2024

REPORT ON THE STATE-OF-THE-ART ON SUPPORTIVE MECHANISMS AND CURRENT PRACTICES IN MANAGING DIGITAL TRANSFORMATION ACROSS INDUSTRIES

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THE EUROPEAN TRAINING NETWORK FOR INDUSTRY DIGITAL TRANSFORMATION ACROSS INNOVATION ECOSYSTEMS (EINST4INE)

Grant agreement no 956745
Start date of the project: 01/01/2021
Duration: 48 months

Document information

WP	2	Organisation and decision-making

Dissemination Level[1]	PU
Nature[2]	R

Due Delivery Date	31/10/2024
Actual Delivery Date	30/10/2024

Lead Beneficiary	RMIT EU, RMIT University
Contributing Beneficiaries	UCAM

Document history

Issue Date	Version	Changes made / Reason for this Issue	Author
22/10/2024	V 1.0	First version	I. Tauroseviciute-Ribikauske (RMIT EU), J. Dabrowska (RMIT), S. Altrock (RMIT EU), V. Marcelino (RMIT EU), L. Mortara (UCAM)
29/10/2024	V 1.1	Final Review	A-L. Mention (RMIT), E. Vallejos (RMIT EU)

Design: Canva templates

1 Dissemination level: **PU** = Public, **PP** = Restricted to other programme participants (including the JU), **RE** = Restricted to a group specified by the consortium (including the JU), **CO** = Confidential, only for members of the consortium (including the JU)
2 Nature of the deliverable: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

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EXECUTIVE SUMMARY

The rapid progress of technology is driving organisations across all industries towards digital transformation, integrating digital technologies into every aspect of their operations and business models. This digital adoption enhances customer experience, fosters innovation, and improves efficiency as well as competitiveness. Digital transformation has gained substantial momentum in recent years, capturing the attention of scholars, practitioners, and policymakers alike. This wave of interest highlights the critical role that digital technologies play in reshaping organisational landscapes across various industries, and the impact they make on broader socioeconomic dimensions. Digital transformation has become a new strategic imperative and a powerful driver of competitive advantage and growth. Yet, it poses significant challenges due to its inherent complexity.

This report offers a thorough overview and compilation of various mechanisms, frameworks and analyses of common practices in managing digital transformation. It aims to provide decision-makers across various industries and policymakers with the insights needed to successfully navigate and implement digital transformation initiatives. Understanding these frameworks and their development will help organisations strategies their transformation efforts and handle the complexities involved.

Key Components

After a short introduction, this report begins with a background section providing a brief **historical view** and an overview of **key concepts** and definitions linked with digital transformation. This basic information is crucial for understanding the frameworks and ideas discussed in the following section, where the development of digital transformation **management practices** is analysed and compared. This reveals both common elements, such as the integration of technology, strategy, and human resources, and notable differences in their specific approaches, ranging from adaptive, iterative strategies to structured, phased methods. These frameworks collectively illustrate an evolution from linear processes to more dynamic and flexible approaches, highlighting the need to align organisational structures with digital transformation goals and strategies.

The report also explores **enablers** and supportive **mechanisms** for successful digital transformation. The emergence and diffusion of digital technologies serve as key external triggers of digital transformation, improving decision-making, efficiency, customer access, and supply chain synchronisation. These digital determinants interact with organisational and environmental factors, driving open innovation supported by various mechanisms. Here, governance, environmental dynamics, knowledge, skills, and learning by doing, plays a crucial role in managing and executing digital transformation initiatives, highlighting the need for diverse and integrated approaches.

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The study concludes with an exploration of a more holistic approach that prioritises human well-being, sustainability, and resilience. The rise of **generative AI** and the shift toward **Industry 5.0** signal a new era that could impact all levels of ecosystems and geopolitical dynamics, highlighting the complex nature of digital transformation.

Practical recommendations for decision-makers and policymakers stress the importance of ensuring digital transformation initiatives align with overall business strategy. It advocates adopting a phased approach to manage risks and track progress. It emphasises the need to focus on training and development to build a digitally skilled workforce and promotes a culture of continuous innovation and agility to stay competitive.

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1.BACKGROUND

In the current rapidly evolving business landscape, digital transformation (DT) is a driving force reshaping industries, changing how businesses operate and deliver value. DT involves the integration of digital technologies into every part of a business, fundamentally shifting traditional practices. For instance, retail giants like Amazon have leveraged AI-driven recommendation systems to personalise the shopping experience, while traditional banks are incorporating blockchain technology to enhance transaction security and efficiency. As digital tools like cloud computing, the Internet of Things (IoT), and big data analytics become increasingly dominant, businesses have to reimagine their entire operations and innovation strategy to retain in the evolving market.

This transformation impacts various levels of industrial practices. Starting with individual employees who are pushed to continuously upskill their digital competencies (Dąbrowska et al., 2022) and have experienced a shift in their daily work, not only through tools like Microsoft Teams, Slack or Miro, which facilitate remote collaboration and a remote work environment, but also through the integration of advanced digital solutions that streamline workflows and enable data-driven decision-making across various tasks and processes. Organisations are also seeing changes in business strategy, internal processes and management practices, such as the adoption of analytics platforms that allow managers to make data-driven decisions in real-time, encouraging a responsive and agile organisational culture.

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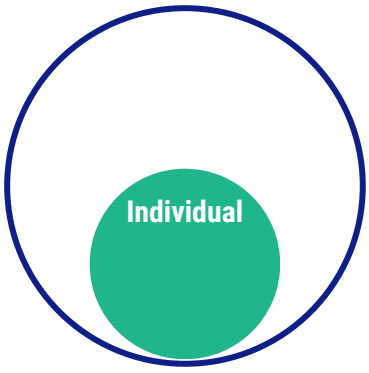
On a larger scale, DT is transforming supply chains within ecosystems, where digital technologies like blockchain suggest transparent, efficient, and sustainable operations. Companies now collaborate more closely with suppliers and partners through integrated platforms, creating more resilient and responsive supply chains that adapt quickly to changes in demand and disruptions. This section introduces the role of DT in reshaping industries by integrating digital technologies into business operations. It discusses how DT affects business models, strategy, and individual employee roles.

The evolution and impact of DT can be analysed from many different perspectives, reflecting its multifaceted nature and the diverse challenges and opportunities it presents. For instance, scholars have identified that this phenomenon can be examined on micro (managing people and teams), meso (new products and service change in industries), and macro (ecosystems and governance) levels (Appio et al., 2021). In the similar manner, other scholars interpret digital transformation through the individual, organisational, ecosystem, and geopolitical lenses (Dąbrowska et al., 2022). This approach allows for a comprehensive and novel examination of how digital technologies affect different actors. For example, how transformation is adopted and utilised by individuals, how organisations strategise and coordinate internal and external transformations, how ecosystems leverage digital technologies in governance and co-produce value propositions, and how geopolitical frameworks regulate the environments within which individuals and organisations operate (Dąbrowska et al., 2022). Digital transformation touches every level of a society and should be discussed as a fundamental and holistic change.

Digital Transformation at the Individual-Level



The individual perspective explores how digital transformation has fundamentally altered the nature of work, job roles, and the skill sets required in the modern workplace. This human-centric view of digital transformation can be divided into two key areas. The first area focuses on the workforce and top management, emphasising the organisation's ability to configure the skills, abilities, and orientations of its employees and leaders (Davenport and Redman, 2020; Dąbrowska et al., 2022). The second area examines the co-existence and interdependence between humans and digital technologies, such as robots and artificial intelligence (AI) (Baptista et al., 2020; Dąbrowska et al., 2022). Whether these areas are discussed together or separately, they both are part of the first Digital Transformation impact level.

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Regarding human skills and competencies, digital transformation presents significant challenges, particularly in terms of bridging skill and competency gaps and adopting new technologies. In this evolving landscape, non-IT employees are increasingly leading technology-based projects, necessitating that IT personnel also possess strong business acumen. Consequently, digital transformation requires employees to develop new skills, though the specifics of what these skills involve and how to effectively support employees in acquiring them remain ambiguous (EINST4INE, 2022). DT development changed the skill set landscape and some jobs become redundant, while new trajectory remains uncertain. For example, consider data entry clerks, administrative and executive secretaries, accounting, bookkeeping and payroll clerk as redundant, while jobs like digital marketing specialists, data scientists or digital transformation specialists did not exist 10 years ago. Trends show that continuous learning, analytical thinking, problem-solving and business knowledge are crucial in the digitally developing world (EINST4INE, 2022). As digital transformation reshapes the workforce landscape, it becomes essential to equip employees with the necessary skills to thrive in a rapidly changing digital environment.

