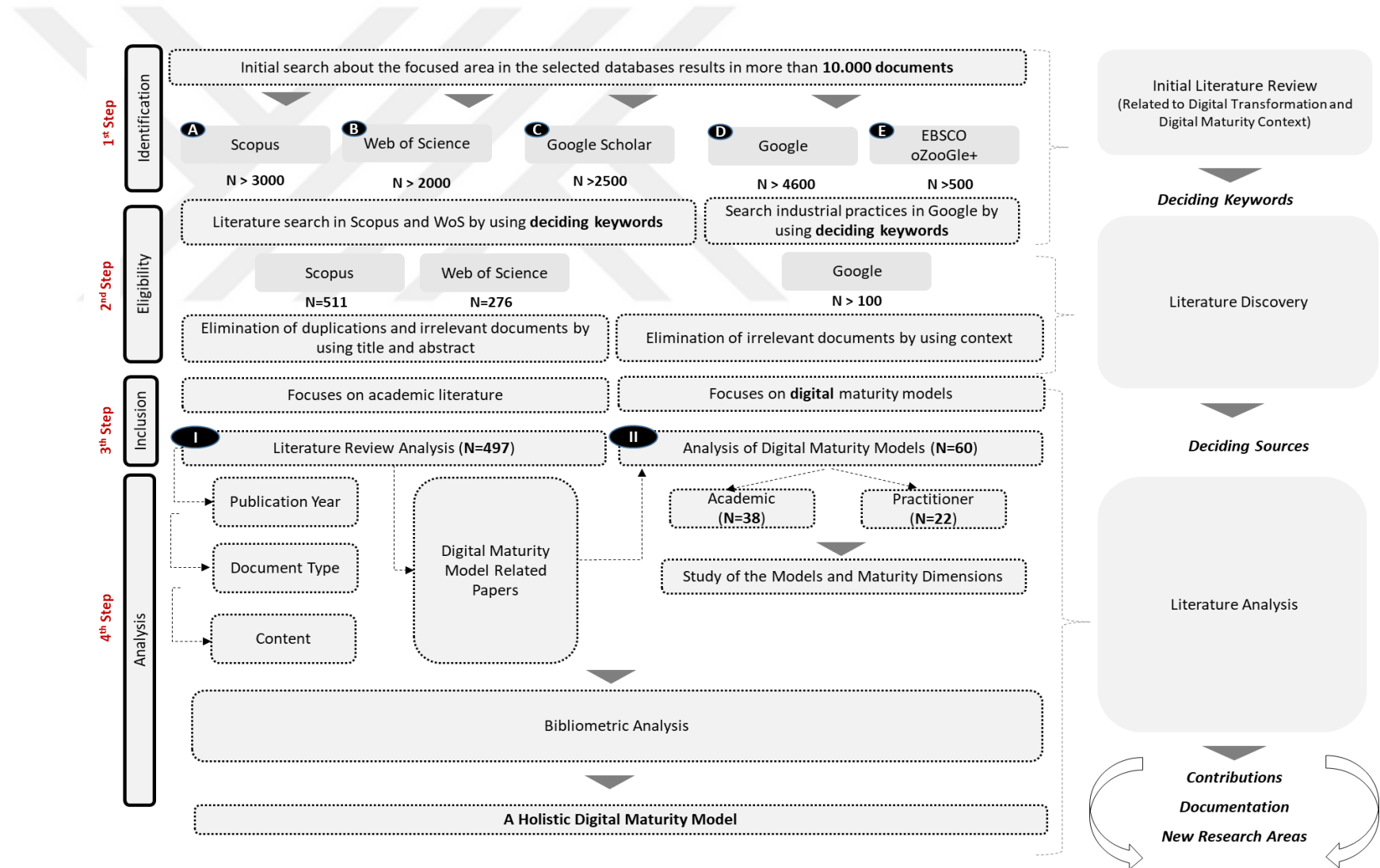


Figure 3. Methodology for systematic literature review

In the second step, the source documents were identified by removing duplicate and irrelevant documents by reading abstracts and removing duplicates from multiple databases. The Scopus and Web of Science (WoS) databases were combed for academic studies, whereas Google search engines were used to locate studies conducted by consulting firms. Comparing the Scopus and WoS databases revealed that the larger Scopus database contained the same documents as the smaller WoS database; consequently, we chose to utilize the Scopus database.

The third step consisted of analyzing the documents to find answers to the research questions aimed at (i) highlighting the significance of DMMs in DT and (ii) presenting a holistic DMM based on the analysis and the literature gaps. This section is divided into the literature review analysis, which aims to answer the first two questions, and the DMM analysis, which examines whether the documents chosen for the literature review are focused on DMMs and thus answer the third question. The final category was subdivided further into academic articles, consulting firm reports, and white papers.

In the fourth step, two types of analysis were conducted. The first one was a bibliometric analysis, inspired by the paper by Uribe-Toril et al. (2019), which reviews 17 years of literature in the fields of Energy, Economy, and Environment. This method of research facilitates measurement-based analysis of scientific literature and utilizes bibliographic mapping tools to generate maps that summarize the attributes and relationships of documents. By employing bibliometric analysis in our research, we aimed to enhance the systematic literature review, examining the development of DT and digital maturity on an annual basis, as well as the interactions and relationships of publications.

The second part of the analysis focused on evaluating the scope of DMMs, considering both academic and consultancy firms' developed models on a component and subcomponent basis. This assessment aimed to reveal the models' content regarding the requirements of an effective DT and the inclusiveness of socio-technical dimensions.

2.1.1. Bibliometric Analysis Using Biblioshiny

The Biblioshiny tool was chosen because its features and visualization capabilities were superior to those of competing tools (Aria & Cuccurullo, 2017). Table 2 compares the visualization capabilities of bibliometric analysis tools currently available.

Biblioshiny tool process are illustrated in Figure 4, comprising of preparation, data analysis, and data visualization and evaluation. The preparation phase involved downloading a dataset containing all relevant documents as a.bib file from Scopus, and the data analysis phase involved importing the Bib file into Biblioshiny, which performs bibliometric analysis by reducing the data and creating a network matrix. In the final phase, various mappings are generated for visualization and evaluation.

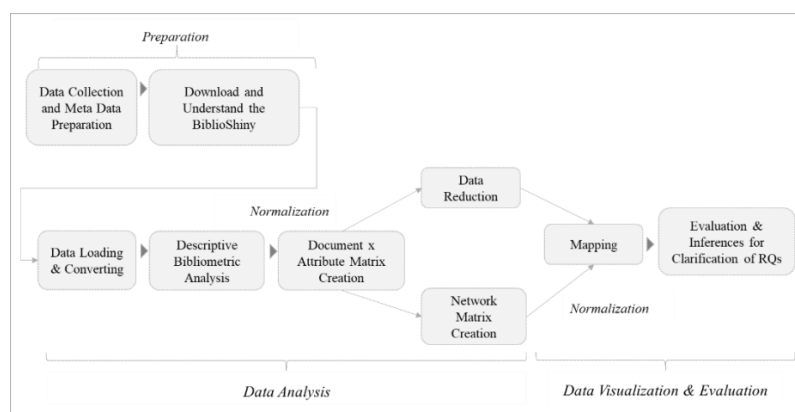


Figure 4. Bibliometric analysis using Biblioshiny²

² Aria & Cuccurullo, 2017; Bibliometrix, n.d.

Table 2. Comparison of bibliometric analysis and visualization tools³

	Thematic Network	Author Network	Reference Network	Other Networks	Evolution	Performance	Burst Detection	Spectrogram	Geospatial	Visualization
					Science Mapping Analysis Tools					
Bibexcel	•	•	•	•	•	•			•	External software
Biblioshiny	•	•	•	•	•	•	•	•	•	Network, three-fields plot, word cloud, tree map, historiograph, strategic diagram, evolution map, and world map
BiblioMaps	•	•	•	•		•			•	Network
CiteSpace	•	•	•	•		•	•		•	Tree ring, geospatial map
CitNetExplorer			•							Network
SciMAT	•	•	•	•	•	•				Strategic diagram, cluster network, overlapping map, evolution map
Sci ² Tool	•	•	•	•			•		•	Temporal, geospatial map, topical, network
VOSviewer	•	•	•	•		•				Network, overlay, density
Bibliometrix	•	•	•	•	•	•	•	•	•	Network, three-fields plot, word cloud, tree map, historiograph, strategic diagram, evolution map, and world map
BiblioTools	•	•	•	•		•			•	Network
Citan						•				Bars, bow plots, and pie chart
Metaknowledge	•	•	•	•			•	•		Timeline graph, spectrogram, and network
scientoText		•				•				
SxientoPy					•	•				Timeline graph, bar graph, evolution graph, and word cloud

³ Moral-Muñoz et al., 2020

As depicted in Figure 5, the literature review analysis conducted in this study makes use of the two types of analyses offered by the Biblioshiny software: one focused on the domain and another on the knowledge structure. Domain focused analysis relies on sources (journals, conference proceedings, etc.), documents, and authors, while knowledge structure focused analysis employs conceptual, intellectual, and social issues. This study examines the domain of the sources and documents in order to gain a broad understanding of the publications and conduct document analysis. The general overview summarizes the number of sources, publications, and citations that can be referred to as metadata. Keyword based document analysis was performed. We utilized only the conceptual structure for our knowledge-structure-focused analysis. Using three Biblioshiny networks, which are co-occurrence networks, thematic maps, and thematic evolution, it was possible to analyze the relationships and trends of the concepts.

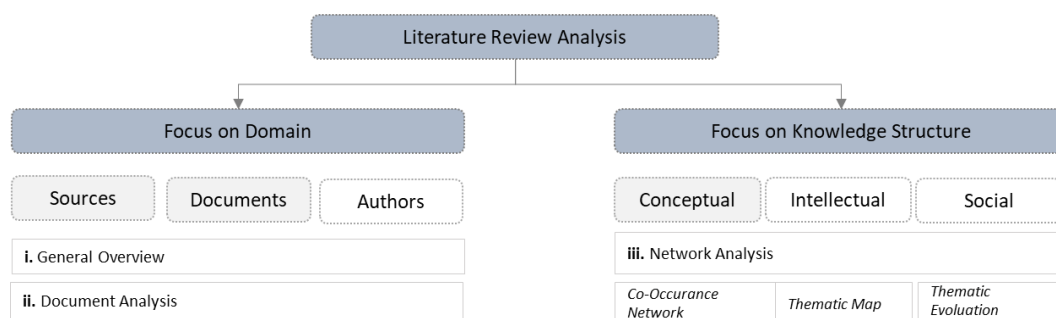


Figure 5. Literature analysis scope using Biblioshiny

A co-occurrence network, which aids in the study of the subject area's evolution over time, was utilized to comprehend the topics covered by the investigated subject area. Each node in the network is represented by a keyword employed by document authors. The diameter of a node increases as the number of documents containing the associated keyword increases. An edge or link exists

between two nodes (keywords) if they both appear in the same document. The number of co-occurrences of two keywords increases the link's strength, which measures the degree of association between them. The second type of network, known as a thematic map, groups documents into four clusters, each represented by a bubble, based on two characteristics of the keywords: degree of centrality and degree of density (Cobo et al., 2011). The degree of centrality indicates the significance of the keywords, whereas the degree of density measures the evolution of the keywords over time. In a thematic map, the size of the bubbles representing clusters is proportional to the number of assigned keywords. The position of the bubbles was determined using Callon centrality and cluster density (Aria & Cuccurullo, 2017). Both map types (Armenta-Medina et al., 2022; Rashid et al., 2021) have been utilized in numerous recent studies pertaining to numerous research disciplines.

2.1.2. Digital Maturity Model Analysis

In this thesis, as depicted in Figure 6, we divided the documents containing DMMs into two groups, with 38 being academic and 22 belonging to consultancy firms, for a total of 60 models. Regardless of their origin, the documents were analyzed using the dimensions of the proposed maturity model.

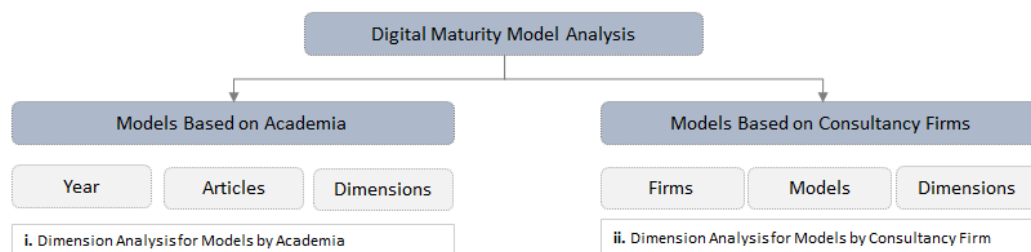


Figure 6. DMM dimensions focused literature analysis scope

During the analysis in the thesis, I examined how the dimensions and sub-dimensions of the models were defined, and whether the publications were considered within the scope of a holistic model or represented sector-specific DMMs. Additionally, I investigated whether assessments were conducted based on these models. Among these publications, we identified which ones were considered within the scope of systematic literature review studies based on DMMs and analyzed the contributions and gaps of these systematic literature reviews.

2.1.3 Literature Review Results

2.1.3.1 Results from Biblioshiny Analysis

Focusing on the domain of the documents, the development of publications over time and publication performance based on citations and document types were examined. The first analysis provides an overview of the number of sources, publications, and citations that can be considered metadata.

As depicted in Figure 7, the first document with a definition of digital maturity was published in 2004. Since then, the number of documents has grown by 3.7%. There were a total of 1481 authors who contributed to the publication, and 14% of them were from other countries. More than 20,000 references have been provided to 497 scanned documents to date, and the average citation performance of the articles was 6.2%.

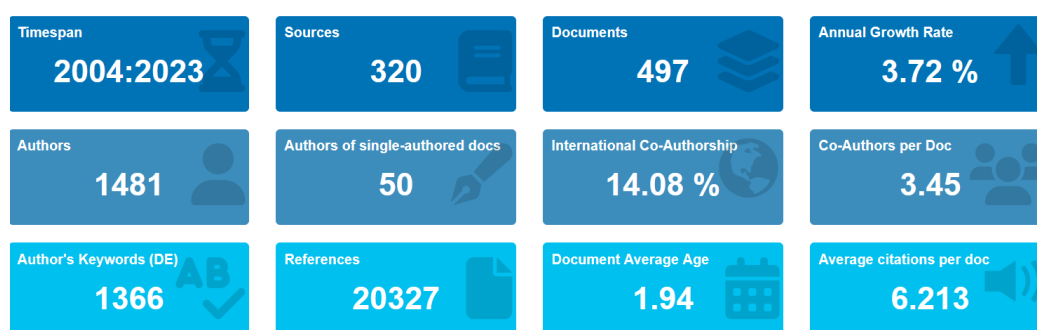


Figure 7. The main information based on literature review metadata

Figure 8a demonstrates that, since 2018, the annual number of publications on digital maturity has steadily increased alongside the growth of DT studies. As shown in Figure 8a and Figure 8b, the significant portion of the increase can be attributed to conference papers.

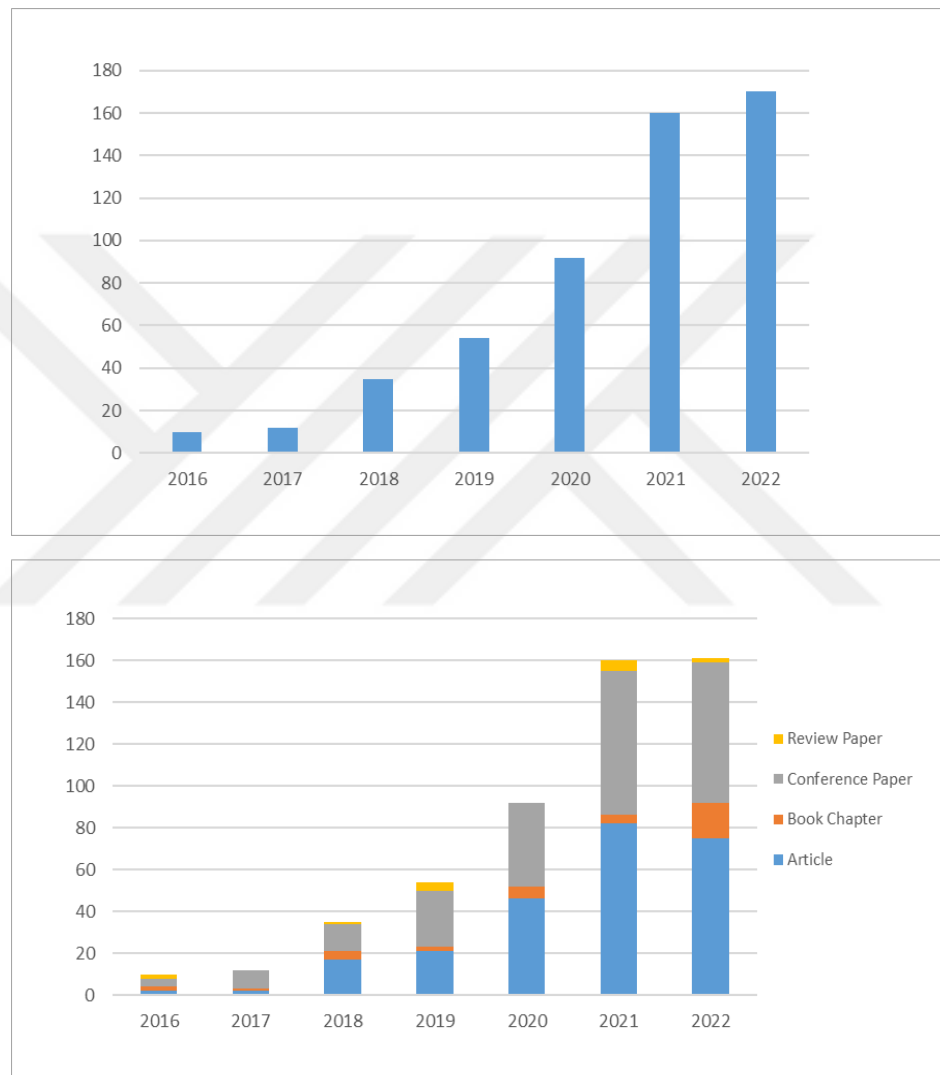


Figure 8. The annual number of publications (a) and (b) document types

As can be observed in Figure 9, the average number of citations received by each publication increased significantly after 2016 alongside the number of publications.

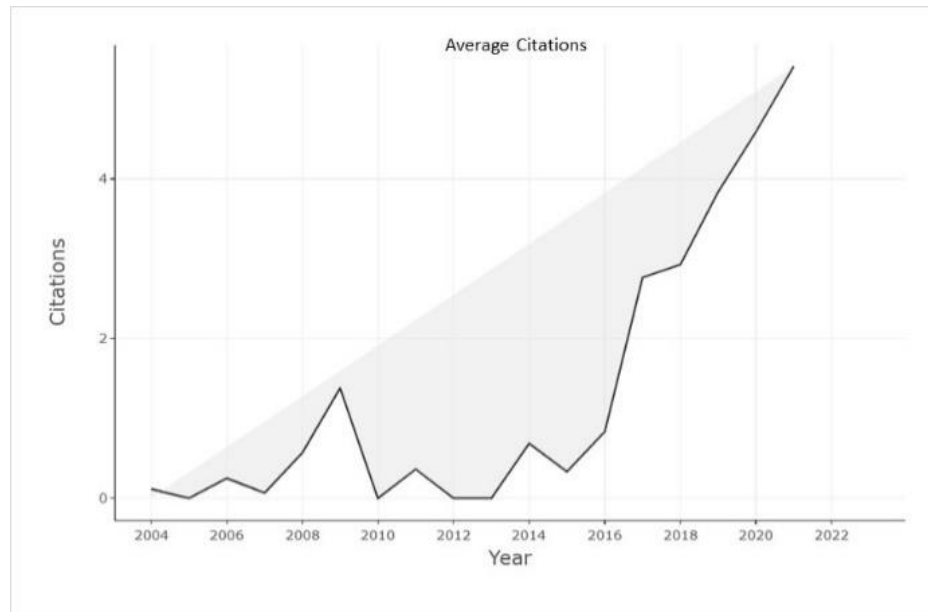


Figure 9. Average number of citations per publication by year

On the basis of keywords, document analysis is performed. As shown in Figures 10a and Figure 10b, when all or the 100 most frequently used keywords are considered, the papers are concentrated on only four: Industry 4.0, digital maturity, maturity model, and digital technologies. DM ranks second after DT when the cumulative occurrences of the keywords are plotted annually in Figure 11. Note that this figure only depicts the total number of occurrences of the most common keywords in the year 2022, whereas the numbers for other years can be read from the plot. For instance, by 2022, DT and digital maturity appeared 131 and 106 times, respectively.

Keyword Dynamics

Term	Cumulative Occurrences (by 2023)
DIGITAL TRANSFORMATION	131
DIGITAL ECONOMY	106
INDUSTRY 4.0	57
DIGITIZATION	55
DIGITAL READINESS	40
MATURITY MODEL	26
COVID-19	15
SME	15
DIGITAL MATURITY	15
DIGITAL ECONOMICS	0

Figure 11. The dynamics of frequently used keywords

Figure 12 depicts the most frequently employed keywords. Analyzing the trend topics of the documents, digital maturity remains the frontrunner; digitalization creates a new wave following digitization and advances in tandem with DM.

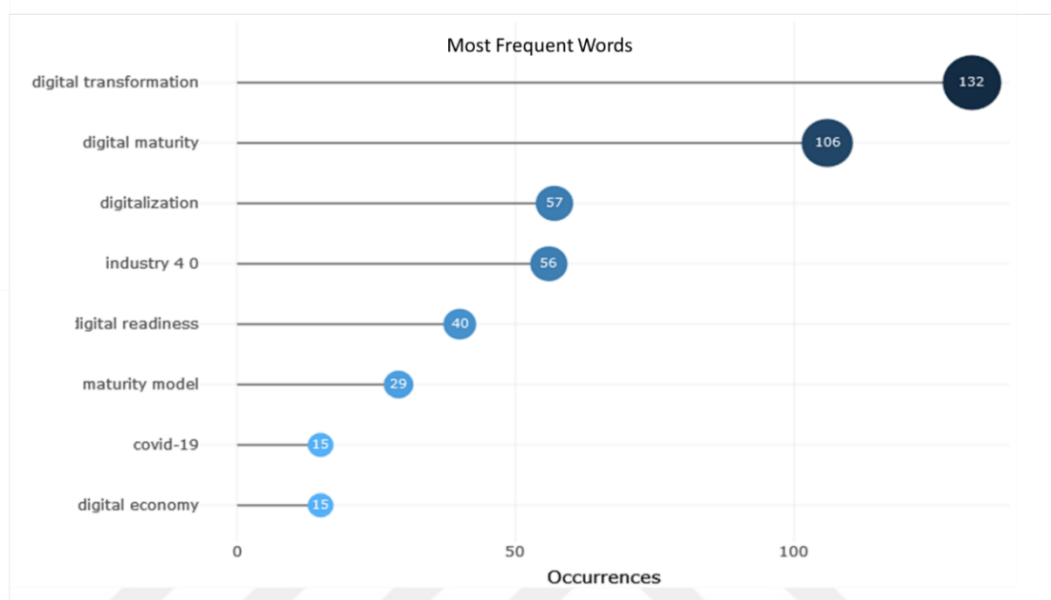


Figure 12. Most frequent keywords

Figure 13 demonstrates that the significance of digital solutions and big data, which reveal the effects and solutions of DT, has increased.

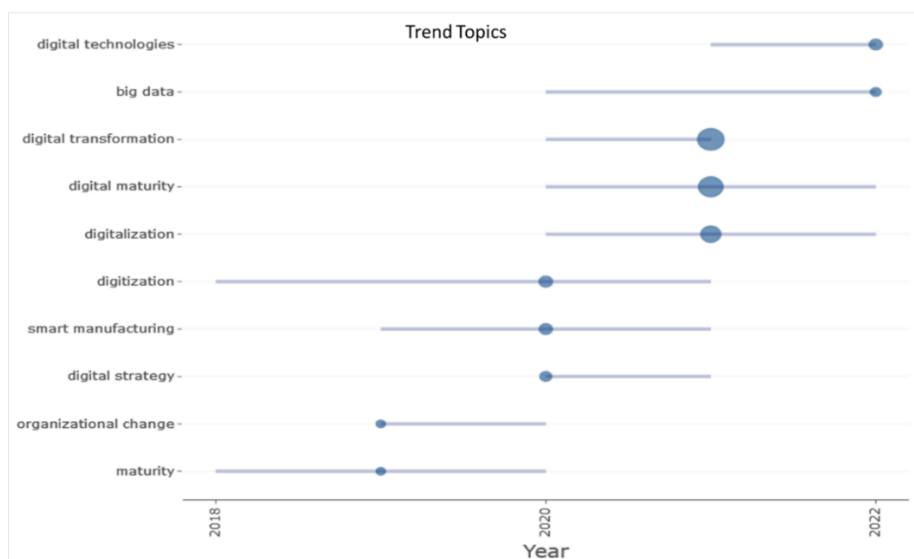


Figure 13. The evolution of trend topics

Knowledge Structure Focused Analysis permits the investigation of the relationships between concepts and their trends utilizing the following Biblioshiny network types: co-occurrence network, thematic map, and thematic evolution. As depicted in Figure 14, the network of co-occurrences reveals that DT is most frequently associated with digital maturity, digitalization, and Industry 4.0. According to the results of the thematic map, which displays clusters based on the density and centrality of the keywords, the keywords DT, DM, and digital model form a distinct and influential cluster across all publications (Figure 15). Keywords digitalization and Industry 4.0 yielded the second significant cluster. The COVID-19 cluster ranks third, followed by digital readiness.