The symbiosis of technologies and humans has resulted in the emergence of numerous new innovations. These technologies facilitate data collection, transmission, and evaluation, enabling autonomous reactions and driving this revolution forward. Some innovations are interdependent and can only fully realise their potential when combined with other technologies. This growing complexity necessitates a shift in perspective, moving away from the traditional supply chain view to embrace a more interconnected system of actors within an ecosystem perspective (EINST4INE, 2023a). DT not only introduced new shape of a workforce but also changed the understanding of the work nature.

Through the individual lens, the transformative effects of digital technologies on individuals can be better understood, highlighting the need for continuous adaptation and the development of new skills to thrive in a digitally-driven world.

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Digital Transformation at the Organisational-Level

In general, **DT marks a significant shift in how businesses operate, transitioning from traditional models to a digital-first approach.** DT has become a strategic imperative for companies. This evolution involves various changes at the organisational level, impacting (macro) **competitiveness, governance structures,** (meso) **strategies, legacies, resource allocation, processes,** (micro) **competencies, cultures, and leadership dynamics** perspectives (Appio et al., 2021). It requires not only the implementation of technology at an individual level but also its integration into the overarching strategic vision of the company (Dąbrowska et al., 2022). This comprehensive restructuring touches every aspect of organisational functioning, challenging established norms and necessitating agility and adaptability to thrive in an increasingly digital landscape.

This report looks through the lens of organisational transformation mainly at the meso level of analysis, **touching upon the interplay of macro and micro perspectives.** It also explores practices and mechanisms on how businesses navigate these changes and leverage digital technologies to drive innovation, enhance efficiency, and remain competitive in today's fast-paced environment.

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2. TRANSITION TO DIGITAL TRANSFORMATION

HISTORICAL VIEW AND KEY TERMS

Technological revolutions have fundamentally altered the landscape of the labour force, steering in new forms and patterns of work that contribute to broader societal changes. The propagation of digital technologies has significantly expanded the reach of businesses, enabling millions of people and entities worldwide to connect and conduct various business functions (Terzi, 2011). Moreover, these advancements in technology play a pivotal role in supporting the achievement of the United Nations' 17 sustainable development goals (Gong and Ribiere, 2023). As digital technologies increasingly influence various aspects of life, from work to daily interactions, the advancement of DT reflects humanity's continuous pursuit of progress and efficiency. This section examines the evolution of digital transformation across time, highlighting the stages of digital transition, key definitions and the progressive investigation of DT in research.

Digitisation is the technical process of converting analogue into digital formats.

Digitalisation is the change process of installing digital technologies to reinforce the organisation's existing value proposition.

Digital transformation is a fundamental change process of an organisation enabled by exploring the use of digital technologies to redefine its business models

Etymologically, the terms "digitisation" and "digitalisation" both originates from the Latin root "digit," meaning "finger" or "toe." The verb "digitise," originally meaning "to finger, handle," appeared in 1704, while "digital," in the context of signals and data represented by distinct values (such as 0 and 1), became common in the 1940s (OED, 2010). Despite these differences, digitalisation is often used interchangeably with digital transformation when describing the widespread impact of digital technologies on societies and organisations (Gong and Ribiere, 2023). These terms form the foundation of the broader concept of digital transformation.

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Historically, digital transformation has evolved through distinct usage stages: digitisation, digitalisation, and ongoing advancements driven by technological progress. As there are many different definitions of these technological periods, in organisational perspective scholars describe them as processes (Gong and Ribiere, 2023).

Digitisation refers to the process of converting information from an analogue format into a digital one. It was linked with the introduction of the first digital computers in the 1940s and first computer storage system in 1956 (Press, 2015). Companies and governments have begun to use computers to digitise data for storage and processing. Later, with the introduction of personal computers, optical scanning and digital imagining technologies, other documents and images became digitised, not to mention the emergence of various forms of media, including music (MP3), video (MPEG), and photography (JPEG).

Subsequently, from around 1990, the emergence of World Wide Web (www) and Enterprise Resource Planning (ERP) systems began (Wessel et al., 2020), aligning with the beginning and results of digitalisation. **Digitalisation** can be defined as a process of leveraging digitised information to improve business processes and operations. Thus, it is often linked with the IT-enabled organisational change and involves using digital technologies to change a business model and provide new revenue and value-producing opportunities.

While, the origins of **digital transformation** are closely linked to the introduction of the worldwide web (WWW) in 1990. Initially, as the Figure 1 indicates, term "digital transformation" emerged in academic literature around 2000 but was better understood in 2011 with the introduction of Industry 4.0 (the paradigm that refers to the intelligent interaction of machines and processes for industry-based purposes) (Xu et al., 2021; Scopus, 2024). Early on, there was a tendency to blend DT with digitisation (technological upgrade) and digitalisation (installation), focusing heavily on the "digital" aspect rather than the comprehensive "transformation" part. However, over the past two decades, the world's attention has increasingly gravitated toward the transformative potential of digital technologies, having almost 27 thousand documents in English in 2024. Concepts such as digital transformation have become synonymous with the profound changes and influences applied by digital technologies across all facets of human life.

> DT has multiple definitions but in this report it is looked as **a fundamental change process, enabled by the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity [e.g., an organisation, a business network, an industry, or society] and redefine its value proposition for its stakeholders.**
> (Gong and Ribiere, 2023)

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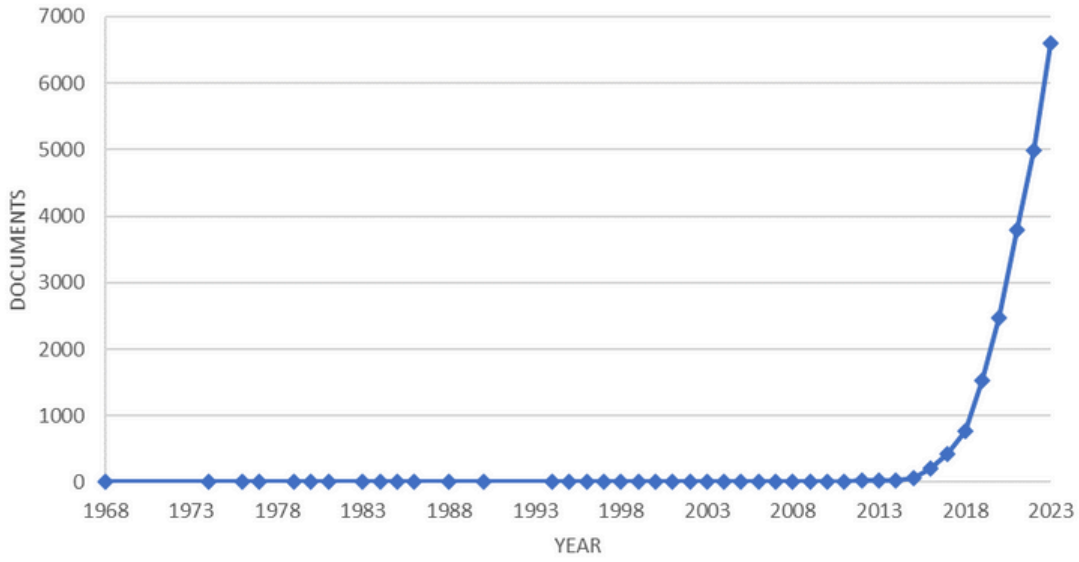

Figure 1. Research on Digital Transformation in SCOPUS database

The landscape of understanding DT and its implementation has witnessed significant evolution over the past decade, with shifts marked by key milestones. Figure 2 illustrates pivotal moments that have shaped DT trajectory. Notably, the efforts of pioneering players across various industries, including but not limited to IBM, Intel, Apple, Microsoft, Oracle, and Google, have been instrumental in boosting the technological revolution forward. These entities have led initiatives aimed at creating new business opportunities, enhancing customer experiences, transforming working environments, and redefining ways of living (Stolterman and Fors, 2004). While technological advancements like Bitcoin, OpenAI GPT-3 or quantum processors open new opportunities for further business and digital development. The initiatives and innovations led by pioneering players have set the stage for future creation, where the beginning is by understanding of organisational readiness.

> **Digital strategy** is the use of Internet-based platforms and data to inform and implement online communication objectives that meet organisational goals.
> (Morehouse and Saffer, 2018)

As digital transformation is more than just adopting digital tools - it entails a comprehensive restructuring of organisational resources, strategies, and legacies to leverage the full potential of digital technologies (meso level). A key aspect of defining digital transformation lies in digital strategy recognising data as a strategic resource and drawing a roadmap for this transformation (Gobble, 2018; Adner, Puranam and Zhu, 2019). Thus, DT framework can be outlined using technologies, changes in **value creation, structural changes, and financial aspect**s (Hess et al., 2020). These dimensions guide organisations through the complexities of transformation, highlighting the need for both traditional and agile development methods. For instance, as Table 1 indicates, an operational backbone requires reliability and efficiency, guided by roadmaps and architecture reviews. In contrast, a digital services platform demands rapid innovation through cross-functional development teams and iterative, agile methods.