Figure 14. Co-occurrence network

The R package Biblioshiny offers an interactive interface for bibliometric analysis. One of Biblioshiny's features is the capacity to generate a thematic evolution map of research themes that have evolved over various time periods. Themes are essentially groups of keywords selected by each paper's author. The map is made in the following way: First, for each time period in question, a network is

constructed from the articles in the database, where the nodes represent the keywords found in the articles and the edge between two keywords indicates that they co-occur in multiple articles. As the number of articles containing the two keywords increases, so does the edge's strength (or, equivalently, the similarity of the keywords).

On a thematic map, quartiers are divided into four distinct sections, each with its unique implications for the research field: *Quartier Q₁*, known as Motor Themes, consists of essential themes for planning and constructing the research field. These themes exhibit strong centrality and high density, making them the driving forces of the field. *Quartier Q₂*, or Highly Developed and Isolated Themes, features themes that are strongly related, highly specialized, and peripheral. Despite their development, they lack the necessary context or significance within the field. *Quartier Q₃* represents Emerging or Waning Themes, characterized by their relatively weak presence, low density, and centrality. These themes primarily denote those that are either emerging or fading within the research area. Lastly, *Quartier Q₄*, known as Fundamental and Transversal Themes, contains themes relevant to the research field but not yet well-developed. This quartier encompasses transverse and fundamentally general themes.

In the analysis, the emergence of DT, DM, and DMM in Quartier Q₁ can be interpreted as these themes being crucial for planning and constructing the research field due to their strong centrality and high density. The text also emphasizes that, as the driving forces of the field, these themes play a significant role in shaping the research landscape and should be prioritized in the ongoing development and exploration of the field (Figure 15).

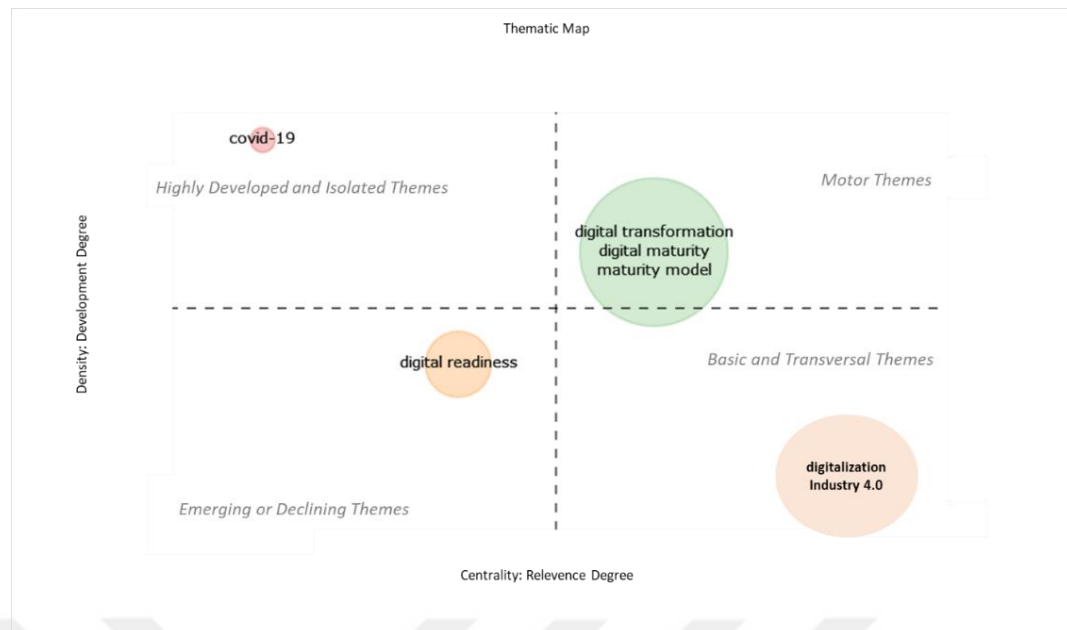


Figure 15. Thematic map

The keywords are grouped based on their similarities using a clustering algorithm. Each cluster corresponds to a distinct area of research. Consequently, the colored boxes at each time period in Figure 16 represent various research topics. When one or more keywords appear in both a theme from time period t and a theme from time period $t+1$, there is a connection between the two themes.

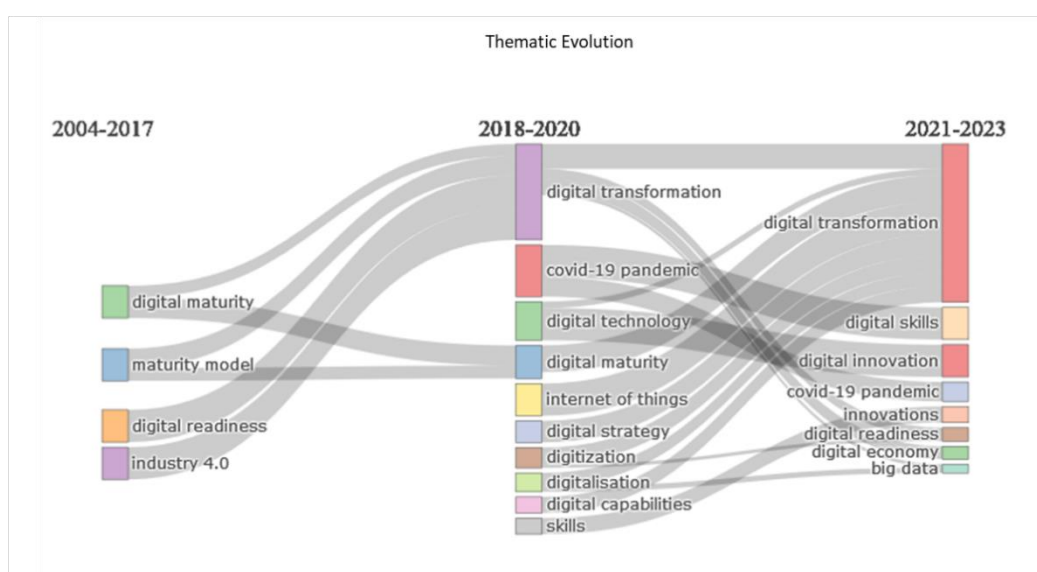


Figure 16. Thematic evolution map

Due to the dramatic increase in the number of documents in 2018, the time horizon has been divided into three time periods: 2004–2017, 2018–2020 and 2021–2022. Figure 16 depicts the thematic evolution of the DM theme from 2004 to 2017 in relation to itself and the DT theme from 2018 to 2020, as well as the maturity model theme from the first two time periods.

2.1.3.2 Results Analysis of Multiple Digital Maturity Models

The increasing significance of DT, its successful implementation, and its failures have prompted both academia and consulting firms to develop DMMs for DT-related projects. The growing importance of DT, along with its successful implementation and potential failures, has led both the academic and consulting sectors to create DMMs for DT related projects. Given that DMMs function as reference frameworks during the DT process, it was crucial in the thesis research to assess these models in terms of their thorough inclusion of critical success factors and socio-technical viewpoints of DT.

Before examining the DMMs, the thesis research assessed the existence of a systematic literature review on DMMs. Five review papers on DMMs were found, with two published in 2019 and three in 2020, as illustrated in Table 3.

Within the scope of DM, the most recent review paper considers documents published through 2020. Furthermore, existing review papers focus primarily on maturity models applicable to small and medium-sized businesses, whereas this study focuses on all papers regardless of industry, allowing for the development of a holistic and exhaustive model. The employment of PRISMA, a systematic literature review technique, in only two of these articles, along with the comprehensiveness of the examined models, highlight the need for a more in-depth analysis of these models.

After eliminating documents containing models that do not qualify as DMMs, the remaining models are examined in depth by separating them into two categories: academic paper models and consultancy firm models. For each category, a subsection is dedicated to the included dimensions and application areas.

Upon examining the DMMs in academic publications, Table 4 presents a list of academic works on DMMs, of which 49% are conference papers, 41% are journal articles, and 10% are book chapters. Only 20% of these book chapters adopted an enterprise-wide perspective, while 80% were tailored to specific industries.



Table 3. Review papers on digital maturity models

Reference	Focus Years	Number of Examined Models	Scope of Models	Analysis Method	Contribution/ Findings	Limitations
Hajoary (2020)	2011–2020	53 Industry 4.0 maturity and readiness models	Academia and consultancy-firm based	Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)	Proposes a holistic model in 10 main dimensions	Based on the Industry 4.0 literature and considers only manufacturing organizations
Hizam-Hanafiah et al., (2020)	2000–2019	30 Industry 4.0 readiness models	Academia and consultancy-firm based	Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)	Performs dimension analysis and groups them under 6 main dimensions	Focuses only on SMEs and analyzes a limited number of maturity models
Soomro et al., (2020)	2007–2019	22 digital readiness models	Academia based	–	Defines 4 critical success factors to achieve digital readiness	Academic and technology focused and analyzes a limited number of maturity models
Teichert (2019)	2018–2018	24 digital maturity models	Academia and consultancy-firm based	–	Determines that most of the digital maturity models are manufacturing-oriented and that a wide variety of digital maturity model stages exist	Literature review of only academic publications from 2018
Williams et al., (2019).	2011–2016	6 maturity models	Academia based	–	Proposes a digital maturity model for SMEs based on 6 dimensions	Focuses only on SMEs and analyzes a limited number of maturity models

All publications were analyzed with respect to four criteria. The first relates to whether a maturity model is proposed based on an analysis of the existing models; only 30% of the studies developed a new maturity model. The second criterion was that the developed model should be holistic; only 21% of the models were holistic. The third criterion asks whether the model is developed with a specific sector in mind; 65% of the models were sector-oriented. The last addresses the existence of a case study that supports the model; 40% of the models related to a case study. Only one study was found to have developed a new holistic model based on the analysis of existing models in the literature and presented an application of the model in the retail sector (Akdil et al., 2018). Thus, the results of the analysis show a holistic model based on a comprehensive literature review has not been developed yet.

Table 4. Maturity models existing in academic papers

Reference	Document Type	Dimensions	DA	HM	SM	CS
Al-Ali& Marks (2022)	Article	1. Digital Transformation Vision, Strategy, Leadership, and Communication, 2. Digital Transformation Talent, Skills, and Knowledge, 3. Digital Transformation Processes, Controls, and Digital Technologies, 4. Digital Transformation Technology Infrastructure, 5. Approach to Understand and Communicate Customers			√	
Barry et al.(2022)	Conference Paper	1. Structural, 2. Informational, 3. Environmental, 4. Security, 5. Quality, 6.Financial, 7. Cultural, 8. Innovation, 9. Participate	√			
Yang & Xu (2022)	Conference Paper	1. Strategy and Organization, 2. Infrastructure construction, 3. Business Innovation and Transformation, 4. Supply Chain Ecological Construction, 5. Digital Performance			√	
Duncan et al. (2022)	Article	1. Strategy, 2. IT Capability, 3. Interoperability, 4. Governance and Management, 5. Patient-Centered Care, 6. People, Skills, and Behavior, 7. Data Analytics			√	
Goumeh & Barforoush (2021)	Conference Paper	1. Customer, 2. Ecosystem, 3. Law, 4. Strategy, 5. Operation, 6. Technology	√		√	
Alsufyani & Gill (2021)	Conference Paper	1. Interaction Layer, 2. Technology Layer, 3. Human Layer, 4. Security Layer, 5. Environment Layer	√			
Cordes & Musies (2021)	Conference Paper	1. Customer Experience, 2. Innovation, 3. Process Digitalization, 4. Information Technology, 5. Digital Skills, 6. Strategy, 7. Culture, 8. Governance, 9.Organization, 10. Collaboration	√			
Yezhebay et al. (2021).	Conference Paper	1. People, 2. Leadership, 3. Strategy, 4. Technology, 5. Operation, 6. Product	√		√	√
Almasbekkyzy et al. (2021)	Conference Paper	1. Strategy, 2. Technology, 3. Operations, 4. Organization and Culture			√	√
Salume et al.(2021)	Article	1. Strategy, 2. Leadership, 3. Market, 4. Operations, 5. Culture, 6. People, 7. Governance, 8. Technology Capability			√	√
Kljajić Borštnar & Pucihar (2021)	Article	1. Digital Technology, 2. Management, 3. HR, 4. Strategy, 5. Digital Business Model, 6. Role of Informatics			√	√
Aslanova & Kulichkina (2020)	Conference Paper	1. Strategy, 2. Organization, 3. People, 4. Technologies, 5. Data	√			
Weritz et al. (2020).	Conference Paper	1. Capabilities Absorptive Capacity, 2. Agility and Flexibility, 3. Cross-functional Collaboration, 4. Innovation Capability, 5. Market Orientation, 6. Relational Capability			√	√
Colli et al. (2019)	Article	1. Governance, 2. Technology, 3. Connectivity, 4. Value Creation, 5. Competences	√		√	√
Bandara et al. (2019)	Conference Paper	1. Products and Services, 2. Technology and Resources, 3. Strategy and Organization, 4. Operations, 5. Customers, 6. Governance, 7. Employees	√		√	
Schumacher et al. (2018)	Article	1. Technology, 2. Products, 3. Customers and Partners, 4. Value Creation Processes, 5. Data and Information, 6. Corporate Standards			√	√
Canetta et al. (2018)	Conference Paper	1. Strategy, 2. Processes, 3. Technologies, 4. Product and Services, 5. People	√		√	
Rossmann (2018)	Conference Paper	1. Strategy Capability, 2. Leadership Capability, 3. Market Capability, 4. Operational Capability, 5. People and Expertise Capability, 6. Cultural Capability, 7. Governance Capability, 8. Technology Capability	√	√		
Akdil et al. (2018)	Book Chapter	1. Strategy and Organization, 2. Smart Products and Services, 3. Smart Business Processes	√	√		√

Table 4. Maturity models existing in academic papers (cont'd)

Reference	Document Type	Dimensions	DA	HM	SM	CS
Gimpel et al. (2018)	Article	1. Organization, 2. Product, 3. Value Chain, 4. Ecosystem, 5. Operations, 6. Customer, 7. Transformation Management, 8. Cloud and Data		√		
Horvat et al., (2018)	Article	1. Organization of Product and Logistics, 2. Employees and Communication, 3. Management and Strategy, 4. Technology, 5. Interim Cooperation			√	
Bibby & Dehe, (2018)	Article	1. Factory of the Future, 2. People and Culture, 3. Strategy			√	√
Botha (2018)	Article	1. Technology, 2. Behavior, 3. Events			√	√
Hamidi et al. (2018)	Conference Paper	1. Strategy and Organization, 2. Smart Factory, 3. Smart Operations, 4. Smart Product, 5. Data-driven Services, 6. Employees			√	√
Sjödén et al. (2018)	Article	1. People, 2. Process, 3. Technology			√	
Mittal et al. (2018)	Conference Paper	1. Finance, 2. People, 3. Strategy, 4. Process, 5. Product	√		√	
De Carolis et al. (2017)	Conference Paper	1. Organization, 2. Processes, 3. Technologies, 4. Monitoring and Control			√	√
Gökalp et al. (2017).	Book Chapter	1. Asset Management, 2. Data Governance, 3. Application Management, 4. Process Transformation, 5. Organizational Alignment	√	√		
De Carolis et al. (2017)	Book Chapter	1. Organization, 2. Processes, 3. Technologies, 4. Monitoring and Control			√	
Von Leipzig et al. (2018).	Article	1. Strategy, 2. Technologies, 3. People, 4. Governance, 5. Culture, 6. Product, 7. Operations, 8. Leadership		√		√
Klötzer & Pflaum (2017)	Conference Paper	1. Competence(s), 2. Innovation Culture, 3. Cooperation, 4. Strategy Development, 5. Process Organization, 6. Complementary IT System, 7. Smart Product and Factory, 8. Offering to Customer, 9. Structural Organization			√	√
Leino & Anttila (2017)	Conference Paper	1. Strategy, 2. Information Technology, 3. Business Model, 4. Customer Interface, 5. Organization and Processes, 6. People and Culture		√		
Valdez-de-Leon (2016)	Article	1. Strategy, 2. Organization, 3. Technologies, 4. Ecosystem, 5. Operations, 6. Customers, 7. Innovation			√	
Schumacher et al. (2016)	Article	1. Product, 2. Customers, 3. Operations, 4. Technologies, 5. Strategy, 6. Leadership, 7. Governance, 8. Culture, 9. People			√	√
Berghaus & Back (2016)	Conference Paper	1. Customer Experience, 2. Product Innovation, 3. Strategy, 4. Organization, 5. Process Digitization, 6. Collaboration, 7. Information Technology, 8. Culture Expertise, 9. Transformation Management		√		√
Rogers (2016).	Book Chapter	1. Customer, 2. Cloud and Data, 3. Innovation, 4. Competition, 5. Value		√		
Ganzarain & Errasti (2016)	Article	1. Processes, 2. Product, 3. Value Network, 4. Market			√	
Leyh et al. (2016).	Conference Paper	1. Basic Digitization Level, 2. Cross-Departmental Digitization, 3. Horizontal and Vertical Digitization, 4. Full Digitization, 5. Optimized Full Digitization			√	

DA: Dimension Analysis, HM: Holistic Model, SM: Sector-Based Model, CS: Case Study and Assessment Results.

A total of 236 dimensions were identified in the 38 publications analyzed and was reduced to 123 by eliminating the common ones. Finally, 12 dimensions were obtained by grouping similar and frequently used ones: strategy, technology, operations, products and services, governance, people, customers, processes, innovation, culture, value and value chains, and leadership. It was found that both alignment with the strategies to maximize the value targeted by DT and the technology, as well as the processes, products, services, and operations where the technology is applied to realize the strategies, play a crucial role. Further, governance and leadership must support the impact of transformation on employees and culture.

The models of consulting firms presented in Table 5 were analyzed to compare them with academic studies. This analysis was based on both dimensions and sub-dimensions, and aimed to validate the comprehensiveness of the holistic model needed. It can be observed that 90% of these publications present a sector-independent model. An analysis was conducted to determine the main dimensions considered. This results in strategy, culture, technology, operations, process, organization, and customer experience.

Upon literature review, it was observed that there is no holistic model that could be implemented by all companies, regardless of sector and size. How the maturity model will be positioned and used end-to-end from the planning stage to the value creation stage in the digitization process has also not been addressed. In this context, there has arisen a need to focus on subject-based literature, which will serve as the basis for the model to be designed, and it was aimed to design a holistic model within the scope of the digital journey.

Table 5. Consultancy-firm-based maturity models and dimensions

References	Consultancy Firms' Model Name	Dimensions
Bain & Company, n.d.	Digital Readiness Survey	1. Business Model, 2. Digital Strategy, 3. Enablers, 4. Orchestration
Deloitte (2022)	Deloitte Digital Maturity Survey	1. Strategy, 2. Innovation, 3. Experience, 4. Digital Channels and Sales, 5. Digital Marketing, 6. Data and Insights, 7. Cyber Security
Earley Information Science, n.d.	Digital Transformation Roadmap	1. Technology, 2. Process, 3. People, 4. Content
Ernst & Young, n.d.	Global Business Service Maturity (GBS)	1. Strategy, 2. Operations, 3. Control and Measurement
Felch et al. (2019)	Digital Capability Assessment (DCA)	1. Strategy and Leadership, 2. People and Culture, 3. Product and Service, 4. Customer Experience, 5. Enterprise Enablement
Gartner (internal source)	Digital Business Maturity Model	1. Digital Strategy and Execution, 2. Customer Experience Management, 3. Digital Product, Service and Digital Revenue, 4. Infonomics, 5. Digital Channels and Ecosystem, 6. Business Agility, 7. Innovation Culture, 8. Digital Leadership, 9. Digital Workplace
(Gartner, n.d.)	Digital Execution Scorecard	1. Generate Digital Revenue, 2. Excel in Customer Experience, 3. Organizational Excellence, 4. Optimize Asset Utilization, 5. Minimize Risk
Geissbauer et al. (2016)	Digital Transformation Framework	1. Digitalization Value Chain, 2. Digital Business Model and Customer Access, 3. Digitalization of Product and Service
Forrester (2017)	Digital Maturity Model 4.0	1. Technology, 2. Insight, 3. Organization, 4. Culture
IMPULS Industry, n.d.	Industry 4.0 Readiness	1. Strategy and Organization, 2. Smart Factory, 3. Smart Operations, 4. Smart Products, 5. Data-Driven Services, 6. Employees
KPMG (2016)	Digital Business Aptitude (DBA)	1. Strategy, 2. Governance, 3. Talent, 4. Process, 5. Infrastructure
Li et al. (2020)	Altimeter's Digital Maturity Assessment	1. Customer Experience, 2. Leadership and Culture, 3. Marketing and Sales, 4. Technology and Innovation, 5. Data and Analytics
McKinsey (internal source)	Digital Quotient (DQ)	1. Strategy, 2. Culture, 3. Organization, 4. Capabilities
Runfrictionless, n.d.	BSC's The Digital Acceleration Index (DAI)	1. Business Strategy Driven by Digital, 2. Customer offer and Go-To-Market, 3. Operations, 4. Support Functions, 5. New Digital Growth, 6. Changing Ways of Working, 7. Leveraging the Power of Data and Technology, 8. Integrating Ecosystems
Runfrictionless, n.d.	Digital Transformation Framework	1. Digitize the Customer Experience, 2. Digitize the Products and Services, 3. Digitize Operations, 4. Digitize the Organization
Runfrictionless, n.d.	Industry 4.0 Digital Operations Self-Assessment	1. Business Models, Product and Service Portfolio, 2. Value Chain and Processes, 3. Market and Customer Access, 4. IT Architecture, 5. Organization and Culture, 6. Compliance, Legal, Risk, Security and Tax
Runfrictionless, n.d.	Digital Transformation Framework	1. Customer Experience, 2. Operational Processes, 3. Business Model, 4. Digital Capabilities

Table 5. Consultancy-firm-based maturity models and dimensions (cont'd)

References	Consultancy Firms' Model Name	Dimensions
Schuh et al. (2017)	Industry 4.0 Maturity Index	1. Information Systems, 2. Culture, 3. Process, 4. Organizational Structure
Tmforum, n.d.-a	Digital Maturity Model	1. Strategy, 2. Customer, 3. Operations, 4. Technology, 5. Organization and Culture
Tmforum, n.d.-b	Open Digital Framework (ODF) DMM Readiness Check Assessment	1. Information Systems, 2. Deployment and Runtime, 3. Implementation, 4. Governance
Tmforum, n.d.-c)	Digital Maturity Model	1. Strategy, 2. Customer, 3. Operations, 4. Technology, 5. Data, 6. Culture
World Economic Forum (2018)	Digital Competency Framework	1. Company Transformation, 2. Market Transformation, 3. Digital Workforce Transformation

2.2 Topic Based Literature Review

After the systematic literature review, a subject-based literature review is conducted in five areas with the aim of deeply focusing on the emerging concepts and defining the gaps in the literature towards answering research questions (Figure 17).

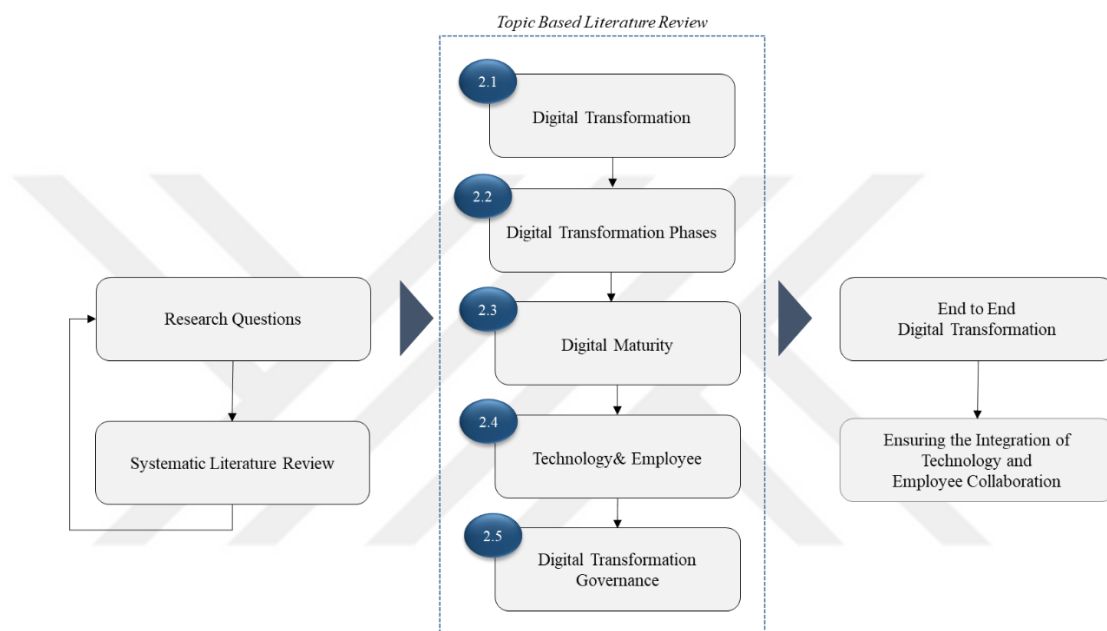


Figure 17. Topic based literature review studies

2.2.1 Digital Transformation

“DT” refers to the process of implementing cutting-edge digital technologies to support significant business improvements that either result in a better customer experience and more efficient operations or the creation of new business models (Warner & Wäger, 2018). To provide value to customers, businesses, and other important stakeholders involves identifying organizational needs and designing new processes or using digital technologies to redesign existing ones (Mergel et al., 2019; Moreira et al., 2018; Vial, 2021). DT should be managed holistically because it affects social, technological, and managerial aspects of the organization at all levels

(Henriette et al., 2015; Verhoef et al., 2021). Additionally, the transformation component suggests that the organization's structure and strategies will undergo significant changes (Berghaus, 2016). DT can therefore be seen as an adoption process that needs to be actively planned, launched, and carried out (Berghaus, 2016). It may also be seen as a process that enables organizations to generate value by combining internal and external resources and using digital solutions to accomplish their objectives. According to its own vision and maturity, each institution moves through specific stages along the way.

Flatter hierarchies, increased people management, cross-functional collaborations, and top management support have been identified by Kurmann and Arpe (2019) as critical success factors in DT implementation. Businesses should make use of digital technologies and customer-centered performance indicators as additional DT business practices (Hrynko, 2019). To avoid circumstances in which they are unable to compete or even survive, they should also evaluate their business models (Kotarba, 2018). Therefore, the strategies used to change business processes are just as important to DT's success as the technology itself. Managers from a variety of industries concur that DT should transition an organization from one in which marginal efficiency gains are sufficient to one in which fundamental innovation principles are applied and disruptive strategies are developed (World Economic Forum, 2016).

Due to the inherent complexity of IT administration and the paucity of studies on how businesses can systematically adopt DT, organizations often struggle to match the appropriate digital approaches and actions during their DT journey (Ikegami & Iijima, 2020). Numerous organizations struggle with a variety of issues, such as weak IT collaboration with other business processes and cultural and talent

gaps (Dhasarathy et al., 2020). A McKinsey report (2018) states that DT necessitates reskilling human resources, modifying organizational culture, encouraging stronger connections between IT and business processes, and meticulously measuring digital value. Therefore, the strategies used to alter business processes are just as important to DT's success as the technology itself. Processes are given life by employees and their working methods. In this situation, an examination of the organizations' capabilities, cultures, and human capital profiles is vital. The dimensions existing in the literature (Griva et al., 2023) can also be used to demonstrate how these dimensions have an impact on digitalization studies.

One subject on which the literature has concentrated is DT, which is defined as a journey that aims to view DT as a holistic, inclusive, and sustainable initiative. The phrase "DT journey" has been in use for some time, and its originator is unknown. However, one of the earliest references to DT in a business context can be found in a report titled "DT: A Roadmap for Billion-Dollar Organizations," released by the MIT Center for Digital Business in 2011 (Capgemini Consulting, 2017). The report highlights the need for businesses to adopt DT to stay competitive and discusses how DT is upending conventional business models. The phrase "DT journey" has since grown in popularity, as businesses of all sizes and in a variety of industries have realized the significance of DT. This essay defines the DT journey as an effort to acquire digital capabilities and to transform them into value. To complete this journey, it is necessary to pinpoint current areas for improvement, to develop a roadmap based on the objectives, and to ensure that the plans and projects support the strategies and objectives.

2.2.2 Digital Transformation Phases

The three stages of digital advancement in organizations are digitization, digitalization, and DT (Hägg & Sandhu, 2017; Verhoef et al., 2021). While digitalization refers to how information technology (IT) or digital technologies can be used to alter current business processes, digitization is defined as the encoding of analog data into a digital arrangement that enables computers to store, process, and disseminate such information. Digitalization can be thought of as the development of new mobile communication channels that make it easier for customers to interact with the company (Verhoef et al., 2021). IT is a key factor in the digitalization process because it creates new business opportunities by modernizing operations such as distribution, communication, and the management of client relationships (Hägg & Sandhu, 2017; Verhoef et al., 2021). The final phase of technological advancement (DT) sees the restructuring of crucial business processes to improve a company's value creation strategy (Gökalp & Martinez, 2021; Hägg & Sandhu, 2017).

The digitization phase requires capabilities such as scanning and data capture technologies, data storage and management solutions, and quality control and data validation processes. The technology–employee interaction intensity during this phase is relatively low. The digitalization phase necessitates the implementation of digital tools and technologies (e.g., enterprise resource planning, analytics tools), process reengineering and workflow optimization, and employee training in digital skills and technologies. The technology–employee interaction intensity in this phase is moderate. However, this is a critical turning points in terms of implementing the technology and starting to work with technological solutions. The DT phase requires strong leadership commitment and vision, an agile and flexible organizational

structure, the adoption of data-driven decision-making and analytics, and the integration of customer-centric strategies and technologies. The technology–employee interaction intensity in this phase is high.

For organizations embarking on their DT journey, it is crucial to understand and consider the phases of digitization, digitalization, and DT. The development of a clear roadmap is a primary benefit of breaking down the process into distinct phases, allowing organizations to prioritize investments, allocate resources, and set achievable goals for each phase (Kane et al., 2015).

Another advantage of considering each phase individually is the ability to establish clear metrics and benchmarks to evaluate progress and make data-driven decisions. This approach helps organizations to measure their progress and success, leading to more effective and well-managed DT initiatives (Kane et al., 2015).

A 2020 McKinsey Global Survey on DT found that the COVID-19 pandemic had significantly accelerated the adoption of digital technologies, with companies rapidly embracing digitization, digitalization, and DT to adapt to the new normal (Baig et al., 2020). The survey indicated that companies had advanced their digitalization efforts by three to four years, on average, with sectors and organizations prioritizing specific phases depending on their needs and existing capabilities (Baig et al., 2020).

2.2.3 Digital Maturity

According to Gökalp and Martinez (2021), DM, is the stage at which digital technology has transformed an entity's activities, skill engagement, and business frameworks. It is what Hägg and Sandhu (2017) refer to as the situation in which an organization has undergone a transformation and has been successful in addressing issues related to digital business landscapes. According to Schumacher et al. (2016),

maturity is defined as the state of being ideal or total, which suggests that a system's developmental stage has advanced. Teichert (2019) uses the term "DT maturity" to acknowledge that there are managerial and technological components to the relationship between DT and DM. According to Gartner (2020), DM is the degree to which a company has adopted digital technologies and business practices to boost its operations and facilitate DT. According to these definitions, DM is a crucial indicator of how well DT adaptation is performing.

By evaluating an organization's capabilities, readiness, and progress in implementing digital technologies to transform its business operations and stay competitive in the digital age, DMA determines the organization's level of digital maturity. To determine an organization's level of DM, this assessment looks at how well the organization is performing in key areas of strategy, culture, processes, technology, and data analytics, using a variety of frameworks, models, and tools. DMA is essential for organizations looking to thrive in the digital age, according to the literature and shared sources such as Kagermann et al. (2013), Ross et al. (2019), and Westerman et al. (2014). Organizations can use the process to identify gaps in their digital capabilities and gain insights into where they need to develop to stay competitive.

A maturity model, according to Berghaus and Back (2016), provides direction on the strategy that a company should choose to plan and implement DT. The main benefit of a maturity framework is easier assessment of the current situation and the clarification of possible, expected, and typical development paths to the desired position (Gökalp & Martinez, 2021). With the help of DMMs, organizations can analyze their capacity to respond to DT based on predefined milestones (Gill & Van Boskirk, 2016).

DMMs, according to Berghaus and Back (2016), include dimensions and sub-dimensions that identify areas for improvement and gauge maturity at various levels, indicating the path of evolution toward full maturity. A “dimension” is defined as a quantifiable, discrete element that represents a significant, important, and distinct aspect of DM (Teichert, 2019). Organizations seeking for the assessment of their progress in DT must use a DMM appropriate for the organization’s industry and objectives.

Once the model has been chosen, the organization must identify the key dimensions it will use to assess its digital maturity-such as strategy, culture, technology, organization, and data (Westerman et al., 2014). After determining the dimensions, the organization must evaluate its current state in each of them. This step involves collecting data from surveys, interviews, and analyses of existing processes and practices. When the assessment is complete, the organization assigns scores to each dimension based on performance. Analyzing these results, the organization can identify gaps and areas in need of improvement, thus helping to prioritize DT initiatives (Gartner, 2020).

To address the identified gaps and improvement areas, the organization must develop a comprehensive action plan, including goals, timelines, and resources required to enhance DM (Ross et al., 2019). Continual monitoring and reassessment of DM are crucial for ensuring that the organization stays on track to meet its goals. This ongoing process helps organizations to remain agile and to adapt to changing business environments (Gartner, 2020).

2.2.4 Technology and Employees

As DT has reshaped various industries in recent years, the effects on workforces have become increasingly apparent. This overview highlights some key

publications that discuss the latest trends and challenges faced by employees in this rapidly changing landscape, focusing on how technological advancements in digital solutions are altering the nature of work.

In *The Future of Work: Robots, AI, and Automation* by Darrell M. West (2018), the author delves into the effects of technology such as robotics, AI, and automation on workforces. West (2018) argues that these advancements will lead to job displacement, the creation of new jobs, and the transformation of existing roles.

Another important publication is the World Economic Forum's "The Future of Jobs Report 2022" (Whiting, 2022). This report highlights the rapid acceleration of technological change in the workplace and predicts the emergence of new job categories and the decline of others due to automation and AI. The study suggests that the reskilling and upskilling of workforces will be crucial to cope with the ever-changing demands of the labor market. It further emphasizes the role of the private sector, governments, and educational institutions in enabling individuals to acquire the skills needed for the jobs of the future.

Big Data and analytics are transforming the workforce, as explained by Davenport (2014). The growing use of data-driven decision-making is changing how work is performed and assessed, presenting both challenges and opportunities for employees. While harnessing data can improve productivity, relying too heavily on it in the workplace will have pitfalls.

Finally, Kurmann and Arpe (2019) offer a comprehensive look at the impact of AI on the workforce. The authors explore the concept of "collaborative intelligence," in which humans and machines work together to achieve optimal outcomes. The book provides numerous case studies and examples of how businesses can successfully integrate AI into their operations while addressing the

need to rethink organizational structures and employee skillsets in the face of rapid technological change.

The systematic review by Kolade and Owoseni (2022) analyzed the disruptive impact of DT on work, examining a collection of 68 scholarly outputs published between 2011 and 2022. There, the future of work is defined by the concept of “Employment 5.0,” which refers to the next phase of the labor market, characterized by increased integration of technology and human capabilities. This new era is expected to bring about fundamental changes in how organizations operate, the skills required of workers, and the nature of work itself. Key aspects of Employment 5.0 will include increased reliance on AI and automation, a shift toward remote and flexible working arrangements, and the growing importance of reskilling and upskilling to remain competitive in the labor market. To succeed in this new environment, both employees and employers will need to adapt to these changes and invest in lifelong learning, as well as the development of new skills and capabilities.

So, the collaboration between technology and the workforce is an area of ongoing research and debate, with many recent publications shedding light on the challenges and opportunities that lie ahead. It is essential for individuals, organizations, and policymakers to remain informed and to adapt to the evolving landscape in order to thrive in the future world of work.

DT technologies can be classified into various types, depending on the criteria or framework in use. It is also possible to examine DT technologies from the perspective of employee collaboration by categorizing them as employee collaboration technologies and non-employee collaboration technologies. This classification indicates the extent to which these technologies directly support or promote collaboration among employees in an organization.

Employee-collaboration based technologies are the digital technologies designed to promote teamwork, communication, and cooperation among employees.

These technologies enable employees to work together more effectively and efficiently, fostering a more collaborative and innovative work environment.

Examples of employee-collaboration-based technologies include the following:

- Enterprise social networks and collaboration platforms such as Microsoft Teams, Slack, and Workplace by Facebook facilitate real-time communication and collaboration among employees, enabling file sharing, project management, and instant messaging (Leonardi et al., 2013).
- Knowledge management systems are digital platforms that allow organizations to capture, store, and share knowledge among employees, promoting collaboration by providing easy access to relevant information, best practices, and expert insights (Alavi & Leidner, 2001).
- Video conferencing and telepresence technologies enable remote collaboration by allowing employees to interact and communicate as if they were physically present in the same location, thereby helping to bridge geographical distances and foster collaboration among distributed teams (Karis et al., 2016)
- RPA involves the use of software robots to automate repetitive, rule-based tasks without direct human intervention. This technology enables organizations to improve efficiency, reduce costs, and increase scalability. By freeing up employee time and resources, RPA promotes collaboration by enabling team members to work together on higher-value tasks (Davenport & Kirby, 2016).

Non-collaboration based technologies, in contrast, are digital technologies that focus on improving business processes, automation, and decision-making without directly promoting collaboration among employees. Examples of these include the following:

- Big Data and analytics which involve the collection, processing, and analysis of large volumes of structured and unstructured data enable businesses to make informed decisions and optimize their operations (Provost & Fawcett, 2013).
- The IoT describes the networking of interconnected physical devices, vehicles, buildings, and other objects embedded with sensors and software to enable automation, monitoring, and decision-making in various industries (Ashton, 2009).
- Cloud computing which involves the delivery of computing services over the internet allows businesses to access resources on-demand, improve scalability, and reduce infrastructure costs (Mell & Grance, 2011).

Indeed, certain DT technologies, such as RPA and Big Data and analytics, can be seen as bridging the gap between collaboration-based and non-collaboration-based technologies. Their impact on collaboration may depend on the extent to which employees choose to automate tasks and leverage data-driven insights in their daily work. In this context, a focusing on RPA technology can provide valuable insights into its potential for fostering employee collaboration.

When organizations implement RPA to automate their tasks and processes, they generate a wealth of data through these automated workflows (Lacity & Willcocks, 2018). This data can then be utilized by Big Data and analytics tools to extract valuable insights and support data-driven decision-making (Agrawal et al., 2018). In other words, RPA can help organizations to efficiently collect and organize

their data, laying the groundwork for more advanced Big Data and analytics initiatives.

Moreover, the integration of RPA with Big Data and analytics can permit the further optimization of business processes, as the insights derived from the data analysis can be used to identify areas for improvement and guide the development of more efficient automation strategies (Wuest et al., 2016). This synergy between RPA and Big Data and analytics can enable organizations to achieve higher levels of DM and drive continuous improvement in their operations.

2.2.5 Digital Transformation Governance

DT governance is a critical aspect of any organization's journey toward embracing digital technologies and improving its own overall competitiveness. In essence, DT governance refers to the processes, structures, and guidelines that help organizations to manage and steer their digital initiatives toward desired outcomes (Matt et al., 2015). The need for effective DT governance cannot be overstated. Without proper governance, organizations risk encountering numerous challenges and potential failures, which can have significant implications for their DT efforts.

One of the key challenges that organizations face in the absence of DT governance is a lack of clear strategic direction. A robust governance framework helps to align DT initiatives with the organization's overall strategy and ensures that digital investments align with the strategic objectives (Verhoef et al., 2021). In the absence of proper governance, organizations may encounter difficulties in identifying priorities, allocating resources, and coordinating digital projects, which can lead to inefficiencies and delays.

Another challenge is the lack of accountability and oversight. DT governance provides a system for monitoring and evaluating the progress of digital initiatives,

which is essential for ensuring their success (Matt et al., 2015). Without a governance framework in place, organizations may struggle to hold stakeholders accountable for their actions, which can lead to poor decision-making, inadequate resource allocation, and ultimately project failures. Moreover, the absence of DT governance can result in poor change management. DT involves a significant degree of organizational change, which requires comprehensive planning, communication, and stakeholder engagement (Verhoef et al., 2021). An effective governance framework helps organizations to manage the change process by clearly defining roles and responsibilities, ensuring transparent communication, and addressing potential resistance. In the absence of governance, organizations may experience difficulties in managing change, leading to employee resistance, lower morale, and project failures.

Finally, a lack of DT governance can result in inadequate risk management. DT projects often involve new and unfamiliar technologies, which can introduce various risks, including cybersecurity threats, data privacy issues, and potential disruptions to existing processes (Matt et al., 2015). An effective governance framework ensures that organizations proactively identify, assess, and mitigate these risks. Without proper governance, organizations may be exposed to higher levels of risk, which can lead to costly incidents and project failures.

In conclusion, DT governance is an essential aspect of an organization's DT journey. By implementing effective governance strategies, organizations can mitigate the challenges and avoid the potential failures associated with an absence of proper governance. This then enables organizations to attain DT success and harness the full potential of digital technologies

CHAPTER 3

DIGITAL TRANSFORMATION JOURNEY AND HOLISTIC DIGITAL MATURITY MODEL DESIGN

As can be easily seen in the literature review, DMMs play a crucial role in DT, serving as a catalyst throughout the process. However, a truly holistic DMM model does not exist in the literature. Therefore, this study aims to develop a comprehensive DMM that addresses all critical factors and capabilities necessary for a complete DT process which encompasses not only organizations but also all stakeholders, employees, and technologies involved, regardless of an organization's sector or size (Figure 18).

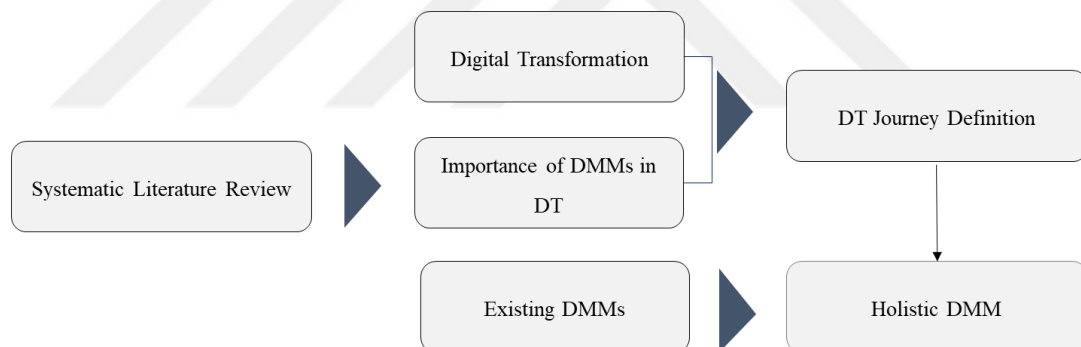


Figure 18. Digital maturity model design process

The analysis of existing models developed by both academia and consulting firms unveils the scope of current DMMs also highlights commonly used dimensions within these models while also identifying unique dimensions that offer fresh perspectives. A key takeaway from this analysis is the lack of a systematic methodology in model development, emphasizing the need for a holistic DMM.

3.1. Digital Transformation Journey

One of the earliest references to DT in a business context can be found in a report titled “DT: A Roadmap for Billion-Dollar Organizations” prepared by the MIT Center for Digital Business in 2011 (Warner & Wäger, 2018). This report discusses how digital technologies disrupt traditional business models and stresses the necessity for businesses to adopt DT in order to remain competitive. Since then, the term “DT journey” has become more prevalent, as organizations of all sizes and industries have realized the significance of DT. In this thesis, the DT journey is defined as the process of acquiring digital capabilities and transforming them into an asset. This journey involves identifying current areas for improvement, developing a road map based on the objectives, and ensuring that plans and projects contribute to the achievement of strategies and objectives.

The review of the relevant literature reveals that no holistic maturity model exists to be implemented in a DT journey. New models are obtained by modifying and extending the existing models with new dimensions and sub-dimensions, which gives rise to an incremental increase in the coverage and usability of the new models. To maximize the value that a DMM can bring to the DT journey, the latter must be defined as having four stages: awareness, readiness, planning, and execution (Figure 19).

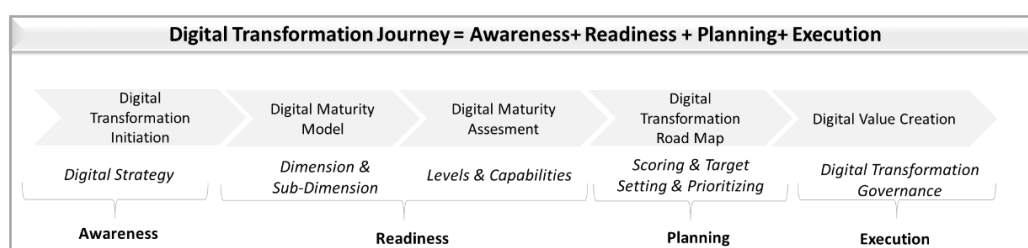


Figure 19. DT journey

- Awareness: It pertains to an organization's decision to initiate DT within the framework of a strategy or strategic initiative to achieve its goals.
- Readiness: The first of this two-step process is the development of a reference model that can reveal the extent and scope of DT, the gaps the organization needs to close, and the improvement areas that require new approaches to implement the intention set forth in the awareness stage. The second step is to perform an assessment based on this model.
- Planning: It provides an input for the creation of a digital roadmap by scoring the assessment results in parallel with the goals and priorities set by the organization.
- Execution: It deals with the systematic implementation and maintenance of the continuity and sustainability of the roadmap.

3.2. The New Holistic Digital Maturity Model

The design of a DMM is a critical step in an organization's DT journey, enabling the assessment and development of digital capabilities and providing a structured approach to achieving digital success. Designing an effective DMM also requires a thorough understanding of existing models in the literature and their limitations, as well as the incorporation of emerging trends and best practices in the field of DT. Taking into consideration the need for comprehensiveness and inclusivity, the DMM proposed in the thesis has been designed with inspiration from the WH (Why, What, Where, Which, Who, How) question framework after examining all existing models in the literature. The following six questions are designed to provide a comprehensive understanding of DT and its implications for organizations:

1. **Why** are the main objectives of DT important? This question seeks to identify the specific goals and targets that an organization aims to achieve through the implementation of DT initiatives, emphasizing the significance of understanding these objectives to ensure the success of the transformation process.
2. **What** value does DT offer? This question addresses the tangible and intangible benefits that an organization can expect to gain from the successful execution of DT, including competitive advantages, operational efficiencies, and enhanced customer experiences.
3. **Where** (in which processes) should the organization apply digital projects? This question focuses on pinpointing the areas within an organization's operations where the integration of digital technologies and projects can deliver the most significant impact and value, determining the optimal locations for their implementation.
4. **Which** technologies support the DT? This question explores the various technological innovations and tools that can be leveraged to facilitate the DT process, such as AI, big data analytics, cloud computing, the IoT, cybersecurity, and risk management solutions. By incorporating these technologies, organizations can ensure a secure and robust DT journey.
5. **Who** is responsible for implementing the DT among employees, and how will they adapt to and collaborate with technology? This question delves into the roles and responsibilities of various employees within an organization in driving the DT process forward. It seeks to understand how employees at different levels, from entry-level to senior management, can contribute to the successful implementation of DT initiatives, as well as

the necessary training, skill development, and support required to empower them in this transformational journey. Furthermore, this question examines how employees will adapt to working with technology and the strategies they will employ to effectively collaborate with technological tools and innovations throughout the DT process.

6. **How** should DT be governed and sustained over time? This question investigates the strategies, practices, and governance structures that an organization can adopt to ensure the long-term success and continuous improvement of its DT initiatives. Key elements to consider include change management, organizational culture, ongoing investment in digital capabilities, and the establishment of a robust governance framework that aligns DT efforts with the organization's overall strategic objectives and promotes accountability, adaptability, and collaboration across all levels of the organization.

The new holistic DMM allows organizations to identify gaps between their current situation and objectives based on their assessment. Comprising six dimensions and twenty-four sub-dimensions, the model not only encompasses all dimensions and sub-dimensions found in existing models but also covers all aspects that need to be addressed during a DT journey (Figure 20).

The first dimension of the model, digital strategy, assesses the ability of corporate-level vision, strategic direction, and DT goals that create value. For this purpose, five sub-dimensions are defined. The “vision” sub-dimension investigates DT’s vision and its comprehension. The “strategies” sub-dimension focuses on the DT strategy and how the competitive advantage that can be obtained through DT is defined. The “business model” sub-dimension relates to the new value proposition

presented by digitalization and the degree to which an extension of the existing product and service portfolio is desired. The “operation model” sub-dimension examines how digitalization impacts the organization’s current operation model. The “leadership sub-dimension” investigates the extent to which digitalization studies are embraced and internalized by leaders.

In this model, the strategy sub-dimension stands out as a distinct component, and only a handful of models define the business model and leadership as distinct dimensions. The second dimension, digital value, focuses on the evaluation of the impact of DT on the value and product portfolio offered to the customer, as well as the scope and dimensions of differentiation in customer value processes. This dimension was broken down into three sub-dimensions. The “create value” sub-dimension questions the role of digitalization in providing new value to the customer and the value proposition difference it creates. The “deliver value” sub-dimension examines the impact of digitalization on the ability to provide new and innovative products/services. In the “capture value” sub-dimension, the emphasis is placed on evaluating the new and innovative products offered to customers via digitalization, new customers, market share among existing customers, and competitive advantage. Despite the fact that the holistic view of this dimension is not perceived under the umbrella of digital value dimensions in the reviewed models, new products are handled in various dimensions in the context of new product launch, innovation, and offering new value to customers.