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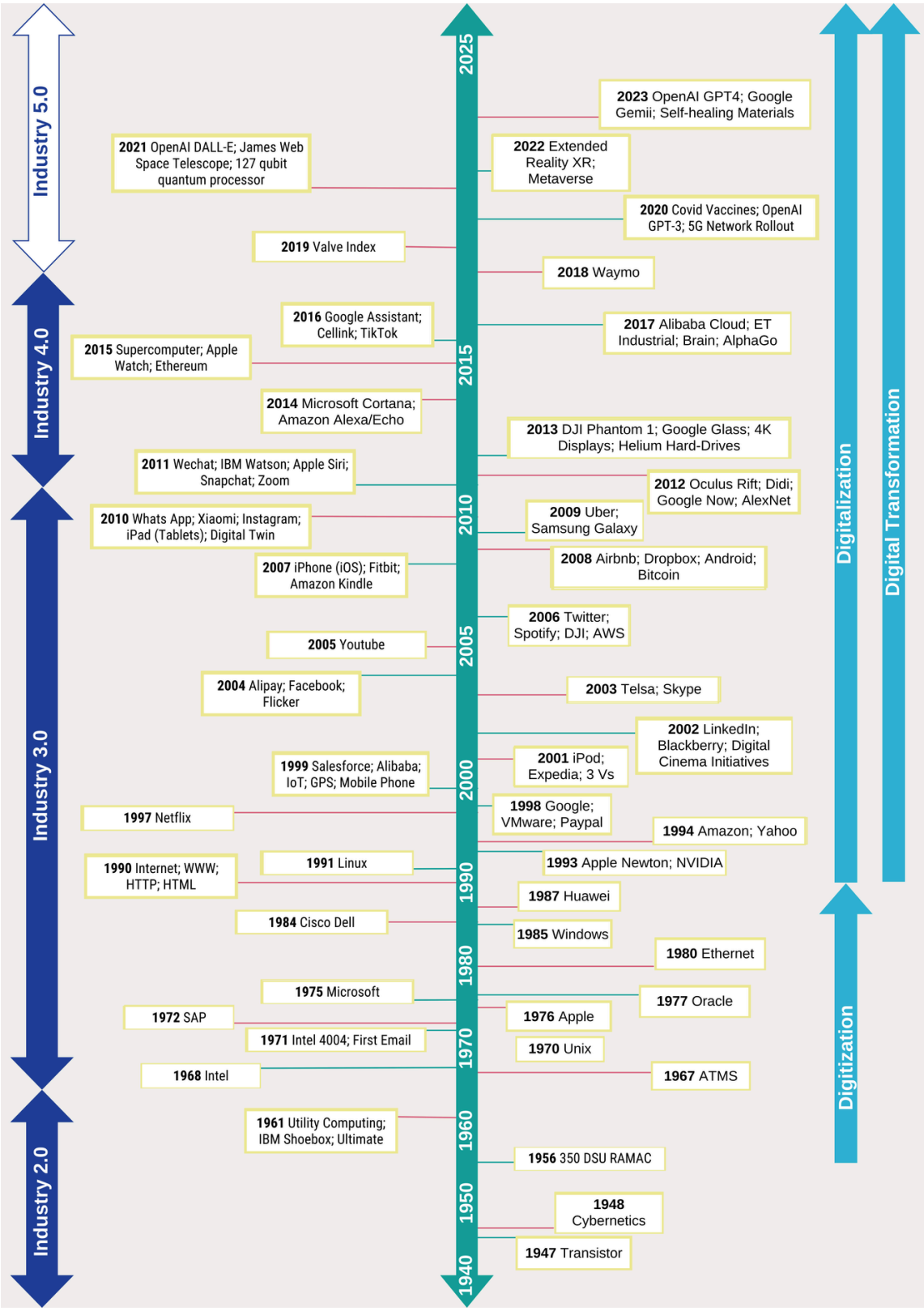

Figure 2.Timeline of the key milestones and players in the history of DT (extended from (Gong and Ribiere, 2023))

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	Operational Backbone	Digital Service Platform
Key Processes	Roadmaps; architecture reviews	Cross-functional development; user-centered design
Architecture Principles	Standardised end-to-end business processes; transparency into systems; data access	Plug-and-play business and technology components
Management Objective	Business efficiency and technology reliability	Business agility and rapid innovation
Delivery Method	Fast waterfall/regular software release/SaaS adoption	Agile and DevOps; use of MVP (minimum viable product) concepts and constant enhancements
Data	Single source of truth for transactional data	Massive repositories of sensor/social media/purchased data
Funding	Major project/program investments	Contiuous funding by business owners

Table 1. Operational approaches for traditional and digital organisation management (adapted from (Sebastian et al., 2017))

> **"Culture is what happens when the boss leaves the room."**
> Westerman, Soule and Eswaran, 2019

Furthermore, digital transformation is an ongoing process (Veldhoven and Vanthienen, 2023), requiring continuous effort and adaptation (micro level). Organisations embarking on digital transformation must shift their focus across various domains (Fernandes and Burcharth, 2024), addressing cognitive beliefs about markets, processes, and products to foster digital innovation (Firk et al., 2022). This adoption is often marked by ambiguity and a trial-and-error approach (Fernandes and Burcharth, 2024), necessitating a mindset that embraces continuous learning and adaptation.

> **"Digital Culture is an emerging set of values, practices and expectations regarding the way people (should) act and interact within the contemporary network society."**
> Deuze, 2006

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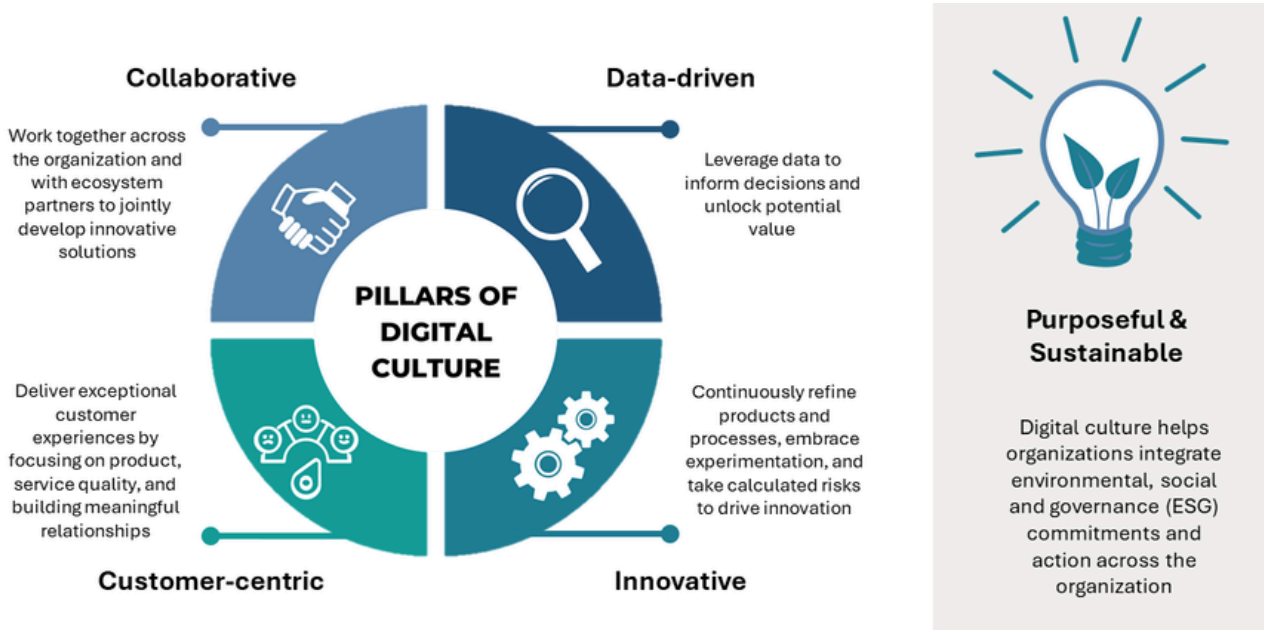
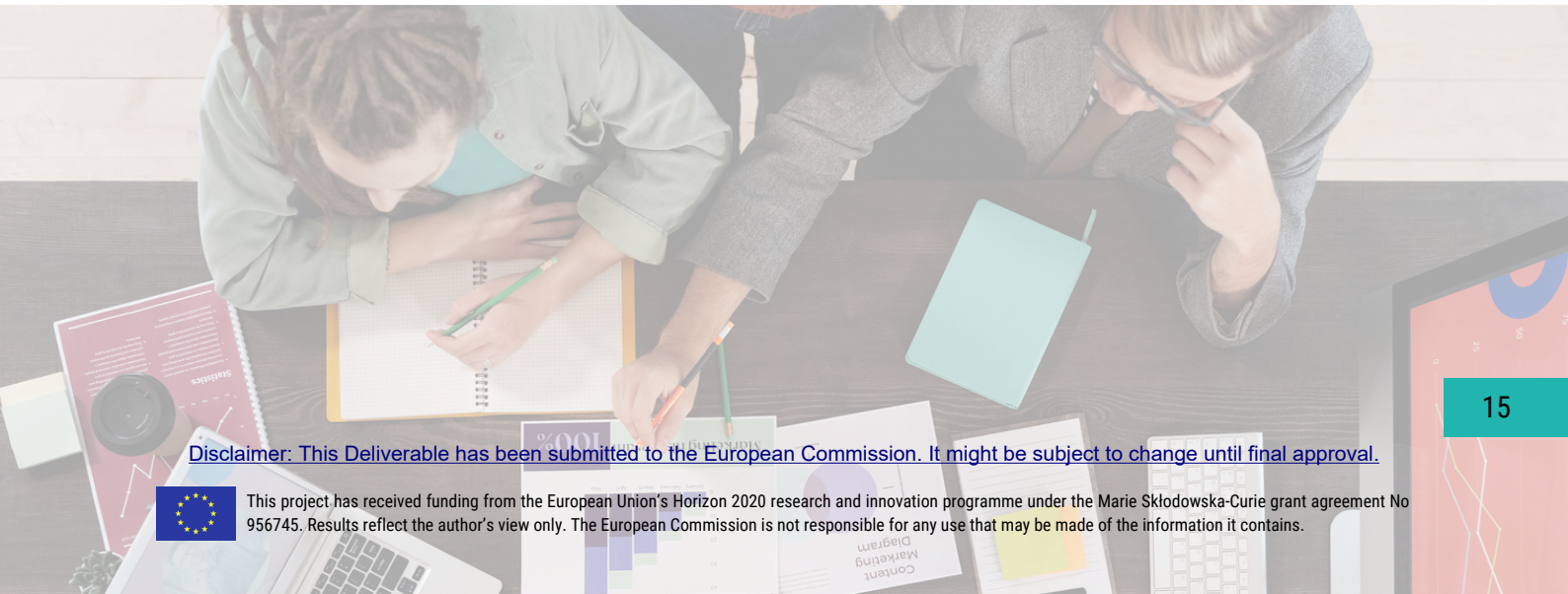