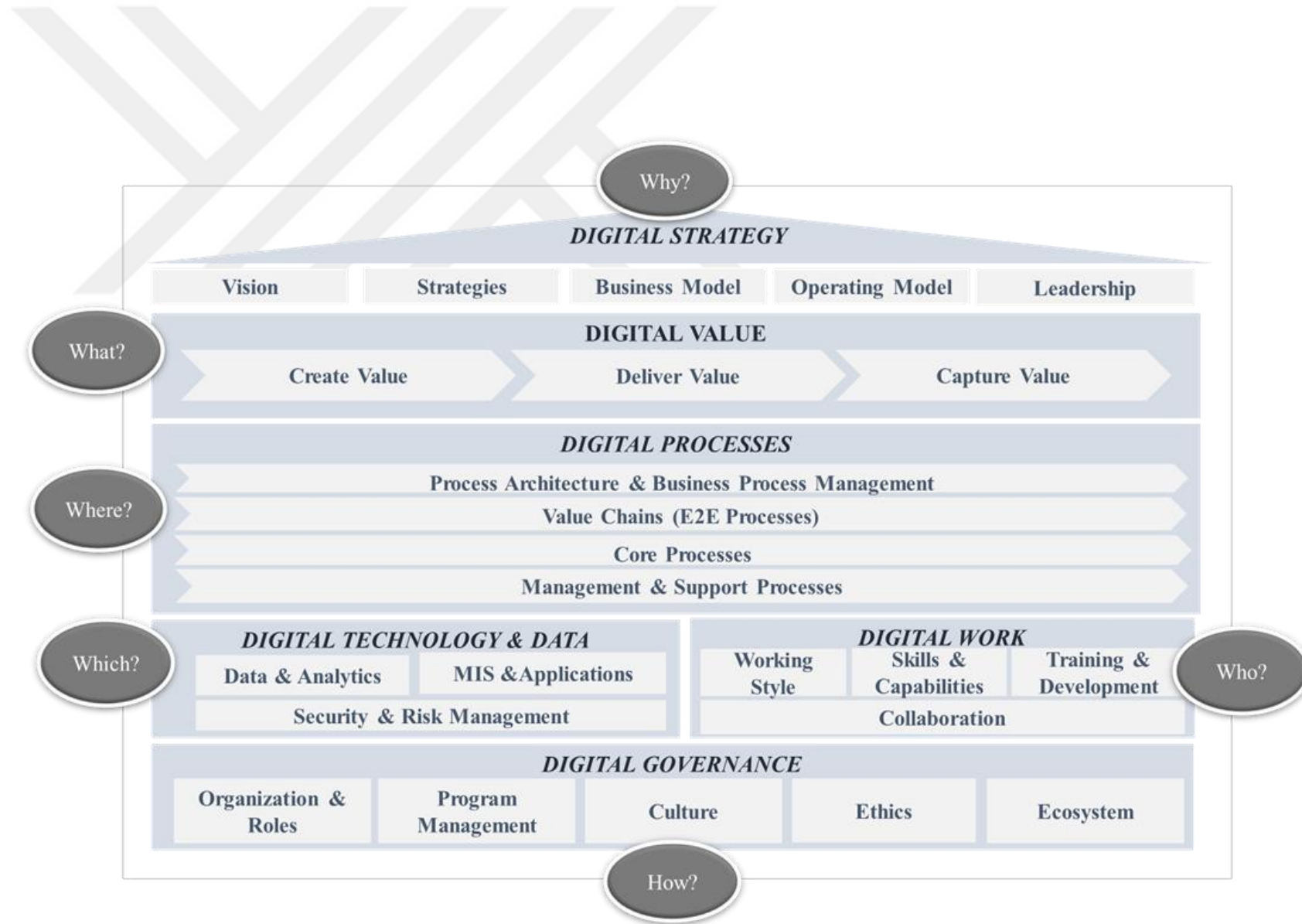


Figure 20. The new holistic DMM

The third dimension focuses on the degree to which DT has been implemented for the processes and is comprised of digital processes. Four sub-dimensions are defined. The “process architecture & business process management” sub-dimension examines the impact of strategies on the organization’s processes and process architecture, as well as the management of digitalized processes. The “value chain” sub-dimension addresses the impact of digitalization on the value chain and the interplay between processes. The “core processes” sub-dimension examines the fundamental processes, such as operations, supply chain, and sales, in which digitalization will be implemented and the extent to which it will have an impact on and alter these processes. The “management & support processes” sub-dimension focuses on the effects and modifications that digitalization will bring to management and support processes. In the reviewed models, this completeness is not observed within the context of digital processes; rather, operational processes are the primary focus. In the proposed model, the evaluation of the impact of digitalization on all organizational processes is beneficial in terms of both enabling the application of a sector-independent model and revealing additional digitalization benefits.

The fourth dimension, “digital technology and data,” focuses on the evaluation of technologies and solutions that sustainably implement DT. The first sub-dimension is “data & analytics,” which examines how digitalization influences and transforms data-based decision-making. The “management information systems (MIS) and applications” sub-dimension pertains to the selection and management of technological solutions during the digitalization process. The “security and risk management” sub-dimension investigates how security and risk factors that emerge concurrently with digitalization are accounted for and managed. In reality, the reviewed models are primarily concerned with information technology, more

specifically MIS and enterprise resource planning applications, whereas security and data are considered as separate sub-dimensions in only a few models.

As the fifth dimension, digital work addresses the effects of DT on an organization's work pattern as well as the breadth and depth of the new skills that employees must acquire. The first of four sub-dimensions is "working style." It examines the shift in working style that must occur concurrently with digitalization and the management of this shift. Differences in the manner in which business is conducted and the variety of participants highlight the diversity of working styles. The focus is on workers who digitalize their jobs concurrently with the DT, derive greater value from digital solutions, and conduct their work via digital platforms. The "skills and capabilities" sub-dimension examines the new knowledge and skills that employees must possess concurrently with digitalization, as well as the new capabilities that the organization requires. The "training and development" sub-dimension focuses on how employees' growth should be facilitated. The "collaboration" sub-dimension investigates how digitalization affects employees' collaboration with technology. In the reviewed models, the digital work dimension focuses primarily on the knowledge, skills, and development of employees under "people." Taking into account the effects of the working environment and collaboration sub-dimensions on employees, in addition to employee focus, may contribute to the literature on maturity models.

The sixth and final dimension, digital governance, focuses on evaluating how managerial and cultural issues are addressed to ensure the successful implementation and sustainability of DT. This objective was served by five sub-factors. The scope of the "organization and roles" sub-dimension relates to the identification of the evolving organizational structure and roles brought about by digitalization and

management. The “program management” sub-dimension addresses how digitalization is managed within the scope of a program and how achievement of results is ensured in accordance with strategic objectives. The “culture” sub-dimension investigates the effects of the digitalization process on the existing culture and how the process is administered. The “ethics” sub-dimension investigates the definition and management of ethical issues that arise within the context of digitalization. In the “ecosystem” sub-dimension, the focus is on how external interactions created by digitalization are managed differently and how to ensure that these interactions create value. Existing maturity models, with the exception of ethical issues, include digital governance; therefore, the inclusion of digital governance in the proposed model is viewed as a contribution, as it is a crucial element in the success of the DT process.

3.3 Comparison of the New Digital Maturity Model with Existing Models

To illustrate the similarities and differences between the proposed model and those examined in the literature review, Table 6 compares the dimensions of the proposed model to those of the examined models. This comparison is based on how frequently and to what extent each sub-dimension of the proposed model is met by the existing models.

Existing academic models appear to emphasize the digitization of essential processes. Customer value creation, digitalization strategy, digitalization program management, and culture are also essential areas of focus. Vision, operation model, processes other than operational processes, security, ethics, training and development issues that support employee adaptation, and managing changes in the working environment are the sub-dimensions of the proposed model that have not been addressed in existing models.

In the maturity models developed by consulting firms, the emphasis is on creating value, implementing digitalization in fundamental processes, innovating via digitalization, and supporting it with cultural transformation. Compared to the proposed model, the sub-dimensions that are not considered are the vision and the operation model, which are integral components of digital strategy management and enterprise process management, ensuring the management of digitalized processes and support of digital work, including digitalization and employee-technology collaboration.

Table 6. Comparison with existing academic and consultancy-firm models

Dimensions	Sub-dimensions	Number of Times Existing in Other Models	
		Academic	Consultancy
1. Digital Strategy	1.1. Vision	0	0
	1.2. Leadership	3	3
	1.3. Strategies	6	11
	1.4. Business Model	2	3
	1.5. Operating Model	0	0
2. Digital Value	2.1. Create Value (Innovation)	7	10
	2.2. Deliver Value	3	9
	2.3. Capture Value	3	11
3. Digital Processes	3.1. Process Architecture and BPM	0	0
	3.2. Value Chains (E2E Processes)	0	2
	3.3. Core Processes	16	13
	3.4. Management and Support Processes	0	4
4. Digital Technology and Data	4.1. Data Analytics	2	6
	4.2. MIS and Applications	4	12
	4.3. Security and Risk Management	0	3
5. Digital Work	5.1. Working Style	0	2
	5.2. Skills and Capabilities	3	4
	5.3. Training and Development	0	1
	5.4. Collaboration	3	
6. Digital Governance	6.1. Organization and Roles	4	2
	6.2. Ecosystem	2	2
	6.3. Program Management	6	4
	6.4. Culture	6	10
	6.5. Ethics	0	0

3.4 The Execution of the New Holistic Digital Maturity Model

To enable DMMs to act as catalysts in DT, it is essential to conduct assessments based on these models, which will reveal the current level and areas of development necessary for growth. This process allows organizations to identify

strengths, weaknesses, and opportunities for improvement in their digital journey, ultimately fostering a more effective and agile approach to transformation.

To effectively implement DMMs, four key design elements are required to support comprehensive assessments. These elements include the preparation of questions, determination of levels, establishment of scoring structures, and identification of capabilities for each level, based on DT capabilities (Figure 21). This provides a quantifiable and objective measure of an organization's DM, allowing for easier tracking of progress and comparison with industry benchmarks.

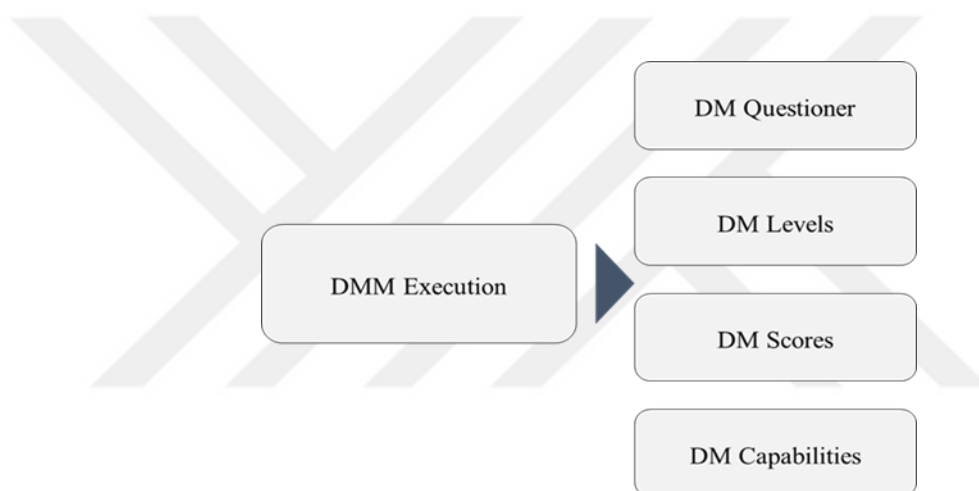


Figure 21. DM model execution scope

Questions that are based on the model's dimensions and sub-dimensions ensure that all relevant aspects of DM are covered. This step provides a thorough understanding of the organization's current state and helps identify areas for improvement. In the thesis, an extensive and well-considered set of questions was developed for each sub-dimension that supports the primary dimensions of the DMM (**Appendix A**). During the design phase of the survey questions, several key factors are taken into account to ensure their effectiveness in capturing an organization's DM.

One of the main factors considered is the relevance and importance of each question within the context of DT. By ensuring that each question accurately represents the significance of its corresponding sub-dimension, the assessment provides a comprehensive understanding of the organization's DM. Another crucial aspect taken into account is the expected capabilities and competencies required for successful DT initiatives. The questions are tailored to address these specific requirements, enabling organizations to pinpoint areas for improvement and focus on developing the necessary skills. Clarity and comprehensibility are also emphasized while formulating the questions. To obtain reliable and actionable insights, the questions are designed to be clear, concise, and easily understood by respondents, minimizing the risk of misinterpretation or confusion.

Lastly, the adaptability of the questions to various organizational contexts is considered. Recognizing that DT efforts may vary across different industries and organizations, the questions are designed to be applicable and adaptable to various contexts, ensuring their relevance and usefulness in diverse settings. By incorporating these considerations into the design of the survey questions, the assessment process offers a more robust and accurate understanding of an organization's DM. This, in turn, serves as a solid foundation for devising targeted strategies and making informed decisions to drive meaningful progress in their digital journey.

The second aspect supporting the model involves establishing levels that correspond to the responses given to the questions, enabling organizations to comprehend their position within the DM spectrum. This process aids in identifying areas for improvement and developing targeted strategies for growth. In the study, drawing upon the levels analyzed in the literature, five maturity levels were

established, which encompass the various stages of digitization, digitalization, and DT capabilities. Each level signifies a unique phase in an organization's DT journey. The levels consist of intention, beginner, adopter, performer, and transformer, which have been detailed as follows:

Intention Level: This is the most immature level, where organizations are only starting to consider digitization and digitalization processes, laying the foundation for DT. At this stage, there is no systematic approach or planned roadmap. Efforts are mostly ad hoc, with sporadic initiatives and fragmented understanding of the potential benefits and challenges of DT. Organizations at this level are yet to make any significant progress.

Beginner Level: At the beginner level, organizations have initiated or planned commitment and improvement studies in digitization and digitalization, but no output or value has been created yet. There is a growing awareness of the importance of DT, and the organization may have started to allocate resources and define strategic goals. However, the transformation process is still in its infancy, and no tangible results have been achieved.

Adopter Level: The adopter level indicates that the fundamental structures and studies related to digitization and digitalization have been completed, paving the way for DT capabilities to create value. Organizations at this level have established the necessary groundwork for DT, including the implementation of relevant technologies, processes, and frameworks. In addition, some valuable outputs have been generated, suggesting that the organization is on the right track toward achieving its digital goals.

Performer Level: At the performer level, organizations are successfully creating value through their DT efforts. Digital projects, grounded in a solid

foundation of digitization and digitalization, are common and mature, demonstrating the organization's competency in leveraging technology and digital strategies. At this stage, the organization has integrated DT into its core operations and is experiencing tangible benefits in terms of efficiency, innovation, and competitiveness.

Transformer Level: The transformer level signifies that the organization has fully embraced DT, with revenue being generated as a result of digital projects or new business models stemming from digitization and digitalization efforts. New products and services have been created, and the organization is thriving in the digital landscape. At this level, the organization has not only successfully implemented DT but also positioned itself as a leader and innovator in its industry.

The third critical topic driving the model is the defined target capabilities for each sub-dimension and level. For each level, specify the necessary capabilities required for successful DT. This ensures a clear understanding of the competencies needed for organizations to progress along the DM spectrum and achieve their DT goals (Appendix A).

The fourth design focus is the definition of a scoring system that not only enriches the basis for evaluation but also allows for a quantitative presentation of the model-based assessment. This feature facilitates a qualitative analysis based on digital stages. The maturity assessment generates a score with a maximum of 1000, with scores differentiated according to the five levels. Score intervals are defined as follows: Intention (0–200), Beginner (200–400), Adaptor (400–600), Performer (600–800), and Transformer (800–1000). These ranges, based on expert opinions, help to identify the digital stage that best describes the organization and provide a comprehensive understanding of its progress towards DT (Figure 22).

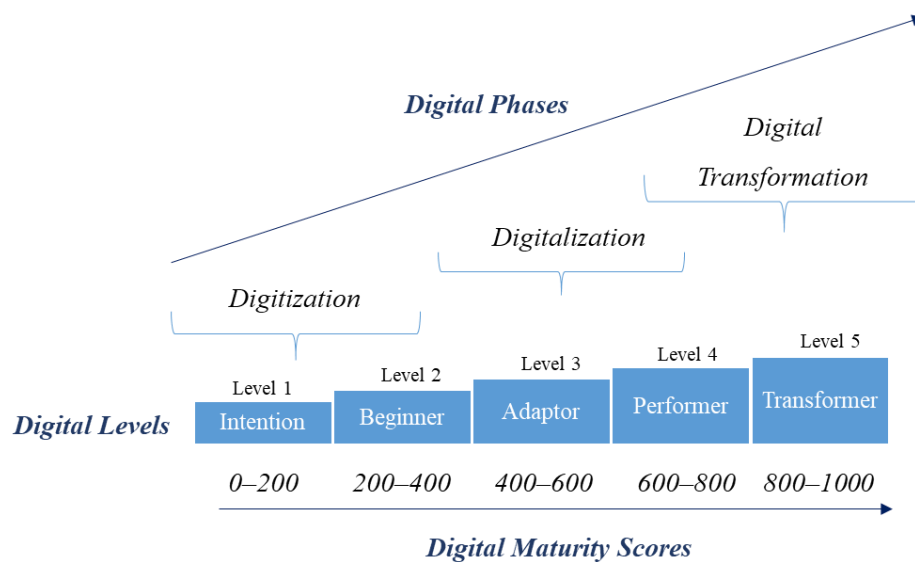


Figure 22. The relationship of DM levels to digital stages and scores

In line with all these definitions, the proposed design enables the interpretation of the assessment based on the DMM in multiple dimensions. It allows for analysis both at the level of DM scores and DM levels, as well as in terms of DT phases. This comprehensive approach provides organizations with a nuanced understanding of their progress and areas for improvement, ultimately facilitating more effective and targeted DT strategies.

In the scope of the digital journey defined in this section, the model's inception requires an evaluation to be made and an effective roadmap to be created based on the results of the evaluation. Therefore, the next part of the study focuses on how assessments can be approached and how they can be transformed into an effective roadmap, incorporating employees' involvement in decision-making processes.

CHAPTER 4

AN EFFECTIVE DIGITAL TRANSFORMATION ROAD MAP

The main aim of this study is to develop a comprehensive and systematic approach to assessing and managing digital maturity and DT processes in companies. To achieve this, the study first utilizes the AHP method to calculate the digital maturity score. This involves taking into account the weights of dimensions and sub-dimensions that constitute the model, and incorporating expert opinions to create a more robust and inclusive framework. Secondly, the study introduces a methodological approach for setting targeted benchmarks against which digital maturity results can be compared. This is done by using the AHP and TOPSIS methods based on the DMM criteria, enabling companies to determine targets for each dimension according to their ultimate goals. This approach allows for the consideration of various dynamics and preferences in the target-setting process. Finally, the study supports effective planning and holistic management of the DT process by prioritizing actions based on the difference between the evaluation results and targets. This enables companies to allocate resources efficiently and interpret Digital Maturity Assessment (DMA) results in line with their main objectives. By presenting these methods and approaches, the study provides a systematic contribution to the holistic management of the DT process, ultimately assisting companies in making effective plans and decisions related to their digital maturity and transformation efforts.

4.1 Proposed Method

4.1.1 The Model and Assessment Results

The model is used by a top-level executive responsible for DT in a large-scale international company to assess the digital maturity of the company. The assessment is conducted based on the capabilities corresponding to five different levels that are defined for each question. The results are presented in terms of digital levels that correspond to the interval of the scores, and DT stages, as illustrated in Figure 22.

The assessment results act as a catalyst, providing input for the creation of the DT roadmap and responding to the first research question with the process described in Figure 23.

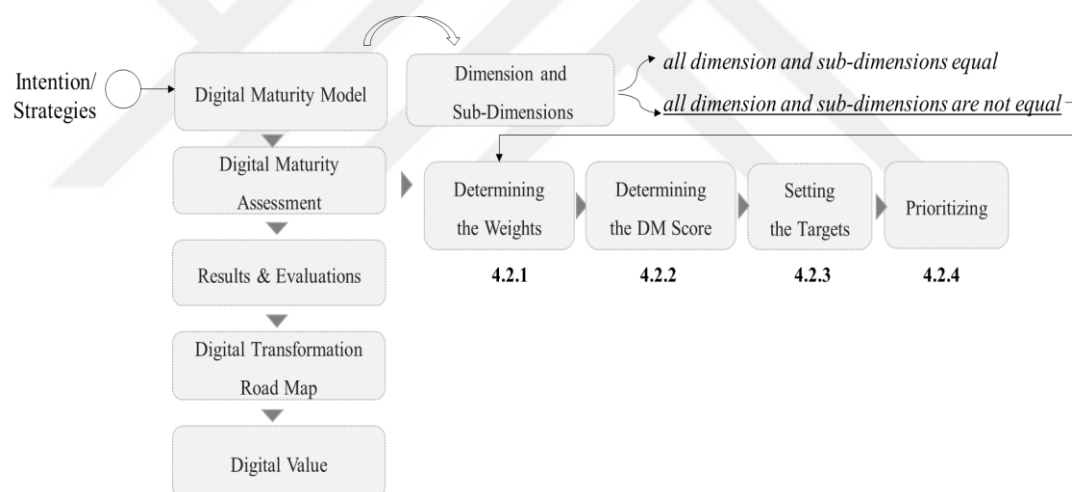


Figure 23. DT road map and creating digital value

4.1.2 Determining the Weights of the Dimensions in the Digital Maturity Model

The AHP is the oldest method that can be used for calculating the weights of criteria used in a MCDM context and for ranking the alternatives based on the criteria (Saaty, 1980). In the thesis, the AHP method is utilized to calculate the weights of the dimensions and sub-dimensions in the DMM model. This requires carefully making pairwise comparisons between criteria with regard to their relative

importance in the final digital maturity score of the organization. Hence, expert opinion is required to reflect the organization's perspective related to the importance of the criteria in the DMM. Fortunately, it is possible in the AHP to ensure that the weights of the criteria that are obtained as a result of pairwise comparisons are consistent. In case of inconsistency, it becomes possible to change the pairwise comparisons to reduce the degree of inconsistency to an acceptable level. AHP is implemented in the following steps.

Step 1. Determining the criteria. In this case, they are either the six dimensions labeled as D1, D2, ..., D6 in Figure 4, or the sub-dimensions that exist in each dimension of the DMM. For example, the first dimension, Digital Strategy, has five sub-dimensions labeled as D1.1, D1.2, ..., D1.5 in Figure 24.

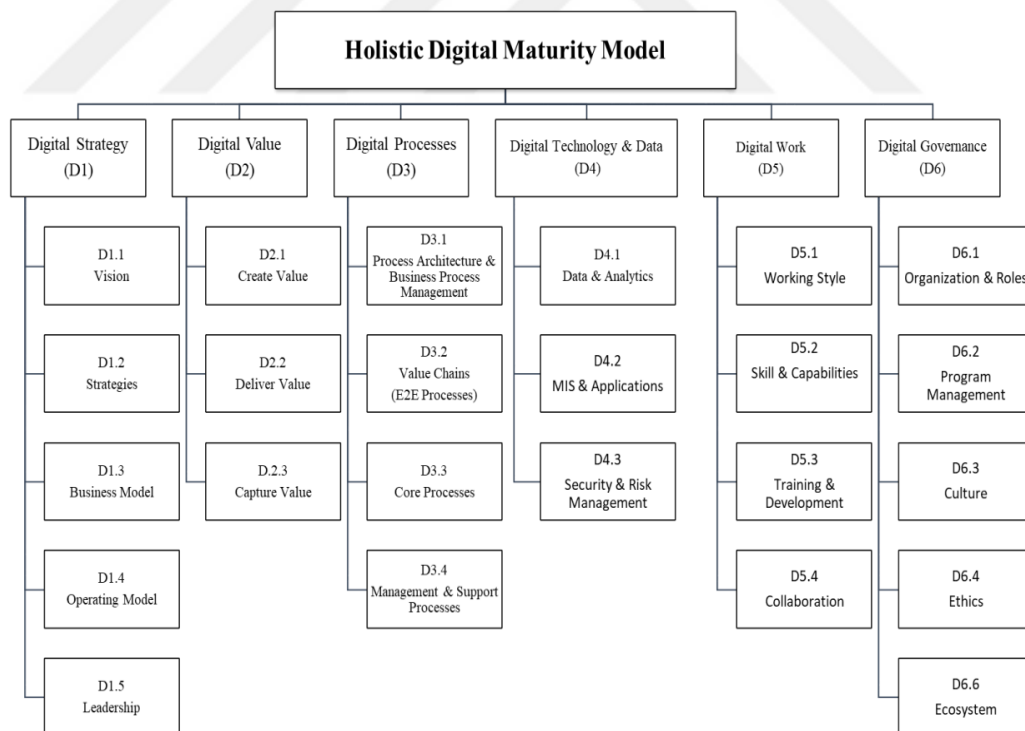


Figure 24. The dimensions and sub-dimensions of the holistic DMM

Step 2. Preparing the comparison matrix that includes the pairwise comparisons of the relative importance of the criteria considered. In creating this matrix, which has as many rows and columns as they are criteria, the domain expert in the field with over 20 years of professional experience makes use of the values displayed in Table 7 to compare the importance of each criterion with another one. The comparison of the criteria was performed by an expert i, and an effective nine-point evaluation scale was used. For example, if criterion 1 is moderately important compared to criterion 2, then the value 3 is used. In this case, the relative importance of criterion 2 to criterion 1 is $1/3$.

Table 7. Fundamental scales and their definitions for the AHP⁴

Scale	Numerical Rating	Reciprocal
Equal Importance	1	1
Equal to Moderate Importance	2	$1/2$
Moderate Importance	3	$1/3$
Moderate to Strong Importance	4	$1/4$
Strong Importance	5	$1/5$
Strong to Very Strong Importance	6	$1/6$
Very Strong Importance	7	$1/7$
Very Strong to Extreme Importance	8	$1/8$
Extreme Importance	9	$1/9$

Step 3. Normalizing the comparison matrix. The normalization is performed by dividing the values in each column by the column sum so that the sum of the values in each column is equal to one in the normalized comparison matrix.

Step 4. Computing the weight of each alternative. The weight of each alternative is obtained by taking the average of the values in the row of the normalized comparison matrix corresponding to the alternative (row of the matrix). This computation ensures that the sum of the weights of the criteria amounts to one.

⁴ Saaty, 1980

Step 5. Performing the consistency check. It is done to ensure that pairwise comparisons are consistent. The check is based on the calculation of the largest eigenvalue of the original comparison matrix. The detail of the calculation is shown in the results section.

4.1.3 Applying the TOPSIS Method for Calculating Targets

TOPSIS is designed to identify the virtual positive- and negative-ideal solutions in a given problem, and then rank the alternatives based on their proximity or similarity to the ideal solution and their distance from the negative-ideal solution (Hwang & Yoon, 1981).

There exist little discussion in the literature of methods for determining how companies should set their goals in this DMAs. Hence, one of the contributions of the thesis is the usage of the TOPSIS method to determine goals at the dimension level. This means that the goals of the company's DT strategy can be set without dependence on the current stage of DT, i.e., digitization, digitalization, and DT. Instead, appropriate and consistent goals can be set based on the desired DT stage of the organization. The TOPSIS method comprises the following steps:

Step 1. Preparing the evaluation matrix which consists of the numerical evaluation of each alternative with respect to each criterion.

Step 2. Normalizing the evaluation matrix. This is accomplished by taking the sum of the squares of the numbers in each column of the evaluation matrix corresponding to a criterion and taking the square root of this sum. All the numbers in each column are then divided by this number.

Step 3. Obtaining the weighted normalized evaluation matrix. The numbers in each row of the normalized evaluation matrix are multiplied by the criteria weights to obtain the weighted normalized evaluation matrix.

Step 4. Determining the positive- and negative-ideal solutions. The ideal solution is obtained by taking the value of the best alternative in each criterion, while the negative-ideal solution is obtained by taking the value of the worst alternative in each criterion.

Step 5. Computing the similarity/proximity of each alternative from the ideal solution. It is calculated by the Euclidean distance between an alternative and the ideal solution.

Step 6. Computing the dissimilarity/distance of each alternative from the negative-ideal solution. It is calculated by the Euclidean distance between an alternative and the negative-ideal solution.

Step 7. The proximity and distance of each alternative is combined in a single measure that gives the desirability of each alternative. The ranking of the alternatives can be found by sorting these desirability measures.

The TOPSIS study was performed by an expert in the field with over 20 years of professional experience, and a five-point evaluation scale was used (Table 8).

Table 8. Scales and their definitions for TOPSIS

Definition	Numerical Rating
Not at all Important	1
Slightly Important	2
Important	3
Fairly Important	4
Very Important	5

4.2 Implementing the Proposed Method and Results

The first step of the implementation consists of the determination of the criteria weights associated with the dimensions and sub-dimensions via AHP. The scores related to DMA are based on these weights. In the second step, the TOPSIS method is used to determine the target values set for each dimension based on the DT

stages. The final step is the outline of an approach for prioritizing and creating a roadmap based on the results and targets.

4.2.1 Computing the Weights of Dimensions and Sub-Dimensions

The comparison matrix that contains the pairwise comparisons of the relative importance of the dimensions is given in Table 9. The table also shows the column sums for each dimension that are used for the normalization of the matrix. The normalized matrix is obtained by dividing each number in a column by the column sum. The weight of each dimension is calculated by taking the average of the values in the row corresponding to that dimension. The weights of the dimensions can also be seen in Table 10. The last step is checking the consistency of the comparison matrix. For this purpose, the consistency index (CI) is calculated as $CI = \frac{\lambda_{\max} - n}{n - 1}$ using the largest eigenvalue computed as given in Equation (1). $\lambda_{\max} = 6.233$, and the CI index is equal to 0.047. To evaluate the consistency, the random index (RI) value is determined as 1.24 as shown in Table 11.

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \left(\frac{\sum_{j=1}^n a_{ij} w_j}{w_i} \right) \quad (1)$$

Table 9. Pairwise comparison matrix for the main dimensions

	D₁	D₂	D₃	D₄	D₅	D₆
Digital Strategy (D ₁)	1.000	0.500	2.000	0.500	2.000	3.000
Digital Value (D ₂)	2.000	1.000	1.000	2.000	2.000	2.000
Digital Processes(D ₃)	0.500	0.500	1.000	1.000	2.000	2.000
Digital Tech. and Data (D ₄)	2.000	0.500	1.000	1.000	1.000	1.000
Digital Work (D ₅)	0.500	0.500	0.500	1.000	1.000	2.000
Digital Governance (D ₆)	0.333	0.333	0.500	1.000	0.500	1.000
Total	6.333	3.333	6.000	6.500	8.500	11.000

Table 10. Normalized comparison matrix for the main dimensions

	D₁	D₂	D₃	D₄	D₅	D₆	Weights
Digital Strategy (D ₁)	0.158	0.150	0.333	0.077	0.235	0.273	0.204
Digital Value (D ₂)	0.316	0.300	0.167	0.308	0.235	0.182	0.251
Digital Processes(D ₃)	0.079	0.150	0.167	0.154	0.235	0.182	0.161
Digital Tech.and Data (D ₄)	0.316	0.150	0.167	0.154	0.118	0.091	0.166
Digital Work (D ₅)	0.079	0.150	0.083	0.154	0.118	0.182	0.128
Digital Governance (D ₆)	0.053	0.100	0.083	0.154	0.059	0.091	0.090
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 11. Random index values

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53	1.56	1.57	1.59

The consistency ratio (CR) is obtained by dividing the CI value by the RI value to yield 0.038. Since this value is below the threshold of 0.10, the comparison matrix is proven to be consistent. According to the results, the digital value dimension is assigned the largest weight due to its criticality in creating and delivering value in digitalization. The “digital strategy” dimension has the second largest weight reflecting its significance in guiding digitalization efforts. Based on these results, it can be concluded that the dimensions of the DMM should be weighed as displayed in Figure 25.

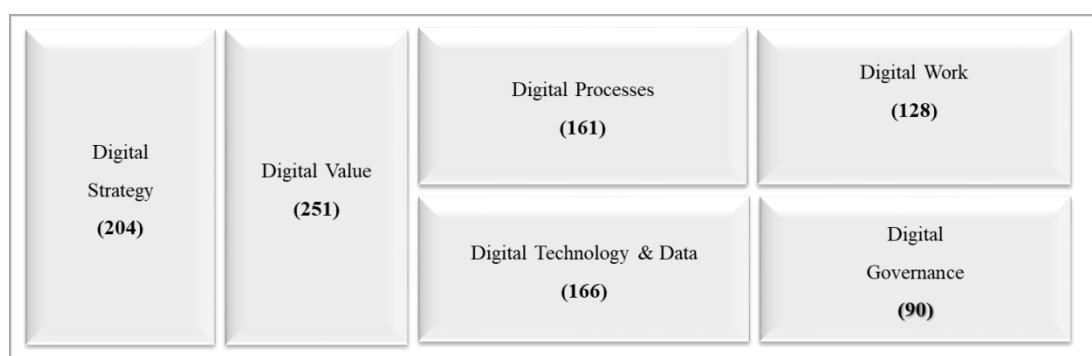


Figure 25. The weights of the dimensions in the DMM

To calculate the weights of the sub-dimensions—as in the process followed for the dimensions—pairwise comparison matrixes are created to determine the

relative importance of all sub-dimensions under each main dimension. These matrixes are normalized, the weights of the sub-dimensions are determined, and the results are validated by computing the consistency ratios which are provided in **Appendix B**. The outcomes obtained for both dimensions and sub-dimensions are summarized in Table 12.

Table 12. The weights of the dimensions and sub-dimensions in the DMM

Dimensions	Weight	Sub-Dimensions	Weight (w)
Digital Strategy	w ₁ =0.204	Vision	w _{1,1} =0.305
		Strategies	w _{1,2} =0.179
		Business Model	w _{1,3} =0.136
		Operating Model	w _{1,4} =0.076
		Leadership	w _{1,5} =0.305
Digital Value	w ₂ =0.251	Create Value	w _{2,1} =0.739
		Deliver Value	w _{2,2} =0.179
		Capture Value	w _{2,3} =0.0082
Digital Processes	w ₃ =0.161	Process Architecture and BPM	w _{3,1} =0.399
		Value Chains (E2E Processes)	w _{3,2} =0.339
		Core Processes	w _{3,3} =0.165
		Management & Support Processes	w _{3,4} =0.097
Digital Technology & Data	w ₄ =0.166	Data & Analytics	w _{4,1} =0.250
		MIS & Applications	w _{4,2} =0.500
		Security & Risk Management	w _{4,3} =0.250
Digital Work	w ₅ =0.128	Working Style	w _{5,1} =0.126
		Skill & Capabilities	w _{5,2} =0.577
		Training & Development	w _{5,3} =0.170
		Collaboration	w _{5,4} =0.127
Digital Governance	w ₆ =0.09	Organization & Roles	w _{6,1} =0.298
		Program Management	w _{6,2} =0.456
		Culture	w _{6,3} =0.131
		Ethics	w _{6,4} =0.071
		Ecosystem	w _{6,5} =0.043

4.2.2 Determining the Digital Maturity Score

There are two candidate approaches to the evaluation of digital maturity scores. The first one is to take the average of the scores obtained for each question under each dimension and sub-dimension. This correspond to assuming that each dimension/sub- dimension has an equal weight. The second approach, as attempted in thesis, is to calculate the score based on the weights of dimensions and sub-dimensions. To this end, the average of the results obtained for the questions in each sub-dimension is computed first. This average is then converted to a score based on

the weight of the sub-dimension. After the scores of the sub-dimensions are added to obtain the score for the main dimensions, the final digital maturity score is calculated as the weighted sum of the main dimension scores, as indicated in Table 13.

Table 13. Calculation of the maturity score

Dimension Score Calculation	
Digital Strategy Score (D ₁)	$w_{1,1}D_{1,1} + w_{1,2}D_{1,2} + w_{1,3}D_{1,3} + w_{1,4}D_{1,4} + w_{1,5}D_{1,5}$
Digital Value Score (D ₂)	$w_{2,1}D_{2,1} + w_{2,2}D_{2,2} + w_{2,3}D_{2,3}$
Digital Process Score (D ₃)	$w_{3,1}D_{3,1} + w_{3,2}D_{3,2} + w_{3,3}D_{3,3} + w_{3,4}D_{3,4}$
Digital Technology & Data Score (D ₄)	$w_{4,1}D_{4,1} + w_{4,2}D_{4,2} + w_{4,3}D_{4,3}$
Digital Work Score (D ₅)	$w_{5,1}D_{5,1} + w_{5,2}D_{5,2} + w_{5,3}D_{5,3} + w_{5,4}D_{5,4}$
Digital Governance Score (D ₆)	$w_{6,1}D_{6,1} + w_{6,2}D_{6,2} + w_{6,3}D_{6,3} + w_{6,4}D_{6,4} + w_{6,5}D_{6,5}$
Dimension Score Calculation	
Digital Maturity Score	$w_{1,1}D_{1,1} + w_{1,2}D_{1,2} + w_{1,3}D_{1,3} + w_{1,4}D_{1,4} + w_{1,5}D_{1,5}$

The obtained scores by using the weights are compared with the scores that do not utilize any weights to assess the impact of weighting on the overall evaluation and prioritization, as presented in Table 14.

Table 14. Comparison of results for dimension/sub-dimension weights

Dimensions	Sub-Dimensions	Equal Weight	Weighted
Digital Strategy	Vision	80	121.8
	Strategies	60	53.7
	Business Model	120	81.4
	Operating Model	60	22.8
	Leadership	80	121.8
	Total	400	401.6
Digital Value	Create Value	133.2	295.8
	Deliver Value	133.2	71.5
	Capture Value	100.2	24.5
	Total	366.6	391.8
Digital Processes	Process Architecture and BPM	43.8	69.8
	Value Chains (E2E Processes)	37.5	50.8
	Core Processes	75	49.6
	Management & Support Processes	100	39.0
	Total	256.3	209.1
Digital Technology & Data	Data & Analytics	83.3	62.5
	MIS & Applications	133.2	200.0
	Security & Risk Management	50.1	37.5
	Total	266.6	300.0

Table 14. Comparison of results for dimension/sub-dimension weights (cont'd)

Digital Work	Working Style	62.5	31.6
	Skill & Capabilities	75	173.2
	Training & Development	62.5	42.4
	Collaboration	87.5	44.3
	Total	287.5	291.5
Digital Governance	Organization & Roles	50	74.4
	Program Management	40	91.3
	Culture	35	22.9
	Ethics	30	10.7
	Ecosystem	35	7.6
	Total	190	207.0
	Digital Maturity Score	294.6	319.7

When the results for the digital maturity score are compared, there was no significant difference in the total scores, while the differences between dimensions and sub-dimensions drew attention to how priorities can change. The weighted results suggest that the capabilities that need to be developed first in the digital strategy dimension are vision and leadership. The results are consistent, as it is not possible to transform digitalization studies into strategies or business and operations models without vision and leadership. Similarly, in the digital value dimension, as it is not possible to present value and generate revenue from value without value creation, the creation of value is much more important and therefore should be prioritized. In digital processes, in comparison with the managerial and support processes, there is a greater focus on the architecture that provides the spread of the operation model, the value chain, and the basic processes in which value is created. In digital work, the capabilities of the employees, as well as the components, are by far the most important and prioritized. In digital governance, on the other hand, roles and responsibilities and the governance of DT are separated from other sub-dimensions.

All these results and interpretations differ depending on the specific weights computed by the organizations based on their conditions. The proposed methodology is generic and versatile in terms of usage. The aim is to support the creation of

corporate-specific outputs and roadmaps of different assessments with the help of a single methodology. The application of this methodology provides an answer to the first research question, which is: How are the dimensions and sub-dimensions weighted in DMAs?

4.2.3 Setting the Targets

Common reasons for DT failure include a lack of clear strategy and vision, resistance to change, inadequate leadership and governance, insufficient resources and budget, a siloed approach and lack of collaboration, an inadequate customer-centric approach, a lack of agility and flexibility, concerns around cybersecurity and data privacy, a lack of continuous monitoring and improvement, and external factors such as market conditions and regulatory requirements. These factors are widely recognized in the field of DT and noted in various industry reports, articles, and case studies on DT failures. Organizations should be aware of these challenges and set the right targets to increase the likelihood of successful DT initiatives.

In the referenced DMM, the leveling of capabilities is associated with the phases of DT (Figure 22). Companies aiming for DT are expected to reach level 5 (the transformer level), while companies aiming for digitalization in their efficiency processes should target level 4 (the performer level). To answer the second research question (which is: How are targets set on the basis of the DT phases?) and develop a generic methodology for organizations to use, this study applies the TOPSIS method to rank the importance of the targets in each of the transformation stages (digitization, digitalization, and DT) of each sub-dimension.

TOPSIS is the best fit for target setting because it permits a comparison of the alternatives using the distances between the alternatives and the positive- and

negative-ideal solutions. For this study, a two-step methodology was developed based on the DT stages:

Step 1: Determine the weights of the sub-dimensions relative to each other on the basis of each criterion (AHP) evaluated in section 4.

Step 2: Determine the target on the basis of each stage, taking into account the weights of the sub-dimensions (TOPSIS).

First, we use the AHP to calculate the weights for each sub-dimension in the dimensions. Before applying the TOPSIS method, we create dimension-based matrixes for each transformation stage. We then evaluate how important each sub-dimension is for each stage (digitization, digitalization, DT) of the five levels (“intention” to “transformer”). For example, we do not expect that vision to be at the “transformer” level in an organization targeting digitization. While the importance level was given as 1, the aim should be a vision of 5 to support the transformation (Table 15).

Table 15. Evaluation matrix

Strategy Dimension & Digitization Stage	Vision	Strategies	Business Model	Operating Model	Leadership
Intention	3	5	1	1	5
Beginner	4	4	1	1	4
Adaptor	2	3	1	1	3
Performer	1	1	1	2	1
Transformer	1	1	1	1	1
Total	5.57	7.21	2.24	2.83	7.21

These values in each column are then normalized by dividing by the total values that are obtained by the total scores in each column, as indicated in Table 16. Recall that these totals are obtained by taking the square root of the sum of squares of the numbers in the columns. Table 17 shows the weighted normalized evaluation matrix which is obtained by multiplying the row numbers with the corresponding sub-dimension weights found by the AHP.

Table 16. Normalized evaluation matrix

Strategy Dimension & Digitalization Stage	Vision	Strategies	Business Model	Operating Model	Leadership
Intention	0.539	0.693	0.447	0.354	0.693
Beginner	0.718	0.555	0.447	0.354	0.555
Adaptor	0.359	0.416	0.447	0.354	0.416
Performer	0.180	0.139	0.447	0.707	0.139
Transformer	0.180	0.139	0.447	0.354	0.139

Table 17. Weighted normalized evaluation matrix

Strategy Dimension & Digitalization Stage	Vision	Strategies	Business Model	Operating Model	Leadership
Intention	0.164	0.094	0.034	0.108	0.124
Beginner	0.219	0.075	0.034	0.108	0.099
Adaptor	0.109	0.056	0.034	0.108	0.074
Performer	0.055	0.019	0.034	0.215	0.025
Transformer	0.055	0.019	0.034	0.108	0.025

Positive- and negative-ideal solutions are determined based on the best level in each sub-dimension, as provided in Table 18. The Euclidean distances of each level between the ideal solution and negative-ideal solution are calculated, which are then combined in a single closeness coefficient, as can be seen in Table 19.

Table 18. Ideal and negative-ideal solutions

Strategy Dimension & Digitalization Stage	Vision	Strategies	Business Model	Operating Model	Leadership
Ideal	0.219	0.124	0.094	0.034	0.215
Negative-Ideal	0.055	0.025	0.019	0.034	0.108

Table 19. Closeness coefficients to the ideal solution

Strategy Dimension & Digitalization Stage	Distance to the Ideal Solution	Distance to the Negative-Ideal Solution	Closeness Coefficient	Target Level
Intention	0.066	0.166	0.714	2
Beginner	0.043	0.189	0.815	1
Adaptor	0.138	0.083	0.376	3
Performer	0.206	0.012	0.053	4
Transformer	0.218	0.000	0.000	5

According to the results summarized in Figure 26, in its digitization phase, a company focuses on the implementation of technology in the targeted processes.

There is no need to pursue an advanced level of maturity in the customer wing, the

working environment, or governance during the digitization phase. In the digitalization phase, it is expected that a certain maturity will be reached in the working environment and among employees. It is vital to create an impact on the customer side, in parallel with the targeted maturity development in the processes, and to support the selection and implementation of technology required in the digitalization phase with a certain maturity of governance; and this is supported by the differentiation in the targets. In the DT phase, the maximum level should be targeted in all dimensions. These results indicate that, for organizations targeting digitization, it is sufficient to aim for the beginner level in the strategy dimension. Similar calculations and interpretations are found for each dimension and DT phase, and the ideal objectives of the dimensions based on the DT phases are presented (Appendix C).

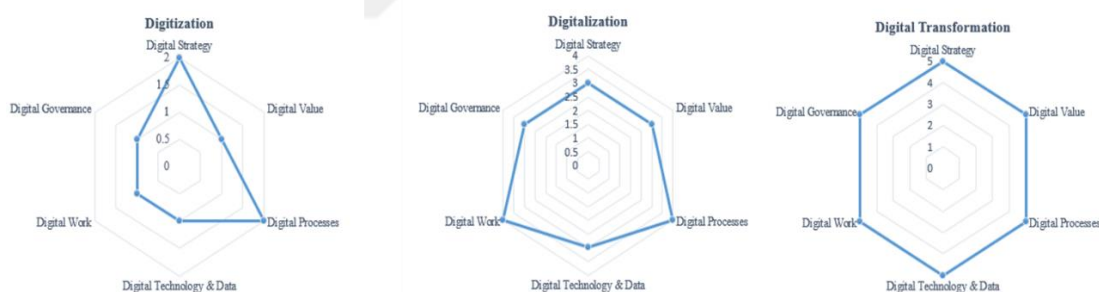


Figure 26. Target setting results

4.2.4 Prioritizing Improvement Areas

At the end of the assessment, it is revealed which digital stage the companies are in and which digital stage they are targeting. According to the model used in the example and the sample evaluation results, it was revealed that the company is targeting digitalization. This requires the company to prioritize, plan, and establish a

governance structure that focuses on efficiency and effectiveness in creating cost advantages (Figure 27).

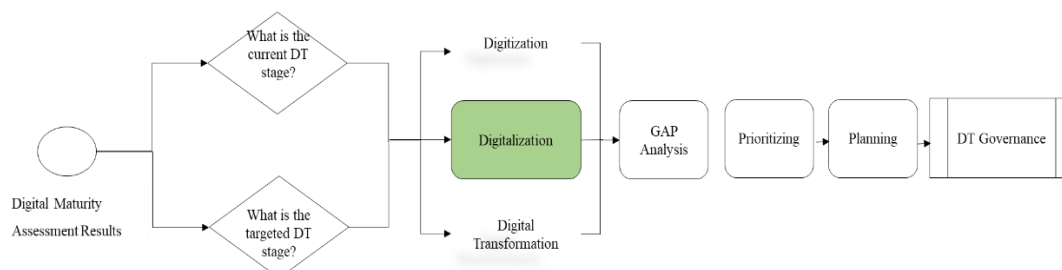


Figure 27. Assessment results evaluation process

It is possible to prioritize and take action on the DMA scores and improvement areas obtained from the DMA by taking the gap between the score and the target. This process is illustrated in Figure 28.



Figure 28. Assessment results, targets and gaps

These results suggest that prioritization should be handled in three stages, taking into account the gaps between improvement areas. The first is the implementation of actions on the digital work axis from beginner to adapter level to support competence and adaptation to digitalization, processes that will indicate the focus of the digitalization, and technological solutions to be adapted to the processes. In this way, the organization identifies where it can take action, the solutions it can apply to do so, and the developments required in terms of its employees and

capabilities. The second is the implementation of actions that will enable the company to reach the level of performer, producing results in line with the goals of the company in order to generate value in these areas of focus. The third is that the company, by demonstrating digitalization performance, begins to create value on the customer side in parallel with the strategies and takes the necessary actions in line with the evaluation outputs in the digital governance dimensions to make these efforts sustainable. This process and approach thus provides an answer to the third research question (**QA3**: How are priorities and development areas determined on the basis of DMA results?).

Summarily, the study is designed to identify a method for effective implementation of DT. Thus, a holistic DMM that allows DT to be managed with all its dimensions was taken as a reference. DMMs are the catalyst in DTs and they are used to perform assessments and turn the results of the assessments into action. Although there have been many studies of maturity models, the literature includes no methodological approach to scoring or to determining the DT goals based on these models.

Within the context of digital transformation, the development of maturity necessitates a holistic consideration of these initiatives across the human, process, and technology dimensions. Therefore, in the next section, focus is given to how RPA solutions, which are striking in terms of employee-technology collaboration, can be approached and managed both socio-technically and with employee inclusion. In this way, an attempt has been made to reveal how digitization can create value for both the organization and the employee.

CHAPTER 5

RPA IMPLEMENTATION AND EMPLOYEE COLLABORATION

Based on the DMA results, organizations strategically plan and initiate RPA initiatives to improve both process efficiency and employee productivity. RPA plays a critical role in the DT journey by serving as a bridge between traditional operations and advanced digital technologies. By automating repetitive, rule-based tasks, RPA enables employees to focus on higher-value, strategic activities that require creativity and critical thinking. This not only enhances the overall productivity of the workforce but also fosters a culture of innovation and continuous improvement.