Figure 3. Key pillars fostering digital culture for DT (adapted from (WEF, 2021))

Organisations that cultivate a robust digital culture leverage digital tools and data-powered insights to inform their strategic decisions. These insights enable a customer-centred approach, ensuring that the needs and preferences of customers and society are at the forefront of business strategies (Figure 3) (WEF, 2021). Additionally, a culture of innovation and collaboration across the organisation is essential to transitioning from creating systems and processes to developing capabilities—fostering a culture where innovation is standard and employees are consistently driven to learn and grow, leveraging the latest technologies and techniques (Westerman, Soule and Eswaran, 2019). By integrating these pillars, companies can navigate the complexities of digital transformation and achieve sustainable growth and competitive advantage.

Crucially, successful digital transformation extends beyond technology. Leadership must also address the human side of the organisation, fostering a culture that supports how people interact with and leverage technology (WEF, 2021). This holistic approach ensures that both technological and human factors contribute to digital success.



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Some of other relevant concepts linked with digital transformation:

Digital technologies	"Digital technologies (viewed as combinations of information, computing, communication, and connectivity technologies) are fundamentally transforming business strategies, business processes, firm capabilities, products and services, and key interfirm relationships in extended business networks" (Bharadwaj et al., 2013).
Digital innovation	"Digital innovation as the carrying out of new combinations of digital and physical components [in a layered modular architecture] to produce novel products" (Yoo, Henfridsson and Lyytinen, 2010).
Digital artifact	"A digital component, application, or media content that is part of a new product (or service) and offers a specific functionality or value to the end-user" (Nambisan, 2017).
Digital platform	"A digital product platform typically encompasses a particular range of layers (e.g., content and service layers) that can function as a new product, but simultaneously enable others to innovate upon using firm-controlled platform resources (e.g., SDKs and APIs)" (Yoo, Henfridsson and Lyytinen, 2010).
Digital infrastructure	"Digital technology tools and systems (e.g., cloud computing, data analytics, online communities, social media, 3D printing, digital makerspaces, etc.) that offer communication, collaboration, and/or computing capabilities to support innovation and entrepreneurship" (Nambisan, 2017).
Sociotechnical regime	"The sociotechnical regime concept accommodates broader community of social groups and their alignment of activities. Sociotechnical regimes stabilise existing trajectories in many ways: cognitive routines that blind engineers to developments outside their focus, regulations and, adaptation of lifestyles to technical systems, sunk investments in machines, infrastructures and competencies." (Geels and Schot, 2007)
Innovation diffusion	"Diffusion of Innovations is the process by which an innovation is communicated through certain channels over time among the members of a social system." (Rogers, 2003)
Disruptive Innovation	"A disruptive technology is a technology that changes the bases of competition by changing the performance metrics along which firms compete." (Danneels, 2004)

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2.1. TRANSFORMATION ACROSS INDUSTRIES

Digital transformation reshapes industry structures and interconnects companies (macro level), presenting both opportunities and threats shaped by contextual factors such as social, economic, political, and competitive environments, as well as organisational governance structures and corporate cultures (Appio, 2021). **This section reviews the adoption of digital technologies across different sectors, highlighting industries like telecommunications, manufacturing, and healthcare.** The section also discusses digital maturity, which refers to the stages organisations go through in their digital transformation journey.

A good indicator of digital transformation development is the **adoption of cloud computing**, which streamlines operations and enables advanced digital capabilities. The Figure 4 illustrates the adoption rates of cloud computing across various industries from 2014 to 2023 in OECD countries, revealing a consistent growing trend among all industries. Information and communication sectors lead the way, with adoption rates starting at around 50% of companies with more than 10 employees in 2014 and reaching approximately 80% by 2023, drawing attention to their reliance on cutting-edge technologies. Professional, scientific, and technical activities also show notable growth, increasing from 40% to about 70% with a significant leap in 2019-2020. Slower yet steady adoption is seen in accommodation and food sectors, highlighting a gradual acceptance of cloud benefits. Most of the industries show significant cloud service adoption increases around 2019-2020, likely driven by the COVID-19 pandemic's demand for digital solutions. Overall, the graph highlights the rising importance of cloud computing as a driver of digital transformation and innovation across diverse sectors.

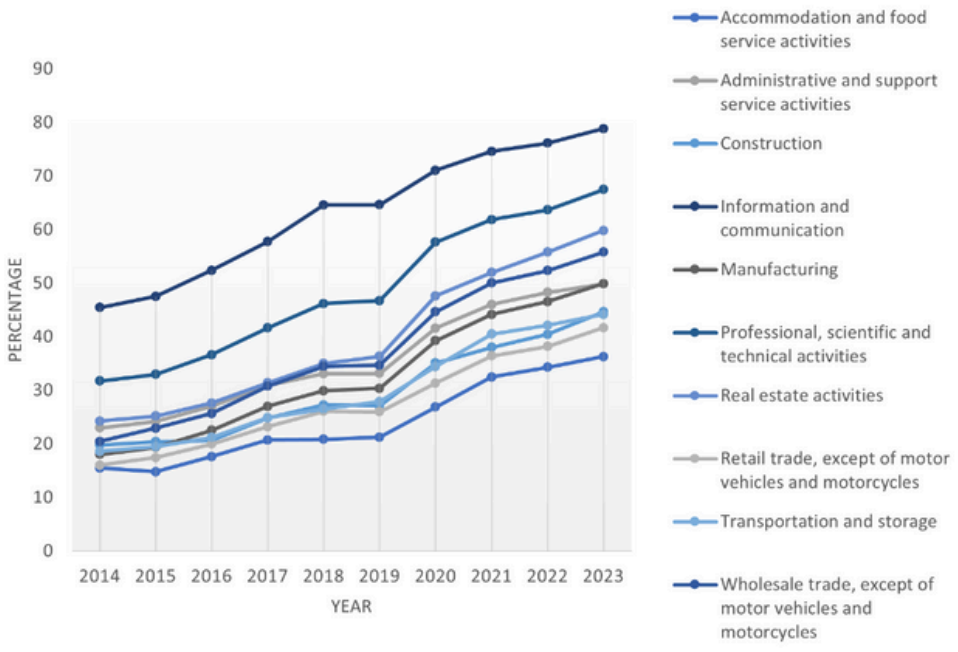

Figure 4. Businesses purchasing cloud computing services showed by industry at OECD countries (from (OECD, 2024))