Moreover, RPA paves the way for the adoption of more advanced technologies, such as AI and data analytics. Integrating seamlessly with existing information technology (IT) systems, RPA provides a solid foundation for organizations to harness the power of AI-driven solutions and data-driven insights. This allows businesses to unlock new opportunities, optimize decision-making, and enhance customer experiences.

As employees adjust to working with digital technologies, RPA helps create a workforce that is ready for the future of work. By providing employees with the skills and knowledge needed to effectively use digital tools, RPA initiatives contribute to the long-term success and adaptability of organizations in the fast-changing digital environment.

Because of its adaptable features and ability to be used across various industries and functions, RPA technology has been chosen as the main focus of this study to better understand the collaboration between technology and employees. As a widely applicable solution, RPA allows organizations of all types to adopt and

benefit from improved teamwork between technology and employees, offering a solid basis for further investigation and discussion.

5.1 Considering Socio-Technical Perspectives While Implementing RPA

The Leavitt (1964) model of a socio-technical system consists of four interacting components-people (actors), tasks, structure, and technology-each of which is crucial for maintaining system stability. By examining these RPA processes from a socio-technical system perspective, organizations can facilitate more effective technological implementation and promote long-term sustainability (Urze et al., 2020). The aim of this thesis is to analyze the RPA through a socio-technical system lens, with a particular focus on fostering collaboration between employees and technology. These components are defined in the mapping, which represents their relationships in the context of RPA (Figure 29).

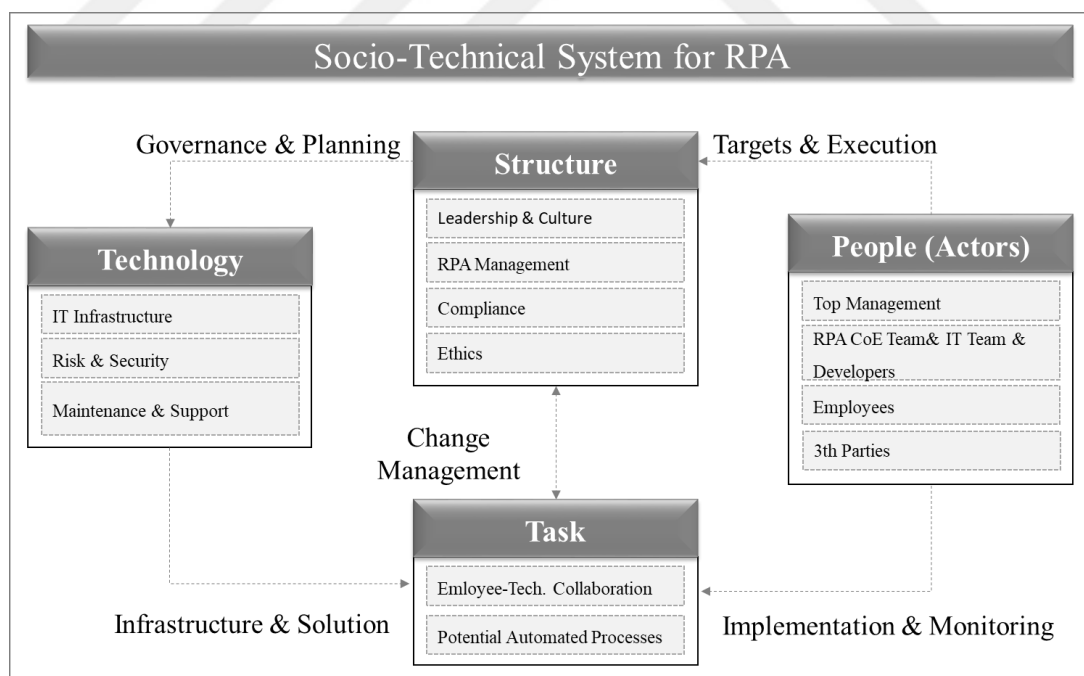


Figure 29. RPA governance using a socio-technical system framework

The people (actors) component consists of individuals who engage with the system, including employees, managers, and other stakeholders. Their skills, knowledge, values, and attitudes shape their interactions with the system and contribute to its functioning (Leavitt, 1964). In RPA studies, the main actors are employees who transfer their tasks to bots and the companies that provide the RPA infrastructure. Among these, the group representing technology–employee collaboration is comprised of employees transferring their current tasks to bots.

Task, as a component, refers to the specific activities, responsibilities, and goals assigned to individuals or groups within the organization. These tasks form the building blocks of the organization's work processes and determine the allocation of resources such as people and technology (Scott, 1992). When tasks are evaluated from a socio-technical perspective in RPA studies, they can be defined as the automation and optimization by RPA technology of manual and repetitive activities previously performed by employees in specific work processes. This takes into account the roles, collaboration, and interactions of both employees and bots within the processes.

The structure component deals with formal and informal relationships, roles, and communication patterns within an organization. Aspects such as hierarchy, decision-making processes, and coordination mechanisms dictate how individuals interact and collaborate (Mintzberg, 1979). In RPA studies, the structure requires all aspects of RPA governance to be defined from a socio-technical perspective. First, the role of leadership and organizational culture is crucial in shaping the vision, strategy, and support for RPA initiatives. Second, RPA management involves coordinating the organizational structures involved in RPA initiatives. Additionally, it is essential to differentiate between compliance and ethics in RPA projects.

“Compliance” refers to adherence to laws, regulations, and industry-specific standards to ensure that the RPA deployment is legally sound. In contrast, “ethics” involves ensuring responsible use of the technology, considering its impact on employees, customers, and other stakeholders. Both compliance and ethics are vital in the implementation and ongoing management of RPA projects for the maintenance of trust and credibility within the organization and the wider community.

Finally, *the technology* component encompasses the tools, equipment, and systems that support the organization’s tasks and processes. This includes hardware and software, as well as the knowledge, techniques, and practices related to the use and management of these technologies. RPA solutions, IT infrastructure, security, maintenance and support, and monitoring and performance management are defined when describing technology from a socio-technical perspective in RPA studies. RPA solutions encompass the platforms, tools, and applications used to implement RPA. The IT infrastructure includes the networks, servers, databases, and other systems that support the use and integration of RPA technology. Security policies, protocols, and measures are crucial, especially those concerning data privacy and protection. Maintenance and support processes and resources are necessary for the upkeep, updates, and continuous improvement of RPA systems. Monitoring and performance-management methods and tools are employed to measure and track the efficiency and effectiveness of RPA applications. These elements provide a comprehensive perspective on defining technology in RPA studies.

It is vital to understand the mutual interdependencies between these components, as changes in one component can trigger adjustments in others to maintain system balance. For instance, introducing a new technology may necessitate changes in the organization’s structure, employees’ tasks, and the skills required of

the involved actors. By recognizing these interdependencies, organizations can better manage change and design systems that effectively balance the needs of people, tasks, structure, and technology (Leavitt, 1965).

Recognizing the roles and responsibilities of the various stakeholders involved in the RPA process is essential for effective management of the process. Emphasizing this point, it is crucial to define the roles and responsibilities of all actors from a socio-technical perspective and ensure their involvement in the RPA implementation process aligns with their roles and responsibilities. This is inevitable for successful technology implementation in DT (Table 20).

Table 20. Roles and Responsibilities in RPA

Roles	Responsibility
Top Management	Setting strategic direction, allocating resources, and fostering a culture of innovation and continuous improvement.
RPA Center of Excellence (CoE)	Driving RPA strategy, standardizing best practices, and ensuring the successful implementation and management of RPA initiatives within an organization.
IT Team	Providing technical support, ensuring seamless integration with existing systems, and maintaining the security and compliance of the automation infrastructure within the organization.
Developers	Designing, building, testing, and deploying automated workflows, as well as customizing and maintaining RPA solutions to meet the organization's specific automation needs.
Employees (Users)	Collaborating with the RPA team to identify suitable processes for automation, adapting to new workflows, and providing feedback to ensure continuous improvement of the implemented RPA solutions.
Third Parties	Providing external expertise, support, and resources, such as consulting services, specialized development, or training, to complement the organization's internal RPA capabilities and ensure successful implementation.

In the thesis study, based on socio-technical system mapping, employees (people) are classified into three capability groups, as illustrated in Figure 30. Business capabilities play a pivotal role in guaranteeing the successful integration of technologies, such as RPA, within an organization by incorporating the components of the socio-technical system into employees' daily tasks.

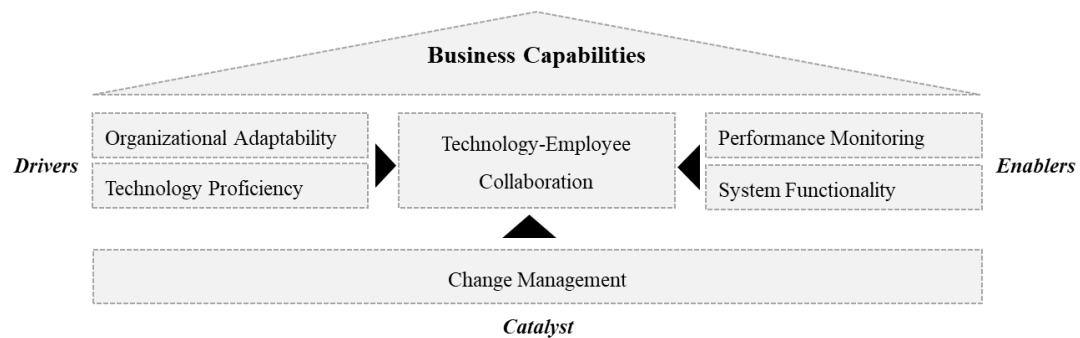


Figure 30. Business capabilities for RPA

Organizational adaptability is the first essential capability. This refers to the organization's ability to restructure its processes, roles, and culture to accommodate the integration of RPA technology. It involves the willingness of the organization to adapt to new ways of working and to embrace the changes that come with the implementation of RPA.

Technology proficiency is another vital capability that involves developing and maintaining the skills and knowledge necessary for employees to effectively utilize RPA tools and interact with software robots. Ensuring that employees are proficient in using RPA technology is crucial for maximizing the benefits of automation.

Fostering technology–employee collaboration is also of paramount importance. This capability requires the establishment of clear communication channels and collaboration mechanisms between human employees and software robots. A synergistic working relationship between humans and robots enables an organization to achieve optimal results from the RPA implementation.

In addition to these capabilities, continuous monitoring of RPA processes and the software robots' performance is necessary to ensure that the processes are meeting the expected outcomes. This allows organizations to identify potential issues and make adjustments as needed to maintain efficiency and effectiveness.

Maintenance, as a capability, refers to the ongoing maintenance and updates required to keep the RPA systems functioning optimally. Regular maintenance ensures that the technology remains effective and aligns with the evolving needs of the organization.

Finally, the catalyst-change management-facilitates a smoother transition during RPA implementation by addressing potential resistance and ensuring the successful adaptation of employees to new processes and technologies. As a catalyst, change management plays a pivotal role in promoting technology–employee collaboration and accelerating the overall integration of RPA within the organization. Therefore, the study focuses on drivers as the starting point and their impact on technology–employee collaboration, aiming to identify the capabilities that trigger such collaboration and to conduct further research on these specific capabilities.

The primary purpose of this distinction is to identify the capabilities that trigger technology–employee collaboration and to delve deeper into research focusing on these specific capabilities. In the thesis study, emphasis is placed on the drivers' capabilities, as these are responsible for activating the technology. The decision-making mechanisms that bring the drivers' capabilities to life are examined in conjunction with employee involvement, focusing on technology–employee collaboration for a more effective and coherent expression.

5.2 Employee Involvement in Decision-Making during RPA Implementation

Involving employees in the decision-making process during RPA implementation is crucial for the success of the project. In the RPA implementation process, two strategic decisions are prominent: the first is vendor selection, and the second is process selection.

Involving employees in the vendor-selection process can lead to more informed decisions, as employees who will be using the RPA technology have valuable insights into the organization's needs and requirements. Cross-functional teams should be encouraged to evaluate different vendors based on factors such as ease-of-use, scalability, integration capabilities, and cost. By including employees in this decision-making process, organizations can ensure that the chosen RPA vendor aligns with the organization's goals and provides a solution that effectively addresses the unique challenges faced by the employees in their daily work.

Process selection is another critical decision in RPA implementation, as not all processes are suitable for automation. Involving employees in the process-selection phase is essential because they possess in-depth knowledge of the workflows and can help identify the best candidates for automation. By including employees in the process-selection decision, organizations can ensure that the chosen processes are the most appropriate for automation, thereby ensuring increased efficiency, reduced errors, and overall project success.

The thesis demonstrated how vendors and processes can be selected by employing the MCDM techniques AHP and TOPSIS (Figure 31) which were explained in detail in Chapter 4. In this way, employee involvement in the RPA implementation is methodically addressed.

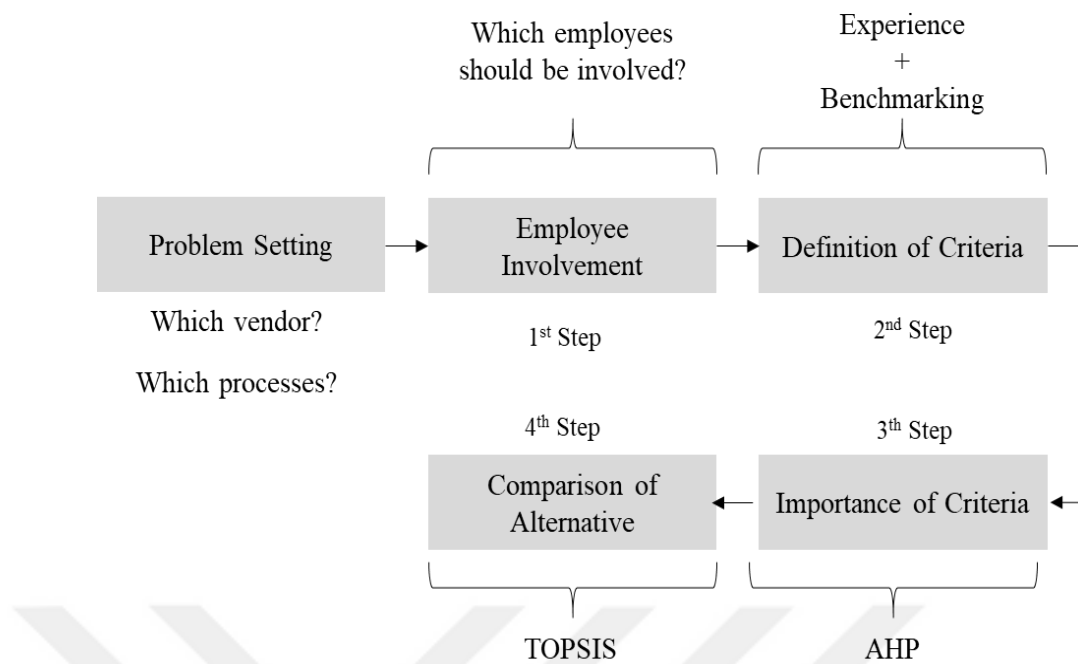


Figure 31. RPA implementation decisions with MCDM techniques

The vendor- and process-selection study comprised four stages. In the first stage, the critical employees (actors) to be included in the decision-making process were determined. In the second stage, the criteria were determined according to the experiences of these employees and the benchmarks. In the third stage, these criteria were prioritized using the AHP method. Finally, in the fourth stage, the TOPSIS method was used to select the ideal alternative. The implementation of vendor and process selection was carried out with data obtained from a large-scale company.

5.3 Vendor Selection

5.3.1 Definition of Decision-Maker Employees

To determine the decision-makers, it was necessary to define the roles of the actors within the framework of the socio-technical system, to identify which would contribute to the vendor selection, and to evaluate these in terms of their importance (Table 21).

Table 21. Decision-makers' importance in vendor selection

	Highest	High	Moderate	Low	Very Low	None
Top Management	√					
RPA CoE Team	√					
IT Team	√					
Developers						√
Employees					√	
Third Parties						√

In determining and evaluating the criteria parallel to this evaluation result, the RPA CoE (Center of Excellence) team and IT team completed the consensus-based evaluations and finalized the process with the approval of the top management.

5.3.2 Definition of Criteria for Vendor Selection

Criteria were determined based on experience, and were validated with benchmarks in the literature. Detailed explanations were prepared to ensure that these criteria could be handled correctly in the evaluation process (Table 22).

Table 22. RPA vendor-selection criteria

Criteria 1(C₁) Preferability: This criterion refers to the reputation and popularity of the RPA vendor in the industry. A preferable vendor often has a proven track record of successful implementations and satisfied customers. Considering this criterion is important because a reputable vendor is more likely to offer reliable solutions, provide better customer support, and ensure the long-term success of the RPA implementation.

Criteria 2(C₂) Pricing: Pricing refers to the cost of the RPA solution, including software licenses, maintenance fees, and any additional costs associated with implementation and support. This criterion is important because it directly affects the organization's budget and return on investment. By comparing the pricing of different vendors, organizations can find an RPA solution that meets their needs while remaining cost-effective. For instance, an organization with a limited budget might prioritize a vendor offering a competitive pricing structure without compromising on functionality.

Criteria 3(C₃) Support: This criterion encompasses the quality and availability of the vendor's customer service and technical assistance. This is crucial because it ensures that organizations have access to timely help and expert guidance throughout the RPA implementation process. A vendor with strong support capabilities can help address any challenges that may arise and ensure the smooth functioning of the RPA solution. For example, a vendor that offers 24/7 customer support and a dedicated account manager can provide the necessary assistance to overcome any technical obstacles during the implementation.

Criteria 4 (C₄) Additional Solutions: This criterion refers to any supplementary products, services, or features offered by the RPA vendor, such as automation platforms, pre-built bots, analytics tools, or process mining capabilities. It is important because additional solutions can enhance the RPA experience, streamline the implementation process, and provide added value to the organization.

Criteria 5 (C₅) Ease of Implementation: Ease of implementation focuses on how simple and straightforward it is to deploy and integrate the RPA solution into the organization's existing systems and workflows. This criterion is important because a smooth implementation process can reduce disruption, minimize potential risks, and enable quicker returns on investment. For example, a vendor with a user-friendly interface and a strong track record of seamless integrations can ensure a smoother transition to RPA technology.

Criteria 6 (C₆) Existence of Developers: This criterion refers to the availability of skilled developers and professionals who are familiar with the RPA vendor's platform and tools. This is important because having access to a pool of qualified developers can facilitate the development and customization of RPA solutions, ensuring that the organization's automation goals are met effectively. For instance, a vendor with a large developer community and extensive training resources can help organizations build a skilled in-house RPA team or find external partners for development tasks.

5.3.3 Weights of Criteria in RPA Vendor Selection

The objective of this study was to determine the weights of criteria (C_1 , C_2 , ..., C_6) defined in Table 22 using the AHP method. To calculate the weights of the criteria, a 6x6 matrix was first prepared, and the importance of the criteria in relation to each other was defined (Table 23), taking into account the consensus of all employees involved in the definition process. The total value of the evaluations for each criterion in each column was obtained. Normalized values were determined by dividing the evaluations in a column by the column's total value. The weights of each criteria were then calculated by taking the average of the values in the row corresponding to that criterion in the normalized values matrix (Table 24).

Table 23. Preference matrix for vendor selection

	C_1	C_2	C_3	C_4	C_5	C_6
C_1	1.000	6.000	3.000	6.000	3.000	6.000
C_2	3.000	1.000	0.333	0.333	0.111	0.333
C_3	3.000	3.000	1.000	3.000	0.333	0.333
C_4	3.000	3.000	0.333	1.000	0.167	0.333
C_5	6.000	3.000	0.333	3.000	1.000	3.000
C_6	3.000	6.000	3.000	3.000	3.000	1.000
Total	19.000	22.000	8.000	16.333	7.611	11.000

Table 24. Normalized matrix for vendor selection

	C_1	C_2	C_3	C_4	C_5	C_6	Weights
C_1	0.053	0.273	0.375	0.367	0.394	0.545	0.335
C_2	0.158	0.045	0.042	0.020	0.015	0.030	0.052
C_3	0.158	0.136	0.125	0.184	0.044	0.030	0.113
C_4	0.158	0.136	0.042	0.061	0.022	0.030	0.075
C_5	0.316	0.136	0.042	0.184	0.131	0.273	0.180
C_6	0.158	0.273	0.375	0.184	0.394	0.091	0.246
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000

After the weights of the criteria have been determined using the AHP method, the TOPSIS method was used to select the best alternative among the options. First, a decision matrix was created by listing the alternatives in rows and the criteria in columns, with the options being the four most-preferred vendors in the market. The

matrix was then completed with the performance values of each alternative for each criterion. The decision matrix was normalized by dividing each value by the square root of the sum of the squares of the values in the corresponding column, ensuring that all criteria were on the same scale (Table 25).

Table 25. Decision matrix for vendor selection

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆
Option ₁	9	9	9	8	9	8
Option ₂	6	8	6	6	8	6
Option ₃	8	8	6	7	8	8
Option ₄	7	8	8	9	8	7
Total	15.17	16.52	14.73	15.17	16.52	14.59

Each value in the normalized matrix was then multiplied by the corresponding criterion's weight, determined using AHP, to create a weighted normalized decision matrix (Table 26).

Table 26. Normalized decision matrix for vendor selection

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆
Option ₁	0.593	0.545	0.611	0.528	0.545	0.548
Option ₂	0.396	0.484	0.407	0.396	0.484	0.411
Option ₃	0.528	0.484	0.407	0.462	0.484	0.548
Option ₄	0.462	0.484	0.543	0.593	0.484	0.480

The ideal and negative-ideal solutions were determined by finding the maximum and minimum values in the weighted normalized decision matrix for each criterion (Table 27).

Table 27. Weighted normalized decision matrix for vendor selection

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆
Option ₁	0.199	0.028	0.069	0.040	0.098	0.135
Option ₂	0.132	0.025	0.046	0.030	0.087	0.101
Option ₃	0.176	0.025	0.046	0.035	0.087	0.135
Option ₄	0.154	0.025	0.061	0.044	0.087	0.118

The ideal solution consists of the maximum values for benefit criteria and the minimum values for cost criteria, while the negative-ideal solution is the reverse (Table 28).

Table 28. Ideal and negative-ideal solutions for vendor selection

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆
Negative Ideal Solution	0.199	0.028	0.069	0.044	0.098	0.135
Ideal Solution	0.132	0.025	0.046	0.030	0.087	0.101

The separation measures, Euclidean distance to the ideal solution (S^+), and negative-ideal solution (S^-) were calculated for each alternative. The relative closeness to the ideal solution (C) was computed for each alternative, using the formula $C = S^- / (S^+ + S^-)$. The values for C ranged from 0 to 1. Finally, the alternatives were ranked based on their relative closeness values (C). The alternative with the highest C value was considered the best choice. Following this process, the TOPSIS method was used to evaluate and rank the alternatives based on their performance across multiple weighted criteria, ultimately assisting in the selection of the most suitable option (Table 29).

Table 29. Evaluation of the options for vendor selection

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness coefficient	Ranking
Option₁	0.005	0.079	0.941	1
Option ₂	0.080	0.000	0.000	4
Option ₃	0.035	0.056	0.613	2
Option ₄	0.049	0.035	0.416	3

All the assessments indicated that the vendor in Option 1 was the best choice. The study took a methodological approach to the vendor-selection process, ensuring the involvement of all employees in the process and supporting compromise in the decision-making process.

5.4 Process Selection

5.4.1 Definition of Decision-Maker Employees

To determine the decision-makers, it was necessary to define the roles of the actors within the framework of the socio-technical system, to identify which would contribute to the process selection, and to evaluate these in terms of their importance (Table 30).

Table 30. Decision-makers' importance in process selection

	Highest	High	Moderate	Low	Very Low	None
Top Management			√			
RPA CoE Team		√				
IT Team			√			
Developers					√	
Employees	√					
Third Parties					√	

In the process selection, employees evaluated the compliance and impact of the work carried out with RPA. The evaluations made by the RPA CoE team are on a process basis.

5.4.2 Definition of Criteria for Process Selection

In RPA, process-selection criteria are determined based on factors that ensure the success of the automation and maximize its benefits. Thus, this study involved consideration of the suitability of the processes for RPA; their readiness to transition to RPA in their current state; and the impact, benefits, and costs that they entail. In line with these factors, five criteria were identified: suitability, readiness, impact, FTE (full-time equivalent) benefit, and cost (Table 31).