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Digital Maturity

Figuring out where an organisation stands on the maturity curve is essential for navigating the challenges and opportunities presented by digital transformation (Iansiti and Nadella, 2022). **Organisations typically progress through various stages on their transformation journey, each characterised by distinct architectural, managerial and organisational capabilities.** Figure 5 demonstrates **five digital maturity stages: Traditional, Bridge, Hubs, Platform, and Native** (Iansiti and Nadella, 2022). In the Traditional stage, companies lack the architectural and organisational capabilities to drive substantial tech adoption, at this stage consumer package goods industry is placed based on the industry analysis of 150 different companies. Moving through the Bridge stage, firms begin piloting not only technology but also novel models of innovation involving collaboration between business and IT stakeholders. However, in the Hubs stage, a scarcity of business employees with the requisite capabilities blocks digital innovation efforts. This stage, however, was the median overall maturity of the companies researched in 2022 dividing industries into leaders and laggards. Progressing to the Platform stage, only Aerospace and health care organisations started resembling software companies, with comprehensive capabilities for product and program management. Finally, in the Native stage there are no leading industries yet but single cases of companies where the focus is on democratising access to technology, investing in training and capability-building among a broad base of business personnel. Understanding these digital maturity stages, offers insights into the openness to technological advancements, strategies and capabilities necessary for successful organisational adaptation.

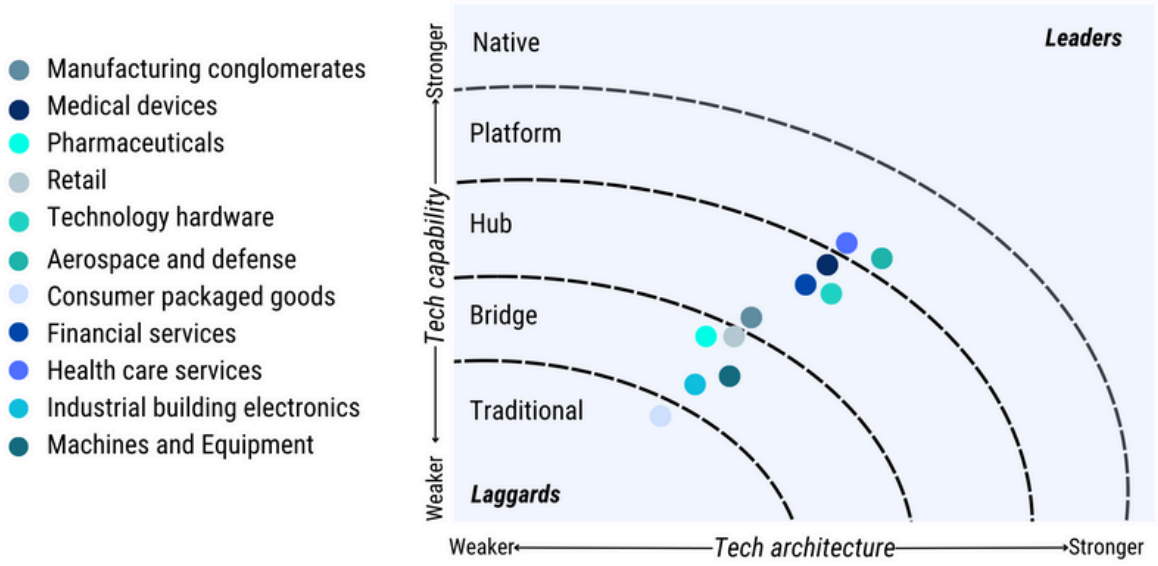

Figure 5. Digital Maturity stages (adapted from (Iansiti and Nadella, 2022))

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As for emerging technologies, the landscape of digital and AI leadership is dynamic, with leading firms continually advancing their capabilities. Over time, these advancements compound, resulting in a significant performance advantage. As Figure 6 indicates, the spread between the most and least digitally mature firms has increased by 60 percent, with the digital and AI maturity scores growing from the overall of 10.3 points in the period 2016-2019 to 16.3 points in 2020-2022. The AI adoption in media sector, however, increased 3 times, while industrials advanced only by 8 percent (McKinsey, 2024). This growing gap highlights the importance of continuous investment in digital and AI capabilities to maintain a competitive advantage.

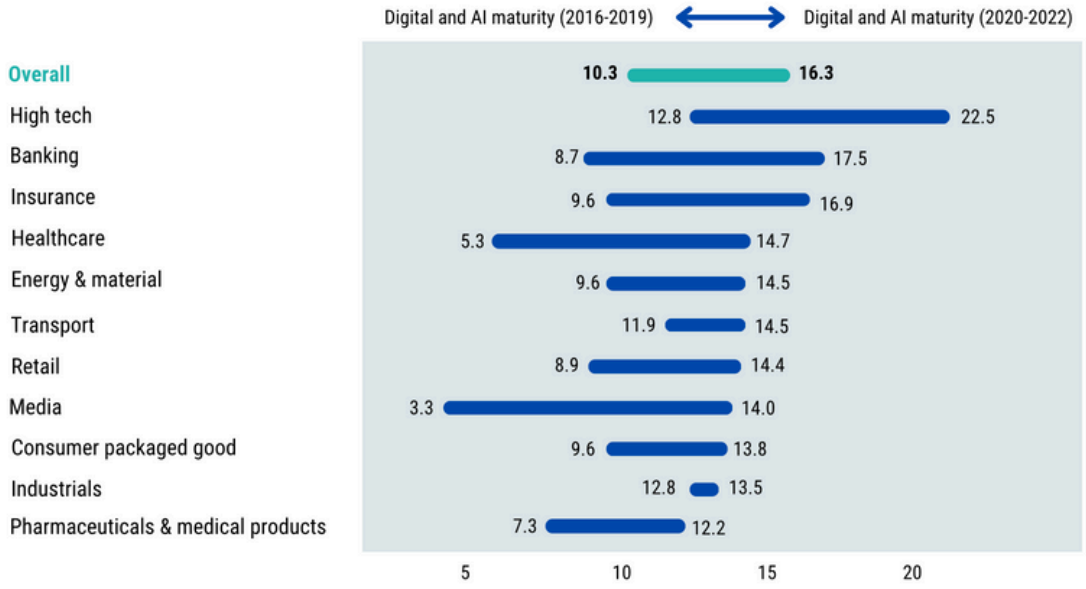

Figure 6. Digital and AI quotient standard by sector (adapted from (McKinsey, 2024)).

While smaller firms are digitalising specific functions, larger firms and digital leaders are rapidly advancing, widening the gap between them and less digitally mature organisations. Digital transformation varies significantly across different industries and organisational sizes. Small and medium-sized enterprises (SMEs) are generally less digitalised than larger firms (Figure 7). Small firms typically prioritise the digitalisation of general administration and marketing operations before other areas. Medium-sized firms, while more advanced than small firms, still lag behind large firms in their overall digital adoption (OECD, 2021). This trend highlights the scalability challenges faced by smaller organisations in their digital transformation journeys.

Despite the enabling size and industry benefits, there are good examples across all sectors. **The following section explores the practices of several leading companies across different industries that have successfully adopted digital transformation.** These case studies provide valuable insights into the strategic approaches, technological integrations, and organisational shifts, offering a roadmap for other businesses aiming to navigate this complex but rewarding journey.

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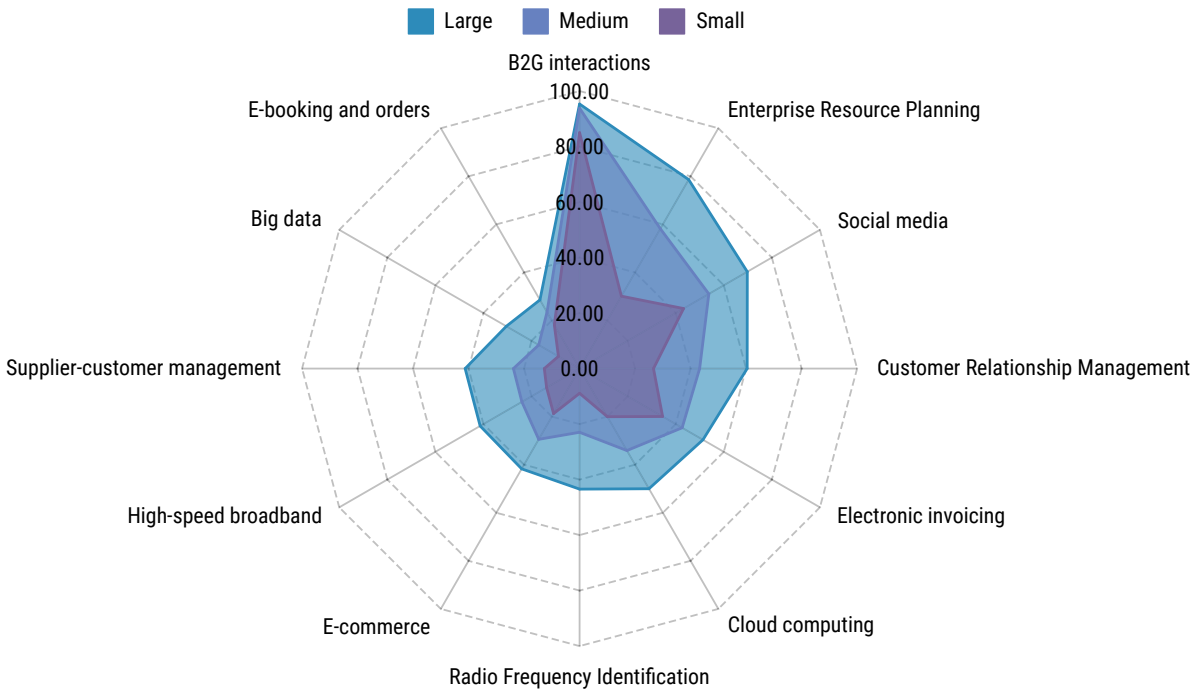

Figure 7. Diffusion rate, median OECD, based on country average percentages of enterprises using the technology over 2015-18 (from (OECD, 2021)).

2.2. GOOD PRACTICES

Large companies, have especially demonstrated significant success in digital transformation due to their capacity to create substantial value and leverage their extensive resources and networks. Digital giants are more capable to win DT mainly because they focus on **creating more value**. They have revolutionised various aspects of our life, from communication and entertainment to shopping and mobility, by offering innovative solutions that meet evolving customer needs and preferences. These companies' ability to **move quickly, operate efficiently,** and **attract top talent** has enabled them to maintain their competitive edge and continue expanding their influence (Denning, 2021). These few well-known examples across different industries illustrate how strategic digital initiatives can lead to transformative outcomes.

Retail

Amazon began its digital transformation journey as an online bookshop and has grown into the largest e-commerce marketplace and cloud computing platform worldwide. The company revolutionised retail with its comprehensive digital strategy, including the development of Amazon Web Services (AWS), which has become a leader in cloud computing. Additionally, Amazon's use of data analytics, AI, and customer-centric innovations, such as personalised recommendations and efficient logistics, has set a high standard in digital transformation (Aleem, 2022). The scalability and flexibility of AWS allowed Amazon to support its growing operations while offering these capabilities to other enterprises, thus leading the industry in cloud technology.

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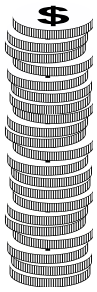
Automotive

Tesla's transformation focused on innovation and sustainability in the automotive sector. The company developed advanced electric vehicle technology and invested heavily in software development. Notable innovations include over-the-air software updates and autonomous driving features (Mohsin, 2024). Tesla's data-driven approach, including the use of AI and big data to enhance vehicle performance and customer experience, has significantly disrupted the automotive industry.

Entertainment Mass Media

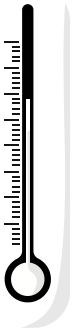
Netflix, founded in 1997, began as a DVD rental service and later transformed into a global streaming giant. They entered the market as a disrupter to traditional video stores such as Blockbuster and Family Video. In 2007, Netflix took its first step into the streaming video industry. In addition to traditional DVD rental, they provided a video-on-demand streaming service, allowing customers to chart their own course at no additional cost to their subscriber base. In addition, they implemented a simple and scalable business model and consistently invested 10% of their budget in R&D (Kulkarni, 2023). Netflix now sits at a valuation of around $31.6 billion in 2022.

Finance



JPMorgan Chase has invested heavily in digital transformation through AI, blockchain, and cloud computing. The COiN (Contract Intelligence) platform, for instance, utilises AI to review legal documents and extract key data points, reducing time and cost associated with manual processing. Blockchain technology is employed to enhance security and transparency in transactions, while cloud computing offers scalable solutions for data management (Vinod, 2024). These innovations streamline operations, enhance customer service, and provide robust financial products, keeping JPMorgan Chase competitive in a rapidly evolving industry.

Healthcare



Mayo Clinic's digital transformation has profoundly impacted patient care and medical research. The shift to electronic health records (EHR) standardised and streamlined patient data management, improving accuracy and accessibility. Telemedicine initiatives expanded access to healthcare, allowing patients to consult with specialists remotely. Advanced diagnostic tools powered by AI, such as machine learning algorithms for medical imaging, enhance the precision and speed of diagnoses (Philpot et al., 2023). Big data analytics facilitates personalised patient care by analysing vast datasets to identify trends and tailor treatments.

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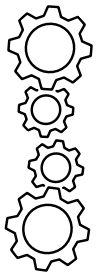
Manufacturing

Siemens has transformed its manufacturing processes through Xcelerator - digital twin technology, IoT, and AI. The shift to digital twins—virtual replicas of physical assets—allows Siemens to simulate and optimise production processes in real-time. IoT connectivity integrates machines and systems, providing continuous data flow that informs decision-making and enhances efficiency. The MindSphere platform, an IoT operating system, connects products, plants, and systems, enabling advanced analytics and predictive maintenance (Rebellius, 2022). This digital ecosystem improves operational efficiency, reduces downtime, and fosters innovation.



Telecommunications

AT&T's digital transformation strategy centres on adopting 5G technology, software-defined networking (SDN), and network function virtualisation (NFV). The shift to 5G enhances network speed, reliability, and capacity, supporting the growing demand for mobile data and IoT devices. SDN allows for more flexible and efficient network management by decoupling network control from hardware. NFV replaces traditional network devices with software-based solutions, reducing costs and increasing scalability (Forbes, 2021). These technologies collectively improve network performance, customer service, and operational efficiency.

Hospitality

Marriott International has embraced digital transformation to enhance guest experiences and streamline operations. The shift to mobile check-ins and IoT-enabled smart rooms offers guests greater convenience and personalisation. Guests can control room settings, such as lighting and temperature, through mobile apps, creating a tailored environment. Marriott's robust loyalty program, powered by advanced analytics, personalises marketing efforts and rewards, fostering customer loyalty (High, 2017). AI-driven insights inform operational decisions, optimising resource allocation and enhancing service quality.

Energy

Schneider Electric's digital transformation strategy focuses on IoT, AI, and advanced analytics for energy management and automation solutions. The shift to the EcoStruxure platform connects devices and systems, providing real-time data and insights. This connectivity enables predictive maintenance, optimising energy usage and reducing costs. AI algorithms analyse energy consumption patterns, offering recommendations for efficiency improvements (High, 2019). By integrating these technologies, Schneider Electric helps clients achieve sustainability goals and enhances its competitive edge in the energy sector.

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2.3. LESSONS LEARNED

Research indicates that digital transformations designed for efficiency improvement often have a high failure rate, reaching up to 90%. Several **common factors contribute to these outcomes: attributes of the technology, the role of opinion leaders, diffusion approaches, timing, and duration of implementation** (Ramesh and Delen, 2021). To effectively manage digital transformation, companies need to tackle three critical business challenges: managing digital disruption, redefining leadership and talent strategies, and transforming into a digital organisation (Kane, 2019). Each of these elements plays a critical role in determining the success or failure of a digital transformation initiative. While analysis of failed case studies highlighted several **main challenges** that include **unspoken disagreements** among top managers about goals, **a divide between digital capabilities** supporting pilot projects and those available for scaling, and a **focus on inward transformation** rather than outward ecosystem evolution (Sutcliff, Narsalay and Sen, 2019). Achieving successful digital transformation can be complex, and some well-known companies set good examples:

General Electric (GE) was transformed by selling off slower-growth, non-industrial businesses and doubling the company's investment in research and development, aiming to modernise GE by focusing on digital transformation and adopting lean startup principles. However, the company's stock market value dropped by half and pushed for aggressive financial restructuring (Blank, 2017). Despite the failure, GE managed to shift their focus and transform, successfully integrating IoT and big data analytics into their industrial processes. They developed the Predix platform, which uses data from industrial machines to improve efficiency and predict maintenance needs (Vinoski, 2022). This digital shift has helped GE streamline operations and enhance product offerings.

Lego, renowned for its iconic plastic bricks, ventured into the digital world with its Digital Designer virtual building program. This initiative allowed users to create virtual Lego models on their computers, merging the physical and digital play experiences. Despite its innovative approach, Lego decided to defund the program. The decision highlights the challenge of balancing traditional business strengths with new digital ventures (Davenport and Westerman, 2018). The program likely faced difficulties in scaling, monetising, and integrating with Lego's core product lines, leading to its discontinuation.