Table 31. RPA process-selection criteria definitions

Explanation	Usage in the Study
Suitability (C₁): This criterion refers to how appropriate a process is for RPA implementation. A suitable process is generally rule-based, structured, and has a high degree of standardization. It involves minimal human judgment or decision-making, making it easier to automate and manage with RPA tools.	The results of the evaluations (%) from the UiPath Automation Hub platform were used. For this purpose, employees were asked the following questions, defined in the system: Is the process rule-based? Is the process repetitive? Is the process stable and well-defined? Does the process involve limited human judgment?
Readiness (C₂): Readiness assesses the extent to which a process is prepared for RPA adoption in its current state. This may include considerations such as the availability of process documentation, the maturity of the existing process, and the level of integration with other systems. A process with high readiness will require fewer adjustments and modifications before automation can be implemented.	The results of the evaluations (%) are based on the assessments conducted in parallel with the following questions asked to the employees and the IT team: Does the process have a low exception rate? Is the process digital? Does the process involve structured or semi-structured data?
Impact(C₃): Impact evaluates the potential effects of automating a process on the organization, including operational efficiency, cost savings, and improvements in quality and accuracy. High-impact processes will deliver more significant benefits to the organization when automated, making them a higher priority for RPA implementation.	For this, the monthly transaction volumes were taken into consideration. It was assumed that the greater the volume of work, the greater the impact created. Information on monthly transaction volumes was obtained directly from the employees and used in the process-selection evaluation.
FTE benefit (C₄): FTE benefit measures the potential reduction in human labor required to perform a process once it is automated. The greater the FTE benefit, the more valuable the automation will be in terms of freeing up employee time and resources, allowing employees to focus on higher-value tasks.	For each transaction, the equivalent employee labor-time spent was calculated. For this purpose, a daily 8-hour work schedule and a 21-day month were used as the basis for calculation. For the calculation, along with the monthly transaction volume information obtained from employees for “impact,” the time spent on each transaction was also collected.
Cost (C₅): The cost criterion considers the expenses associated with implementing and maintaining RPA for a particular process. These may include software and hardware costs, development expenses, and ongoing maintenance and support costs. Processes with lower costs and higher returns on investment are more attractive candidates for RPA implementation.	Since bot costs will be evenly distributed across processes, and maintenance costs will not be applicable before deployment, the values defined by the RPA CoE team based on the estimated efforts provided by developers were used for costs during the process-selection stage.

5.4.3 Weights of Criteria in RPA Process Selection

The objective of this study was to determine the weights of the criteria (C₁, C₂,...,C₅) in Table 31, using the AHP method. To do so, a 5x5 matrix was prepared and the importance of the criteria in relation to each other was defined (Table 32), taking into account the consensus of all employees involved in the definition process. The total value of the evaluations for each criteria in each column was thus obtained. Normalized values were determined by dividing the evaluations in a column by the column's total value. The weights of each criteria were calculated by taking the average of the values in the row corresponding to that criteria in the normalized values matrix (Table 33). Other studies using AHP and TOPSIS methods for process

selection have recently appeared in the literature (Costa et al., 2023). In this study, differentiation was achieved by both enriching the criteria and evaluating the impact on employees.

Table 32. Preference matrix for process selection

	C ₁	C ₂	C ₃	C ₄	C ₅
C ₁	1.000	9.000	9.000	9.000	9.000
C ₂	0.111	1.000	3.000	3.000	3.000
C ₃	0.111	3.000	1.000	6.000	9.000
C ₄	0.111	0.333	0.333	1.000	6.000
C ₅	0.111	0.167	0.167	0.111	1.000
Total	1.444	13.500	13.500	19.111	28.000

Table 33. Normalized matrix for process selection

	C ₁	C ₂	C ₃	C ₄	C ₅	Weights
C ₁	0.692	0.667	0.667	0.471	0.321	0.564
C ₂	0.077	0.074	0.222	0.157	0.107	0.127
C ₃	0.077	0.222	0.074	0.314	0.321	0.202
C ₄	0.077	0.025	0.025	0.052	0.214	0.079
C ₅	0.077	0.012	0.012	0.006	0.036	0.029
Total	1.000	1.000	1.000	1.000	1.000	1.000

After determining the weights of the criteria using the AHP method, the TOPSIS method was used to select the best option. The steps of the TOPSIS method are exactly the same as the ones explained before for vendor selection. Table 34 gives decision matrix to start the TOPSIS method.

Table 34. Decision matrix for process selection

	C ₁	C ₂	C ₃	C ₄	C ₅
Process ₁	100%	90%	3000	2.98	10
Process ₂	100%	100%	400	0.79	20
Process ₃	93%	80%	200	1.19	60
Process ₄	100%	100%	5000	2.48	5
Process ₅	100%	90%	15000	7.44	5
Process ₆	100%	60%	32000	15.87	5
Process ₇	100%	90%	30	0.18	60
Process ₈	73%	50%	4	0.07	180
Process ₉	100%	60%	1	0.14	1440
Process ₁₀	100%	80%	4200	0.42	1
Process ₁₁	79%	80%	0	0.00	0

In the next stage, each value in the normalized matrix was multiplied by the corresponding criterion's weight, as determined using AHP, to create a weighted normalized decision matrix (Table 35).

Table 35. Normalized decision matrix for process selection

	C ₁	C ₂	C ₃	C ₄	C ₅
Process ₁	0.316	0.333	0.083	0.165	0.007
Process ₂	0.316	0.370	0.011	0.044	0.014
Process ₃	0.294	0.296	0.006	0.066	0.041
Process ₄	0.316	0.370	0.139	0.138	0.003
Process ₅	0.316	0.333	0.416	0.413	0.003
Process ₆	0.316	0.222	0.887	0.881	0.003
Process ₇	0.316	0.333	0.001	0.010	0.041
Process ₈	0.231	0.185	0.000	0.004	0.124
Process ₉	0.316	0.222	0.000	0.008	0.990
Process ₁₀	0.316	0.296	0.116	0.023	0.001
Process ₁₁	0.250	0.296	0.000	0.000	0.000

The ideal and negative-ideal solutions were determined by finding the maximum and minimum values in the weighted normalized decision matrix for each criterion (Table 36).

Table 36. Weighted normalized decision matrix for process selection

	C ₁	C ₂	C ₃	C ₄	C ₅
Process ₁	0.178	0.042	0.017	0.013	0.000
Process ₂	0.178	0.047	0.002	0.003	0.000
Process ₃	0.166	0.038	0.001	0.005	0.001
Process ₄	0.178	0.047	0.028	0.011	0.000
Process ₅	0.178	0.042	0.084	0.032	0.000
Process ₆	0.178	0.028	0.179	0.069	0.000
Process ₇	0.178	0.042	0.000	0.001	0.001
Process ₈	0.130	0.024	0.000	0.000	0.004
Process ₉	0.178	0.028	0.000	0.001	0.028
Process ₁₀	0.178	0.038	0.023	0.002	0.000
Process ₁₁	0.141	0.038	0.000	0.000	0.000

The ideal solution consists of the maximum values for the benefit criteria and the minimum values for the cost criteria, while the negative-ideal solution is the reverse (Table 37).

Table 37. Ideal and negative-ideal solutions for process selection

	C ₁	C ₂	C ₃	C ₄	C ₅
Negative Ideal Solution	0.178	0.047	0.179	0.069	0.000
Ideal Solution	0.130	0.024	0.000	0.000	0.028

The separation measures, Euclidean distance to the ideal solution (S^+), and negative-ideal solution (S^-) were then calculated for each alternative. The relative closeness to the ideal solution (C) was computed for each alternative using the formula $C = S^- / (S^+ + S^-)$. The values for C ranged from 0 to 1. Finally, the alternatives were ranked based on their relative closeness values (C). In this way, the TOPSIS method aided in evaluating and ranking the alternatives based on their performance across multiple weighted criteria, ultimately leading to the identification of the most suitable option and presenting the results in terms of the alternatives' relative rankings (Table 39).

Table 39. Closeness coefficients to the ideal solution for process selection

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness coefficient	Ranking
Process₁	0.172	0.063	0.267	5
Process₂	0.189	0.061	0.243	6
Process₃	0.190	0.047	0.199	8
Process₄	0.162	0.068	0.294	3
Process₅	0.102	0.107	0.513	2
Process₆	0.019	0.200	0.914	1
Process₇	0.192	0.058	0.234	7
Process₈	0.199	0.025	0.111	11
Process₉	0.195	0.048	0.199	8
Process₁₀	0.170	0.062	0.268	4
Process₁₁	0.196	0.033	0.146	10

The applied method demonstrated both the involvement of employees in the process selection and ranking, and how decisions can be made based on the five criteria for the 11 processes selected as a sample. Owing to the increasing need for decision-making and ranking within growing numbers of processes in companies as

part of their DT efforts, the application of this MCDM method will provide valuable systematic insights.

5.5 Importance of Employee Collaboration in Technology Implementation

In the fast-paced business environment, technology implementation is crucial for organizations looking to sustain their competitive advantage and boost efficiency, and success relies on effective decision-making that involves not only choosing the right technology but also actively engaging employees in the implementation process. Incorporating a socio-technological perspective into technology implementation can enhance employee collaboration and ownership. This approach recognizes the interdependence of social and technical factors and emphasizes the need to consider how technology will affect an organization's social structure and work processes. Employee collaboration plays a vital role in success, as it fosters a sense of ownership and commitment, leading to smoother technology adoption. In this study, an emphasis on the importance of employee collaboration and the use of MCDM techniques during technology implementation led to better outcomes (Figure 32).

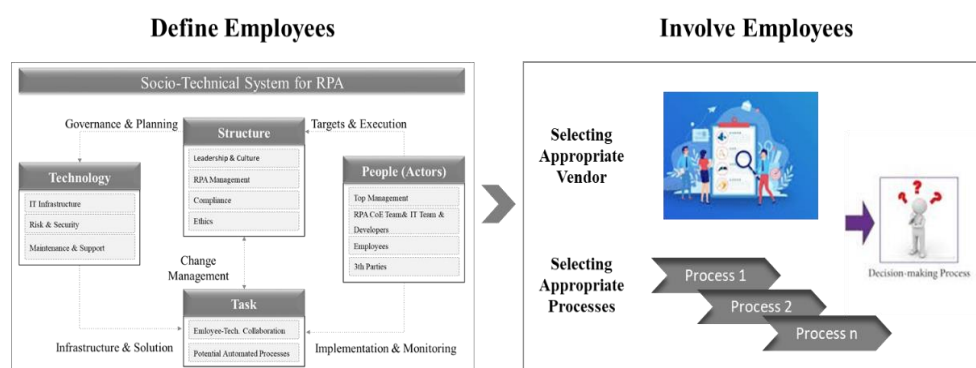


Figure 32. Technology implementation and employee collaboration

In this study, the application of AHP and TOPSIS provided several benefits, with employee collaboration being an essential aspect of this. AHP proved helpful in managing complexity by organizing relationships between criteria and alternatives in a hierarchical structure, making the decision-making process simpler and more comprehensible for all team members. It also facilitated group decision-making by taking into account the views and evaluations of multiple decision-makers, promoting consensus, and further emphasizing the role of employee collaboration.

In addition, TOPSIS provided benefits such as the use of ideal and negative-ideal solutions in the decision-making process, enabling a clear distinction between the better and worse alternatives based on their performance. This approach encouraged employees to actively participate in the process because it revealed the rationale behind the decisions. TOPSIS also made it easier for employees from diverse disciplines to compare alternatives. The method calculated a relative closeness score for each alternative based on its proximity to the ideal solution, aiding in the ranking and selection of alternatives with the collective input of employees.

In summary, this study effectively highlights the importance of employee collaboration and the utilization of MCDM techniques such as AHP and TOPSIS for successful technology implementations. The findings emphasize the value of engaging employees in the decision-making process and show how this contributes to the overall success of an organization's DT journey. Thus, the study demonstrates how technology ensures employee inclusion both in socio-technical terms and through the quantitative decision-making mechanisms of the approaches and methods presented.

CHAPTER 6

CONCLUSION

This thesis focuses on the broad, inclusive, and impactful subject of DT and contributes to the literature by building upon three fundamental design principles. First, the subject is approached holistically and in an end-to-end manner. Second, the study proposes non-specific, applicable models and methodologies that are independent of sector and size. Third, it constitutes a multi-faceted analysis, covering various dimensions that enable the subject to be examined from a socio-technical perspective. Being carried out in line with these design principles, this study makes three types of contribution to the literature: theoretical, practical, and socio-technical.

Theoretical contributions are new ideas or concepts that advance understanding of a particular field or topic. They can be achieved by conducting research and analyses to reveal new insights, challenge existing theories, or propose a new framework for understanding a phenomenon. The theoretical contributions of this thesis are summarized as follows:

- A systematic literature review has been conducted on DT and the DMM that plays a catalyst role in this thesis. Sixty maturity models developed by academics and consultants have been analyzed.
- This study is the first in the field to present a systematic literature review that includes bibliometric analyses in addition to PRISMA.
- The DT journey process, which enables an end-to-end definition of DT, is described.
- A holistic DMM has been designed, taking into account both the critical success factors and capabilities required by DT and the dimension and sub-

dimension analyses of all models developed to date, which can serve as a reference regardless of industry and size.

- Questions have been prepared for each dimension and sub-dimension to support the implementation of the model.
- Digital maturity levels and scores have been associated with the phases of DT (digitization, digitalization, and DT).
- A methodology has been developed that applies MCDM techniques to determine targets for DMA scoring, and an approach for prioritizing and planning based on differences between scores and targets has been presented.
- A selection methodology has been developed to determine the stage at which the chosen technological solutions are implemented during the transformation process.
- Methodological support is provided to address and manage the employee dimension when implementing RPA, giving an example of employee–technology collaboration that can be applied in many processes.
- A framework has been created to provide a governance structure for the management of the DT journey.

The practical contributions of a study or research project are defined by its real-world impact on practitioners, industries, and society. They can involve developing solutions to practical problems, enhancing existing practices, and informing policy making. The practical contributions of this thesis are summarized as follows:

- DMM and the DMA (based on questions prepared within this scope) have been validated for a large-scale company in terms of both question comprehensibility and reflection of the current situation in the results.

- Digital maturity scoring and target setting were conducted within the framework of applied DMA results and expert opinions.
- In the context of RPA, 11 processes were selected and evaluations were performed based on a real case and expert opinions.

The socio-technical contributions are the positive impact of the research on society and technology, including the addressing of social challenges or needs and the improving or advancing of technological capabilities. This type of contribution can lead to increased efficiency and more sustainable practices. The socio-technological contributions of this thesis are summarized as follows:

In this thesis, DT is considered not only in terms of targeted outcomes or technology implementation, but also as a holistic DMM that takes into account all stakeholders who influence and are affected by the process. In this context, an integrated approach has been ensured for elements such as leaders, customers, employees, and the ecosystem.

- For the first time, the issue of ethics is included in the DMM and evaluations, guaranteeing consideration of all parties and associated potential risks.
- The methodologies are designed to be sufficiently flexible to allow different perspectives and priorities to be reflected in the outcomes and planning.
- RPA enables both faster, efficient, and error-free task completion by transferring employees' tasks to bots, as well as increased productivity and motivation by eliminating non-value-added tasks. Due to all these features, RPA governance has been approached from a socio-technical perspective, trying to determine how value can be balanced from both organizational and employee perspectives.

This thesis includes a comprehensive literature study and takes a socio-technical approach to design a digital maturity model and methodologies developed to fill the gaps in the literature.

Considering DT as an end-to-end process offers considerable strength, yet also presents limitations. The time needed to implement different methods across various sectors and companies can be extensive, as each must be uniquely adapted and integrated. Furthermore, due to the rapidly evolving nature of the field and the alluring nature of the subject, there is a continuous need for dynamic validation. With new sources, publications, and technologies emerging daily, it is essential to constantly re-assess and validate the outputs. This ongoing necessity to remain current and validate new developments may be perceived as a further constraint, adding to the complexity of the process.

Future studies hold promising potential in various areas of DT. One such opportunity lies in creating a DM Index based on a Holistic DMM for assessments across different sectors and sizes. This comprehensive index would enable systematic evaluation and comparison of digital maturity stages, providing invaluable insights for various stakeholders.

Another compelling area of research is Digital Value Creation. Developing a standard set of KPIs that can measure the value created by DT across stakeholders is of utmost importance. Furthermore, defining the interaction between these KPIs would help better assess the efficiency and impact of digital initiatives.

The field of optimization presents significant potential. It involves optimizing the investment and utilization of technology. An example could be enhancing the efficiency of bots, thereby ensuring that digital resources are leveraged to their full potential.

Moreover, focusing on the effects of technology on employee productivity can provide insights into the human factors of DT. As technology continues to evolve and influence work environments, studying its impact can enable organizations to better manage changes and enhance employee efficiency.

The development of digital employee capabilities is another promising area. It involves classifying and defining new skills that employees must possess in the digital age, categorizing them into various areas such as governance, technical abilities, and technology-based skills. Understanding these capabilities can help organizations to effectively upskill their workforce, fostering an environment that can fully leverage digital opportunities.

Lastly, considering compliance, ethics and values within the context of DT can provide a comprehensive perspective. This holistic approach ensures that the process of DT is not only technologically sound and beneficial, but also ethically robust and compliant with all necessary regulations. This can help avoid potential pitfalls and legal challenges, ensuring a smooth and responsible transition into the digital era.

Through such studies, we can begin to tackle issues and discover solutions to ensure digital solutions produce optimal value at every level of an organization.

APPENDICES

APPENDIX A: DM ASSESSMENT QUESTIONS, DM LEVELS, AND CAPABILITIES

Table A1. Digital Strategy: Vision (1a)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Vision (1a)	At what stage are you in the digitalization process?	Understanding and embodying the benefits to gain from digitalization	Identifying visions and directions for digitalization	Beginning to realize the vision for digitization	Providing gains that affect business results with digitalization	Entering new business areas with digitalization, producing digital products
	What is your vision for DT?	No defined vision, concrete strategy, or objectives defined	Limited to automation studies	Creating competitive advantage with digitalization in certain functions and processes (functional strategy)	Creating a competitive advantage with digitalization that spans the organization or its intended scope (business strategy)	Creating disruptive competitive advantage by directing new product and service strategies (DT strategy) to achieve a share of the digital economy
	At what level and to what extent do you address digitization?	Triggered by employees	Some functions and business units with set digitalization targets	Some functions implemented on the basis of business units	Supporting targets with digitalization studies	Strategies implemented through digitalization studies

Table A2. Digital Strategy: Leadership (1b)

Sub-Dimension	Questions	Maturity Levels and Capabilities				
		Intention	Beginner	Adaptor	Performer	Transformer
Leadership (1b)	How important is digitalization for senior management, and what level of determination is demonstrated?	Digitalization is not among the priorities of senior management.	Interested in trends and competitive conditions noted by functional leaders	Strategically important and supported in targeted functions and business units	All digitalization process and studies are supported, and senior management takes a role as a sponsor in all critical projects	Considered to be part of corporate change and transformation, owned and led by the senior management team
	What is the size of the budget allocated to the DT process?	No budget or resource allocation provided	Creating budget projections for necessary improvements and infrastructure	Ensuring minimum budget allocation for necessary improvements and infrastructure	Budget planning and realization that supports corporate-level plans and targets	Long-term budget planning and allocation, covering all resource and investment requirements for transformation

Table A3. Digital Strategy: Strategies (1c)

Sub-Dimension	Questions	Maturity Levels and Capabilities				
		Intention	Beginner	Adaptor	Performer	Transformer
Strategies (1c)	What dimensions of strategic competitive advantage are targeted in the DT process?	Undefined	Reducing costs	Reducing costs, reducing risks, optimization, process excellence	Reducing costs, reducing risks, optimization, operational excellence	Earning additional income from new products, business excellence
	What strategic performance indicators and targets for digitalization have been determined?	None	Key performance indicators (KPIs) for the process	KPIs to evaluate the impact on operational performance	KPIs to evaluate the impact on strategic performance	KPIs to evaluate performance against the competition

Table A4. Digital Strategy-Business Model (1d)

Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Business Model (1d)	What is the new value proposition offered?	Undefined	No additional value proposition	Activating existing products and service delivery processes	Supporting the development and improvement of existing products and services	Enabling to introduce brand new products and services
	Do digital strategies require defining a new business model?	No	Improving the existing business model	Defining a new business model	Operating the new business model	Creating value with the new business model

Table A5. Digital Strategy-Operating Model (1e)

Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Operating Model (1e)	To what extent is the current operating model capable of supporting digital strategies?	Not at all	On a functional basis, independent of other functions and business units	Process-based functions require interregional standardization and integrations	Requires standardization and integrations on the basis of business units	To what extent is the current operating model capable of supporting digital strategies?
	How does the current operating model require you to address digital targets?	Not applicable	Limited	Function based	Process based	Enterprise wide

Table A6. Digital Value: Create Value (2a)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Create Value (2a)	Are customers defined and segmented?	No	Criteria for customer segmentation have been defined	Customers are segmented based on products offered	Customers are segmented at the corporate level and based on the value offered or to be offered	Customer segments are managed based on the defined organization, service levels, and processes
	What is the place and importance of customers in your strategies?	Not defined, the strategies are financially weighted	Defined strategies and objectives from a financial perspective for customers	Defined segments, strategies, and goals based on targeted value	Implemented strategies and goals based on segments and targeted value	Implemented strategies and goals based on segments and targeted value provide a competitive advantage
	How does the digitalization process address the value offered (or to be offered) to customers?	No systematic definition	It is defined but not integrated with digitalization strategies.	It is integrated with digitalization strategies and defined.	The process of offering additional value to customers has begun within the scope of digitalization.	Value that creates a difference in competition is offered to customers within the scope of digitalization.
	How is the voice of the customer (VoC) managed in the digitalization process?	No systematic management	The organization is managed in a fragmented way based on functions and departments with disconnected VoC processes and customer platforms.	The VoC processes and customer platforms are managed in an integrated manner between functionalities.	Solutions and values to be offered within the scope of digitalization based on VoC data have started to enter the goals.	Proactive digitalization strategies based on VoC data have been implemented.

Table A7. Digital Value: Deliver Value (2b)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Deliver Value (2b)	What is the place and importance of digitalization in your product and service portfolio?	No concept of “digital products and services” or “digital revenue” exists within the enterprise. Revenue focus remains on traditional products. No metrics are in place to track digital revenue.	Pockets of digital products and services or digital revenue are emerging within the enterprise, yet organization-wide visibility is lacking. Digital revenue metrics are typically internal and tracked exclusively by the business unit pursuing them.	Senior management recognizes the potential and value of digital revenue and driving it strategically. An enterprise-wide effort to identify, leverage, and measure digital revenue opportunities has begun.	Digital products and services are well-understood across the enterprise, and digital revenue with specific targets is an accepted part of its financial statements. Digital revenue is measured at the enterprise level as a key enterprise metric that is widely shared internally and, in some cases, shared externally with investors and shareholders.	Digital products and services and digital revenue have transformed the organization’s financials. As a digital leader, they have established new benchmarks in the industry. Digital revenue is measured in the same way as in the “Performer” level. Target goals are communicated in earnings calls.
	What extent of differentiation does digitalization require in the current product and service portfolio?	None	Augmented digital product player; focus on products with digital features such as sensors or communication devices	Complete solution/ service provider; focus on digital products and data-based services that provide a complete solution for the customer	Data analytics, content and platform integrator; focus on data analytics and data-based services; access to customers via a dedicated (online) platform	Integrated digital ecosystem provider; integration of third-party partner or competitor products and control systems in a complete customer ecosystem
	What is the impact of innovation reflected in products and services in the digitalization process?	None	Seeking differentiation in products and services and pilot implementations	Initiating differentiation efforts in existing products and services	Offering a new product and service experience	Offering innovative products and services

Table A8. Digital Value-Capture Value (2c)

Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Capture Value (2c)	What added value will be created by the product and service offered in the scope of digitalization?	None	Limited revenue growth in certain customers	Limited revenue increase in all critical customers	Targeted satisfaction and revenue increase in all critical customers	Acquiring new customers and revenue beyond loyalty and competitive revenue increase in all critical customers
	What value will the product and service offered in the scope of digitalization create for your organization?	None	Cost reduction	Increased satisfaction of existing customers	Ensuring existing customer loyalty	Acquiring new customers beyond the current portfolio

Table A9. Digital Process: Process Architecture and BPM (3a)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Process Architecture and BPM (3a)	Is your process architecture defined?	No	Have current processes been defined with classifications (e.g., core, management, support)?	The process architecture design to support the operation model has been completed.	The process architecture design has been created to support the operational model and business capabilities.	The process architecture is designed to be integrated with the enterprise architecture.
	How are processes managed?	No systematic management, or they are managed based on individual definitions	Managed based on documented definitions	Systems that support automation have been commissioned and analysis of historical data has begun (i.e., digitization).	They are managed based on instant data produced over commissioned systems (i.e., digitalization).	They are managed based on data analysis that supports decisions based on deployed technology, systems, and platforms (i.e., transformation).
	Are the roles defined and effective in BPM governance?	No	Paired with owners of functional structures	Process-based responsibilities involving more than one function have begun to be defined.	Process ownership has been implemented.	At the institutional level, process owners and their responsibilities are functional and integrated with the organizational structure.