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Nike, a global leader in athletic footwear and apparel, made significant strides in the digital space with its Nike+ Fuelband activity tracker. Launched in 2012, the Fuelband was part of Nike's broader digital strategy to integrate fitness tracking with its products. However, by 2014, Nike decided to halve the size of its digital unit, discontinuing the Fuelband and other digital investments (Davenport and Westerman, 2018). This move reflected the complexities of competing in the rapidly evolving wearable technology market, where challenges such as technological advancements, consumer preferences, and competitive pressures can impact the sustainability of digital initiatives.

Procter & Gamble, a giant in consumer goods, announced its ambition in 2012 to become "the most digital company on the planet." This bold goal aimed to leverage digital technologies to enhance marketing, customer engagement, and operational efficiencies. However, P&G faced significant challenges in achieving this vision. Economic difficulties and growth challenges hindered progress, underscoring the importance of aligning digital transformation with broader economic conditions and business realities (Davenport and Westerman, 2018). P&G's experience highlights that ambitious digital goals must be supported by resilient strategies capable of navigating economic headwinds.

Burberry, the British luxury fashion brand, aimed to be the world's best digital luxury brand. Under CEO Angela Ahrendts, Burberry invested heavily in digital initiatives, including social media, online sales, and in-store digital experiences. Initially, these efforts led to improved performance and a stronger connection with younger, tech-savvy consumers. However, the company's performance began to suffer after the initial successes, indicating that maintaining momentum in digital transformation requires continuous innovation, effective management, and adaptation to market changes (Davenport and Westerman, 2018). Burberry's journey highlights the need for ongoing commitment and flexibility in digital strategies.

Ford, a leading automobile manufacturer, invested heavily in digital initiatives to modernise its operations and product offerings. This included advancements in connected cars, mobility services, and digital marketing. Despite these efforts, Ford's stock price lagged, primarily due to cost and quality issues in other parts of the company. This scenario highlights a crucial lesson in digital transformation: isolated digital initiatives cannot compensate for broader operational challenges (Davenport and Westerman, 2018). Effective digital transformation must be integrated with overall business strategies and address core operational issues to achieve sustainable success.

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Kodak, once a dominant player in the photographic film industry, attempted to transition to digital photography, creating Ofoto. Despite being an early inventor of digital camera technology, Kodak was slow to embrace digital photography, fearing it would overtake its film photography business (Anthony, 2016). The hesitation and lack of a coherent digital strategy led to its eventual bankruptcy in 2012, as it was outpaced by competitors who fully embraced digital photography.

Key lessons from failed transformations include **the importance of defining a business strategy** before investing in digital technologies, **leveraging insider knowledge, designing customer experiences** from the outside in, **recognising employees' fear of being replaced**, and adopting Silicon Valley **start-up culture** (Tabrizi et al., 2019). These insights provide valuable guidance for organisations aiming to navigate the challenges of digital transformation effectively. To understand how organisations can effectively manage this digital transformation, the following chapters will provide an in-depth analysis of the practices and overview of supportive mechanisms that facilitate transformation successfully.

KEY TAKEAWAYS

Digitisation, digitalisation, and digital transformation are distinct but interrelated concepts, which reflect **the evolution of digital transition.**

Concepts associated with Digital Transformation include: Digital culture, Digital technologies, Digital innovation, Digital artifact, Digital platform, Digital infrastructure, Sociotechnical regime, Innovation diffusion and Disruptive Innovation.

Each **industry adopts digital transformation at different paces**. Healthcare and manufacturing industries, for instance, are leaders in implementing advanced technologies like AI and IoT.

Across industries, understanding where an organisation stands on the **digital maturity curve** is critical for navigating digital transformation. Companies that continuously invest in AI and digital capabilities maintain a **competitive advantage**, and the gap between digitally mature firms and less advanced ones is widening, especially in large firms compared to SMEs.

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Digital transformation is driving **innovation, efficiency, and competitiveness across industries** by leveraging technologies like AI, IoT, cloud computing, and advanced analytics. Across sectors, successful digital transformations focus on **customer-centred approaches, robust digital strategies, and maintaining flexibility** in operations.

Each sector tailors digital strategies to its unique challenges, with leaders using these technologies to enhance customer experiences, streamline operations, and maintain a competitive edge.

High failure rates in digital transformation initiatives are linked to issues such as **lack of clear strategy, poor leadership, and underestimating the complexity of integrating digital technologies.**

Successful digital transformation requires clear strategy alignment, continuous innovation, and adaptability to broader business realities, with a focus on integrating digital efforts across the entire organisation.

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3. MANAGING DIGITAL TRANSFORMATION

KEY FRAMEWORKS FROM RESEARCH AND THE DEVELOPMENT OF MANAGERIAL PRACTICES

The holistic view integrates technology, organisation, and social interaction as intertwined drivers of digital transformation. **This section examines the management practices crucial for successful digital transformation, with an emphasis on frameworks from academia and industry actors that guide DT in organisations.** The frameworks discussed **provide organisations with structured approaches to manage the complexities of digital transformation.**

A systematic literature review observed **a trend towards malleable organisational designs** that continuously adapt to their environments. This adaptability is facilitated by the availability of large data volumes and advanced technologies for analysing environmental changes. However, this flexibility also blurs the lines between internal and external sources of change, making it harder to pinpoint where changes originate. The unpredictable evolution of external technologies further complicates this dynamic (Hanelt et al., 2021). The research findings are organised linking contextual conditions, mechanisms, and outcomes as showed in Figure 8. Contextual conditions trigger digital transformation and are shaped by material, organisational, and environmental antecedents. Innovation mechanisms involve the application and alignment of new and existing resources, processes, and capabilities. The outcomes reflect the organisational gestalt, environmental context, and economic consequences, including organisational setups, economic impacts, and spillovers.

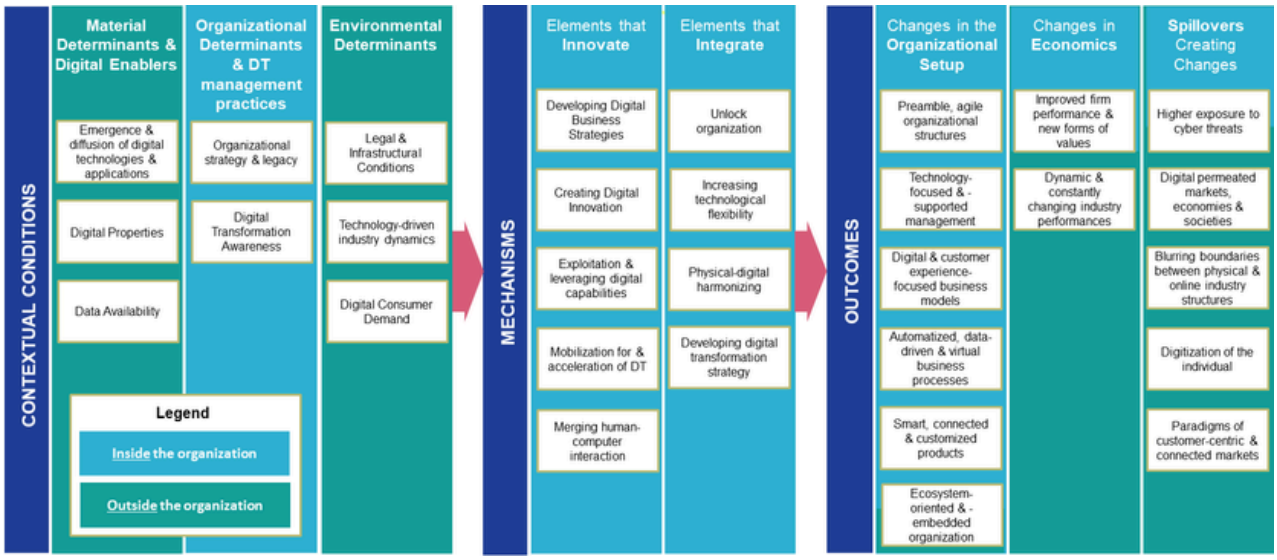
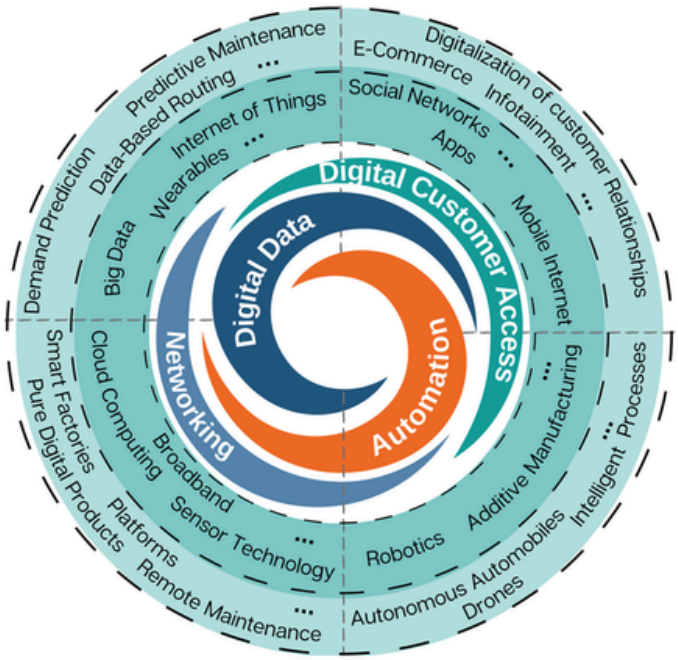