Table A10. Digital Process: Value Chain-E2Es (3b)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Value Chain-E2Es (3b)	Are your value chain processes defined?	Not defined	Starting to be defined	Processes within the scope of the existing architecture integrated with E2Es	Optimization of processes with E2Es	E2Es provide competitive advantage
	To what extent are your end-to-end processes digitized?	Planning phase	Automation phase	Digitization phase	Digitized	Provide competitive advantage across the value chain
	To what extent has the governance of E2E processes been implemented?	Not defined	E2E ownership governance is defined	E2E process owners are assigned	E2E process owners seek supra-functional performance	Improvements and digital solutions are implemented in the entire value chain

Table A11. Digital Process: Core Processes (3c)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Core Processes (3c)	Are your core processes defined?	Not defined	Partially defined	All basic processes (e.g., production, supply chain, marketing-sales)	Efficient and effective performance of key processes	Performance of core processes provides strategic competitive advantage
	To what extent are your core processes digitized?	Planning phase	Automation phase	Digitization phase	Digitized	Digitalization has started to generate value (e.g., productivity and competitive advantage)

Table A12. Digital Process: Management and Support Processes (3d)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Management & Support Processes (3d)	Are your managerial and support processes defined?	Not defined	Starting to be defined	All administrative processes (e.g., HR, IT, finance, strategy)	Supports core processes	Offering value in terms of standardization and guidance
	What is the progress level of digitalization efforts for your managerial and support processes?	Planning phase	Automation phase	Digitization phase	Digitized	Digitalization has started to generate value (e.g., productivity and competitive advantage)

Table A13. Digital Technology and Data: Data and Analytics (4a)

Sub-Dimension	Maturity Levels and Capabilities					
	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Data & Analytics (4a).	What is the level of data access and data management?	None or as needed	Manual in a limited number of processes	Hybrid (based on data fed from both manual and automated systems) in a limited number of processes	Fully automated in the management of critical processes	At the corporate level operational and strategic performance
	In what scope and dimension is data usage?	None or as needed	To capture problems	To analyze past performance based on root causes of problems	To analyze the achievability of goals beyond capturing problems	To support predictive decisions for the future
	Are there established standards and governance related to data?	The importance of data is known, but the infrastructure and governance to effectively utilize the data have not yet been implemented.	Data are collected and used on a project basis.	Standards and infrastructures have been established for organization-wide data access and usage.	Data are systematically collected and monitored.	Strategic competitive advantage is provided by supporting data and data management.
	Are the necessary roles and responsibilities defined for data management?	Defined	Profiles that focus on data-driven insights and reporting are developing within IT teams and business units.	Data engineers and data analysts are trained within the organization.	All organization-wide responsibilities for data management (from technological, analytical, and business unit perspectives) have been defined.	All roles interact to generate proactive value for the organization.

Table A14. Digital Technology and Data: IMS and Applications (4b)

Maturity Levels and Capabilities						
Sub-Dimens	Questions	Intention	Beginner	Adaptor	Performer	Transformer
IMS & Applications (4b)	How is information access and information management supported?	Ad-hoc	Manual	Systems that provide access to and flow of rmation (e.g., mobile internet and al network, ch platforms) are in operation.	Platforms that support communication and workflow among employees and other stakeholders are in operation (e.g., supplier portal, corporate portal, customer portal, systems, e-commerce, and e-tendering).	Communication and interaction are supported and implemented independently of humans with the help of intelligent systems (e.g., advanced data analytics and AI)
	In what dimension do you approach digitalization?	With current competencies, on-demand and responsive	By developing competencies and collaborations beyond current capabilities, system primarily in the cultural dimension	Supporting the deployment of new systems by strengthening the current system infrastructure in addition to the cultural dimension	By supporting all critical processes with automation and digitalization solutions in parallel with cultural transformation and strengthening of system infrastructure	By providing digital platforms and solutions that enable entry into new business areas beyond automation and digitalization in internal processes
	At what stage are you regarding the following digital solutions? Robotic process automation (RPA), remote monitoring and control systems, digital performance management, optimization solutions, advanced analytics solutions (e.g., predictive maintenance, predictive quality, demand forecasting, OEE, smart energy consumption), human and robot collaboration (e.g., digital twin, 3D printing, augmented reality, IoT).	In the research phase	A roadmap has been created	Solutions implemented in certain processes	Targeted solutions have been successfully implemented and have started to contribute positively to business outcomes.	All targeted solutions have been put into operation and support the achievement of the ideal performance that will make the company an industry leader.
	To what extent are digital solutions being used?	Selection of critical and exemplary application areas is planned.	Within the scope of pilot or exemplary applications	Only automation solutions have been implemented in a limited number of processes.	Solutions that support digitalization are operational in all critical processes.	Within the scope of the most advanced digital solutions that will enable end-to-end processes to be systematically managed independently of humans
	To what extent are digital solutions generating value?	Investment or implemen-tation phase	Applications have started, but their impact has not yet been seen	They have started to increase efficiency	They have not only increased our efficiency, but also improved our effectiveness	They have increased our agility beyond productivity and efficiency

Table A15. Digital Technology and Data: Security and Risk Management (4c)

Sub-Dimension	Maturity Levels and Capabilities					
	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Security and Risk Management (4c)	How are risks associated with digital solutions managed?	Despite awareness of the risks, no defined control mechanisms exist.	Some controls have been identified and documented.	Although many controls have been identified and documented, risks are managed based on individual approaches.	Controls are performed and effectiveness is monitored, but they are not supported by automation.	Controls are supported by automation and enable proactive management of security risks.
	To what extent are you using security technologies?	For security purposes only (e.g., physical security, access control, and antivirus protection)	For protection purposes (e.g., firewalls and identity management)	For content control purposes (e.g., edge and device firewalls)	For monitoring purposes (i.e., technologies used to detect abnormalities)	For the purpose of preventing threats (e.g., an OT threat management platform)
	How is business continuity ensured based on digitalization infrastructure and solutions?	Identification of responsible parties is planned	It is managed within the scope of a simple IT infrastructure and networking expertise.	Security systems have been installed by a responsible team, and risk assessments have been conducted.	Incidents are detected, problems and potential new risks are prevented, and expertise in cybersecurity is being developed.	Advanced security technologies and cyber security expertise are being used to proactively manage risks and prevent threats.

Table A16. Digital Work: Working Style (5a)

Sub-Dimension	Maturity Levels and Capabilities					
	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Working Style (5a)	How have digital solutions impacted your work life?	Structuring corporate systems and platforms for communication and information flow is planned.	The tools and platforms used are limited to those that support corporate communication and information management, such as intranet.	The platforms and solutions that will support the work are being implemented.	The productivity and communication network based on the established systems and platforms has been increased, and it is possible to expand further.	The established systems and platforms proactively guide employees' communication and work.
	To what extent have digital solutions changed the working order and style?	The traditional working model continues, and alternative solutions are being evaluated.	A roadmap has been created for digital solutions in terms of working methods and working routines.	Digital solutions have started to be implemented to increase communication and work efficiency.	Digital solutions have started to tangibly increase work efficiency, effectiveness, and employee satisfaction.	Digital solutions have been implemented to support the organization to work efficiently, flexibly, creatively, and in an agile manner

Table A17. Digital Work: Skills and Capabilities (5b)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Skills and Capabilities (5b)	To what extent do employees' current skills align with your organization's digitalization goals?	Evaluation has not been executed systematically; only a prediction exists.	The roadmap for meeting the organization's goals in line with the needs and development has been prepared.	The current competencies partially meet the digitalization goals.	The current competencies are meeting the critical priority digitalization goals.	The current competencies fully meet the digitalization goals and are directive.
	How does the organization benefit from digital skills and capabilities?	Planning limited projects based on current individual competencies	Starting to benefit from limited existing competencies toward the goals	Developing existing skills to reactively make improvements	Generating proactive value based on existing competencies on a functional and process level	Creating innovative and disruptive solutions at the corporate level based on existing competencies

Table A18. Digital Work: Training and Development (5c)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Training and Development (5c)	What is the impact of education and development activities on the corporate digitalization competence?	General awareness, education, and training about digitalization are provided.	Digital transformation goals-oriented training and development plans have been prepared.	Basic competencies and competency gaps for digital transformation goals have been identified, and education and development plans have been implemented.	Training and development plans tailored to functional process and job families for digital transformation goals have been customized and supported.	DT goals are supported by customized training and development plans for both corporate and individual levels to become the best in class.
	How do training and development activities support digital transformation efforts?	Training and development activities are in the planning phase.	Training and development activities are limited within the existing education budget.	Annual goals are being planned and supported to the extent necessary.	Training and development activities are addressed and supported at a scope and scale that will support strategic goals.	Beyond the strategic goals, a program is managed to support a scope and scale that will facilitate cultural transformation for sustainability.

Table A19. Digital Work: Collaboration (5d)

Sub-Dimension	Maturity Levels and Capabilities					
	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Collaboration (5d)	What level of collaboration is needed to be supported by digitalization?	Determining and analyzing the concrete scope	Limited to access to information needed by the employee	Supporting communication and collaboration among employees	Supporting communication and collaboration at the corporate level	Enabling employee and machine interactions for intra and inter organizational communication and collaboration, in line with corporate strategies
	How and to what extent does digitalization and digital solutions support collaboration?	It limits knowledge sharing and teamwork to a certain extent.	Solutions and synergies are addressed and supported on a project basis.	Collaboration systems and platforms enable employee synergy and knowledge sharing.	Corporate level systems and platforms facilitate synergy and knowledge exchange.	Solutions and platforms enable synergy and knowledge exchange with critical stakeholders outside the organization.

Table A20. Digital Governance: Organization and Roles (6a)

Sub-Dimension	Maturity Levels and Capabilities					
	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Organization & Roles (6a)	Has the organizational dimension of digital transformation efforts been analyzed?	No	The need for organizational differentiation is being examined.	Organizational requirements necessitated by the digitalization process have been identified.	Organizational changes required by the digitalization process have been made.	Implemented organizational changes required by the digitalization process have become operational.
	Are roles and responsibilities for digital transformation defined and monitored?	Not yet, or relevant functions and areas are researching what can be done.	Only the roles and responsibilities of teams responsible for technology are defined.	The roles and responsibilities within the process and relevant functions where technology will be applied have been defined.	Responsibilities and objectives that are compatible with organizational change have been defined.	The performance of newly defined or revised roles and responsibilities is being monitored and rewarded.

Table A21. Digital Governance: Program Management (6b)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Program Management (6b)	Are digitalization efforts being systematically managed within a program?	Not defined	Action plans created based on current knowledge and forecasts through a to-do list	Digital maturity assessment conducted to create a comprehensive program	Roadmap and program created based on the evaluations and strategic objectives	Implementing strategic initiatives and projects defined within the program
	How are digitalization efforts monitored and reported?	Not defined	Action plans are tracked and reported within monitoring tables (e.g., in Excel)	They are tracked and reported within the scope of existing project management approaches and tools.	They are tracked and reported on separate dashboards created for the program.	The dashboards and reporting created for the digital transformation program have been integrated with existing strategic performance monitoring and reporting.
	How is the sustainability of digitalization efforts ensured?	Not defined	Handled on a project basis	In addition to project-based management, how it will be managed on a process and function basis has been described.	The roles, responsibilities, processes, and monitoring mechanisms have become functional at the corporate level and throughout the organization.	Processes, systems, and employees within the corporate architecture integrity generate processes that serve the organization's strategic objectives.

Table A22. Digital Governance: Culture (6c)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Culture (6c)	How do you evaluate the impact of the existing culture on digitalization efforts?	Deep-rooted and difficult to change cultural norms are prevalent	The extent to which the existing culture will change with digitalization has been analyzed.	A roadmap and program were created regarding how cultural change elements required by digitalization (e.g., risk-taking, speed, and collaboration) will be adapted to the existing culture.	Employees have adapted to the cultural change and have started to demonstrate the necessary competency and behavior styles.	The cultural change requirements brought by digitalization have led to a new culture and working style throughout the organization.
	How is the contribution and participation of employees ensured in digitalization efforts?	Not defined	Communication tools serve to raise awareness within the organization.	Communication and cultural transformation plans are being initiated based on the evaluations and dimensions of the transformation.	The cultural transformation brought by digitalization is managed within a program, and employee contribution, participation, and adaptation to change are supported.	Employees have adapted to the cultural transformation necessitated by digitalization. With the support and contribution they provide to digitalization efforts, they are accelerating the progress of the work.

Table A23. Digital Governance: Ethics (6d)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Ethics (6d)	How are ethical issues that may arise within the scope of digitalization efforts addressed?	Although it is considered a critical aspect, its scope and scale have not been evaluated.	Analysis and evaluation have been made for potential ethical issues that may arise.	The management of ethical issues that may affect reputation has been considered.	The management of ethical issues that may have legal impact has been considered.	All ethical issues are managed within the scope of corporate risks as part of the digital transformation.
	In which scope and scale are ethical elements being addressed?	The current and potential impacts are limitedly known and/or within the scope of known impacts.	With regard to the scope and scale that may affect revenue	Within the framework of legal obligations	Within the framework of all corporate responsibilities (i.e., reputation, revenue, and legal)	Within the framework of identified and potential obligations for all stakeholders and technological tools

Table A24. Digital Governance: Ecosystem Engagement (6e)

Maturity Levels and Capabilities						
Sub-Dimension	Questions	Intention	Beginner	Adaptor	Performer	Transformer
Ecosystem Engagement (6e)	How is interaction and value creation in digitalization efforts supported through ecosystem engagement?	A strategy for ecosystem engagement has not yet been defined.	Only an ecosystem involving employees is being considered.	An ecosystem including relevant processes for products and services in addition to employees has been designed.	An ecosystem involving customers has been designed, as well.	An ecosystem has been designed involving all stakeholders and based on a mutual win-win value platform.
	To what extent do the existing ecosystem channels and platforms impact digitalization efforts?	No channel or platform supporting the ecosystem has yet been defined.	The design of channels and platforms supporting employee participation and innovation is planned.	Channels and platforms supporting employee participation and innovation have been implemented.	Channels and platforms supporting customer participation in addition to employees and a data infrastructure have been implemented.	Digitalization efforts are being proactively managed with outputs based on ecosystem channels and platforms involving all stakeholders.

APPENDIX B: AHP RESULTS: SUB-DIMENSIONS WEIGHT

Table B1. Pairwise comparison matrix for digital strategy

Digital Strategy	D _{1.1}	D _{1.2}	D _{1.3}	D _{1.4}	D _{1.5}
Vision (D _{1.1})	1.000	2.000	2.000	4.000	1.000
Strategies (D _{1.2})	0.500	1.000	2.000	2.000	0.500
Business Model (D _{1.3})	0.500	0.500	1.000	2.000	0.500
Operating Model (D _{1.4})	0.250	0.500	0.500	1.000	0.250
Leadership (D _{1.5})	1.000	2.000	2.000	4.000	1.000
Total	3.250	6.000	7.500	13.000	3.250

Table B2. Normalized matrix for digital strategy

Digital Strategy	D _{1.1}	D _{1.2}	D _{1.3}	D _{1.4}	D _{1.5}	Weight
Vision (D _{1.1})	0.308	0.333	0.267	0.308	0.308	0.305
Strategies (D _{1.2})	0.154	0.167	0.267	0.154	0.154	0.179
Business Model (D _{1.3})	0.154	0.083	0.133	0.154	0.154	0.136
Operating Model (D _{1.4})	0.077	0.083	0.067	0.077	0.077	0.076
Leadership (D _{1.5})	0.308	0.333	0.267	0.308	0.308	0.305
Total	1.000	1.000	1.000	1.000	1.000	1.000
Confidence Score	0.0131					

Table B3. Pairwise comparison matrix for digital value

Digital Value	D _{2.1}	D _{2.2}	D _{2.3}
Create Value (D _{2.1})	1.000	6.000	7.000
Deliver Value (D _{2.2})	0.167	1.000	3.000
Capture Value (D _{2.3})	0.143	0.333	1.000
Total	1.310	7.333	13.000

Table B4. Normalized matrix for digital value

Digital Value	D _{2.1}	D _{2.2}	D _{2.3}	Weight
Create Value (D _{2.1})	0.764	0.818	0.636	0.739
Deliver Value (D _{2.2})	0.127	0.136	0.273	0.179
Capture Value (D _{2.3})	0.109	0.045	0.091	0.082
Total	1.000	1.000	1.000	1.000
Confidence Score	0.0882			

Table B5. Pairwise comparison matrix for digital processes

Digital Processes	D _{3.1}	D _{3.2}	D _{3.3}	D _{3.4}
Process Architecture and BPM (D _{3.1})	1.000	2.000	2.000	3.000
Value Chains (E2E Processes) (D _{3.2})	0.500	1.000	3.000	4.000
Core Processes (D _{3.3})	0.500	0.333	1.000	2.000
Management & Support Processes (D _{3.4})	0.333	0.250	0.500	1.000
Total	2.333	3.583	6.500	10.000

Table B6. Normalized matrix for digital processes

Digital Processes	D _{3.1}	D _{3.2}	D _{3.3}	D _{3.4}	Weight
Process Architecture and BPM (D _{3.1})	0.429	0.558	0.308	0.300	0.399
Value Chains (E2E Processes) (D _{3.2})	0.214	0.279	0.462	0.400	0.339
Core Processes (D _{3.3})	0.214	0.093	0.154	0.200	0.165
Management & Support Processes (D _{3.4})	0.143	0.070	0.077	0.100	0.097
Total	1.000	1.000	1.000	1.000	1.000
Confidence Score	0.0568				

Table B7. Pairwise comparison matrix for digital technology & data

Digital Technology & Data	D _{4.1}	D _{4.2}	D _{4.3}
Data & Analytics (D _{4.1})	1.000	0.500	1.000
MIS & Applications (D _{4.2})	2.000	1.000	2.000
Security & Risk Mng. (D _{4.3})	1.000	0.500	1.000
Total	4.000	2.000	4.000

Table B8. Normalized matrix for digital technology & data

Digital Technology & Data	D _{4.1}	D _{4.2}	D _{4.3}	Weight
Data & Analytics (D _{4.1})	0.250	0.250	0.250	0.250
MIS & Applications (D _{4.2})	0.500	0.500	0.500	0.500
Security & Risk Mng. (D _{4.3})	0.250	0.250	0.250	0.250
Total	1.000	1.000	1.000	1.000
Confidence Score	0			

Table B9. Pairwise comparison matrix for digital work

Digital Work	D _{5.1}	D _{5.2}	D _{5.3}	D _{5.4}
Working Style (D _{5.1})	1.000	0.500	4.000	3.000
Skill & Capabilities (D _{5.2})	2.000	1.000	2.000	3.000
Training & Development (D _{5.3})	0.250	0.500	1.000	2.000
Collaboration (D _{5.4})	0.333	0.333	0.500	1.000
Total	3.583	2.333	7.500	9.000

Table B10. Normalized matrix for digital work

Digital Work	D _{5.1}	D _{5.2}	D _{5.3}	D _{5.4}	Weight
Working Style (D _{5.1})	0.279	0.214	0.533	0.333	0.126
Skill & Capabilities (D _{5.2})	0.558	0.429	0.267	0.333	0.577
Training & Development (D _{5.3})	0.070	0.214	0.133	0.222	0.170
Collaboration (D _{5.4})	0.093	0.143	0.067	0.111	0.127
Total	1.000	1.000	1.000	1.000	1.000
Confidence Score	0				

Table B11. Pairwise comparison matrix for digital governance

Digital Governance	D _{6.1}	D _{6.2}	D _{6.3}	D _{6.4}	D _{6.5}
Organization & Roles (D _{6.1})	1.000	0.500	3.000	5.000	6.000
Program Management (D _{6.2})	2.000	1.000	4.000	6.000	8.000
Culture (D _{6.3})	0.333	0.250	1.000	2.000	4.000
Ethics (D _{6.4})	0.200	0.167	0.500	1.000	2.000
Ecosystem (D _{6.5})	0.167	0.125	0.250	0.500	1.000
Total	3.700	2.042	8.750	14.500	21.000

Table B12. Pairwise comparison matrix for digital governance

Digital Governance	D_{6.1}	D_{6.2}	D_{6.3}	D_{6.4}	D_{6.5}	Weight
Organization & Roles (D _{6.1})	0.270	0.245	0.343	0.345	0.286	0.298
Program Management (D _{6.2})	0.541	0.490	0.457	0.414	0.381	0.456
Culture (D _{6.3})	0.090	0.122	0.114	0.138	0.190	0.131
Ethics (D _{6.4})	0.054	0.082	0.057	0.069	0.095	0.071
Ecosystem (D _{6.5})	0.045	0.061	0.029	0.034	0.048	0.043
Total	1.000	1.000	1.000	1.000	1.000	1.000
Confidence Score	0.0189					

APPENDIX C: TOPSIS RESULTS FOR DIMENSIONS' TARGET SETTING

C.1 TOPSIS Results for Digitization Stage

Table C1.1 TOPSIS results for digital strategy

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.066	0.166	0.714	2
Beginner	0.043	0.189	0.815	1
Adaptor	0.138	0.083	0.376	3
Performer	0.206	0.012	0.053	4
Transformer	0.218	0.000	0.000	5

Table C1.2 TOPSIS results for digital value

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.000	0.383	1.000	1
Beginner	0.191	0.191	0.500	2
Adaptor	0.383	0.000	0.000	3
Performer	0.383	0.000	0.000	3
Transformer	0.383	0.000	0.000	3

Table C1.3 TOPSIS results for digital processes

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.175	0.178	0.505	4
Beginner	0.237	0.327	0.580	1
Adaptor	0.245	0.300	0.550	2
Performer	0.229	0.248	0.520	3
Transformer	0.251	0.149	0.373	5

Table C1.4 TOPSIS results for digital technology & data

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.000	0.308	1.000	1
Beginner	0.118	0.218	0.648	2
Adaptor	0.166	0.157	0.486	3
Performer	0.235	0.078	0.250	4
Transformer	0.308	0.000	0.000	5

Table C1.5 TOPSIS results for digital work

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.133	0.140	0.513	2
Beginner	0.144	0.138	0.489	3
Adaptor	0.051	0.259	0.835	1
Performer	0.146	0.126	0.462	4
Transformer	0.264	0.000	0.000	5

Table C1.6 TOPSIS results for digital governance

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.070	0.081	0.534	2
Beginner	0.000	0.146	1.000	1
Adaptor	0.081	0.070	0.466	3
Performer	0.146	0.000	0.000	4
Transformer	0.146	0.000	0.000	4

C.2 TOPSIS Results for Digitalization Stage

Table C2.1 TOPSIS results for digital strategy

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.226	0.000	0.000	5
Beginner	0.161	0.068	0.297	3
Adaptor	0.039	0.209	0.843	1
Performer	0.124	0.118	0.487	2
Transformer	0.210	0.015	0.069	4

Table C2.2 TOPSIS results for digital value

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.383	0.000	0.000	4
Beginner	0.383	0.000	0.000	4
Adaptor	0.000	0.383	1.000	1
Performer	0.128	0.255	0.667	2
Transformer	0.128	0.255	0.667	2

Table C2.3 TOPSIS results for digital processes

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.300	0.187	0.383	5
Beginner	0.254	0.221	0.465	3
Adaptor	0.234	0.385	0.623	2
Performer	0.205	0.365	0.641	1
Transformer	0.343	0.289	0.457	4

Table C2.4 TOPSIS results for digital technology & data

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.080	0.110	0.578	3
Beginner	0.040	0.130	0.764	1
Adaptor	0.051	0.130	0.719	2
Performer	0.110	0.080	0.422	4
Transformer	0.158	0.000	0.000	5

Table C2.5 TOPSIS results for digital work

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.217	0.000	0.000	5
Beginner	0.143	0.075	0.344	4
Adaptor	0.073	0.146	0.666	3
Performer	0.035	0.211	0.856	1
Transformer	0.074	0.150	0.671	2

Table C2.6 TOPSIS results for digital governance

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.194	0.040	0.172	4
Beginner	0.171	0.081	0.322	3
Adaptor	0.040	0.194	0.828	1
Performer	0.075	0.178	0.704	2
Transformer	0.220	0.018	0.077	5

C.3 TOPSIS Results for Digital Transformation

Table C3.1 TOPSIS results for digital strategy

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.234	0.000	0.000	5
Beginner	0.187	0.046	0.199	4
Adaptor	0.109	0.117	0.516	3
Performer	0.054	0.171	0.760	2
Transformer	0.000	0.234	1.000	1

Table C3.2 TOPSIS results for digital value

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.424	0.000	0.000	4
Beginner	0.424	0.000	0.000	4
Adaptor	0.212	0.212	0.500	3
Performer	0.106	0.318	0.750	2
Transformer	0.000	0.424	1.000	1

Table C3.3 TOPSIS results for digital processes

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.255	0.260	0.505	4
Beginner	0.268	0.205	0.434	5
Adaptor	0.253	0.263	0.509	3
Performer	0.234	0.271	0.537	2
Transformer	0.260	0.322	0.553	1

Table C3.4 TOPSIS results for digital technology & data

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.306	0.000	0.000	5
Beginner	0.242	0.071	0.227	4
Adaptor	0.142	0.182	0.562	3
Performer	0.034	0.293	0.897	2
Transformer	0.000	0.306	1.000	1

Table C3.5 TOPSIS results for digital work

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.218	0.000	0.000	5
Beginner	0.147	0.071	0.326	4
Adaptor	0.075	0.148	0.664	3
Performer	0.017	0.213	0.926	2
Transformer	0.000	0.218	1.000	1

Table C3.6 TOPSIS results for digital governance

	Distance to the Ideal Solution	Distance to the Negative Ideal Solution	Closeness	Target Level
Intention	0.153	0.000	0.000	5
Beginner	0.133	0.034	0.205	4
Adaptor	0.117	0.070	0.376	3
Performer	0.057	0.117	0.671	2
Transformer	0.000	0.153	1.000	1

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