Figure 8. Multi-dimensional framework of digital transformation (adapted from (Hanelt et al., 2021))

Figure 9. Digital radar with enablers and applications (adapted from (Schallmo, Williams and Boardman, 2017))



The emergence and diffusion of various digital technologies and applications act as material determinants or external digital enablers that trigger the DT cycle. **The digital enablers** (Figure 9) improve decision-making through digital data, automation for enhanced efficiency and cost reduction, digital customer access for better transparency and service, and networking to synchronise supply chains and shorten production times (Schallmo, Williams and Boardman, 2017). These material determinants **interact with organisational factors, particularly organisational and managerial characteristics.** Finally, both material and organisational determinants are integrated within and influenced by environmental determinants, including policies, industry dynamics, and consumer demands.

Unpacking managerial and organisational characteristics, it is important to begin by defining the term "practice" in the context of digital transformation. Practice refers to the actual application or use of an idea, belief, or method, contrasting with the theoretical principles behind it (OED, 2024). In the context of digital transformation, this means the specific actions, technologies, and processes that organisations implement to achieve their digital transformation goals.

Digital transformation practices (Figure 10) involve the use of various information, computing, communication, and connectivity technologies to drive significant organisational changes. These practices are essential for leveraging digital tools to improve efficiency, enhance customer experiences, and drive innovation (Vial, 2019). Through the strategic application of these technologies, organisations can navigate the complexities of digital transformation and achieve sustainable growth. On the other hand, practices managing digital transformation focus on the methodologies, frameworks, and strategies that guide the digital transformation process within an organisation. These management practices are crucial for overseeing change, aligning digital transformation initiatives with business goals, and ensuring successful implementation. They include managing change, fostering a digital culture, and setting clear objectives for digital projects (McKinsey, 2018). Effective management practices are vital for steering the organisation through the transformation journey.

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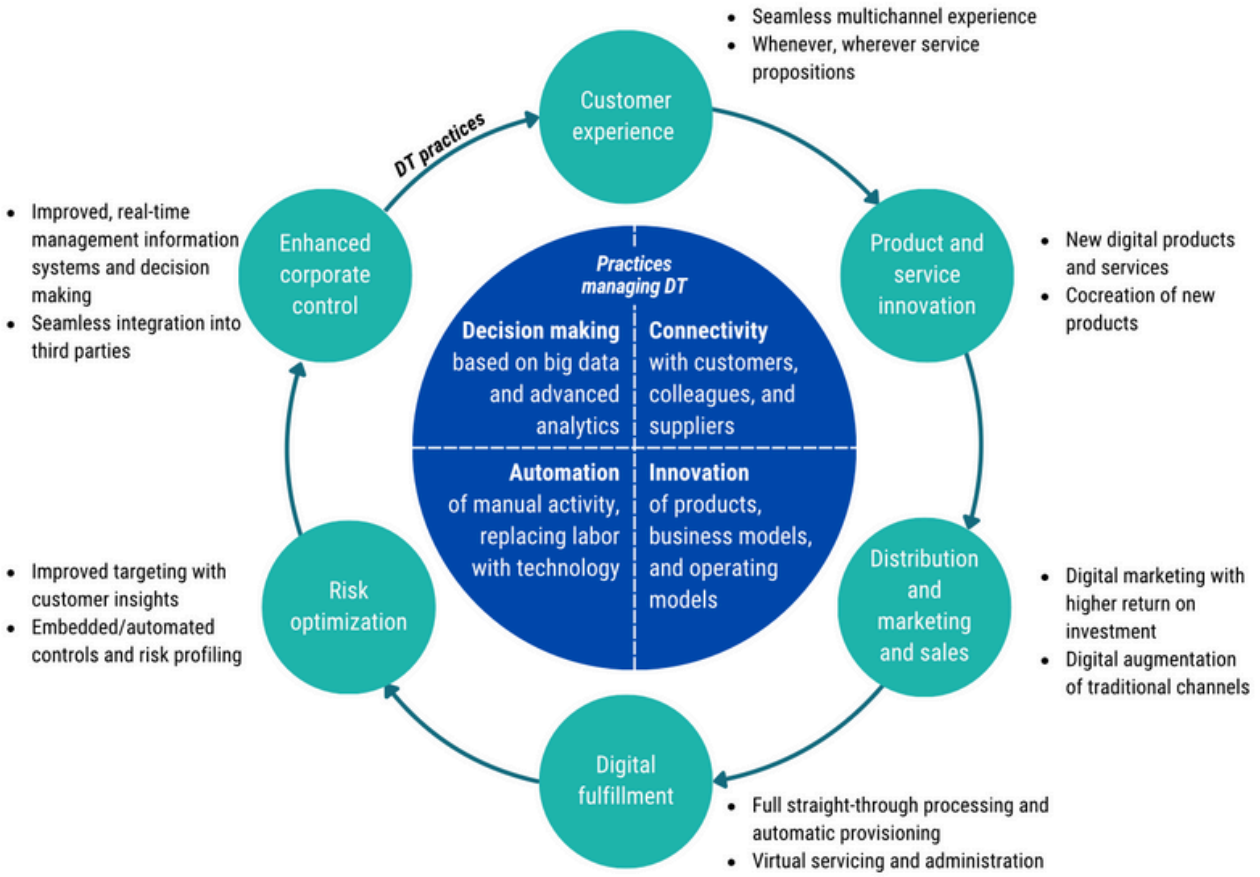

Figure 10. Practices managing DT vs DT practices (adapted from (McKinsey, 2013))

Technological transformation significantly impacts management processes by enhancing connectivity, automating manual tasks, improving decision-making, and innovating products or services (McKinsey, 2013). These advancements empower organisations to create value through digital processes, demonstrating the practical benefits of digital transformation. This requires a holistic approach that integrates technology, processes, and people. **It is not merely about implementing new technologies; it is also about fundamentally changing how an organisation operates and delivers value to customers** (Vial, 2019). This comprehensive approach ensures that all aspects of the organisation work together to transform successfully.

Learning from the successful examples and scientific findings, **the following section will focus on specific processes involved in managing digital transformation.** Holistic approaches, steps and roadmaps provide detailed insights and practical guidance for organisations to efficiently harness transformation.

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3.1. STATE-OF-THE-ART FRAMEWORKS FOR MANAGEMENT PRACTICES

In the field of digital transformation, there are many **frameworks to offer guidance** for organisations. In this report, seven influential ideas of the time are discussed to provide an overview of different perspectives for the successful transformation implementation. Parviainen et al. (2017) propose a systematic approach involving iterative steps to assess impact and implement actions. Schallmo, Williams, and Boardman (2017) provide a roadmap from Digital Reality to Digital Implementation, detailing the transformation of business models. Li (2020) suggests flexible, action-oriented strategies used by global digital champions. Wrede, Velamuri, and Dauth (2020) focus on understanding digitalisation and leading change. Vidal et al. (2022) highlight practices such as driving business change and managing talent complexity. McKinsey (2023) emphasises building six enterprise capabilities to effectively integrate technologies like AI. Fernandez-Veldhoven and Vanthienen (2023) advocate for a structured process from reality scanning to continuous evolution. These frameworks collectively offer diverse insights for managing digital transformation.

i. Four Iterative Steps

Based on synthesis of a multiple case studies in 2 years timespan, Figure 11 indicates a systematic approach to tackling digital transformation that involves several iterative steps. First, organisations must analyse the potential impact of digitalisation and decide on their desired position in the change. Second, they should review their current state, identify gaps between the present and desired future. Third, organisations should roadmap the transition and define concrete actions to bridge these gaps. Finally, implementing and validating these actions allows organisations to gradually build and fine-tune their digital transformation goals and plans (Parviainen et al., 2017). This iterative model provides strategic practices to overview the journey and ensure continuous improvement and adaptation.

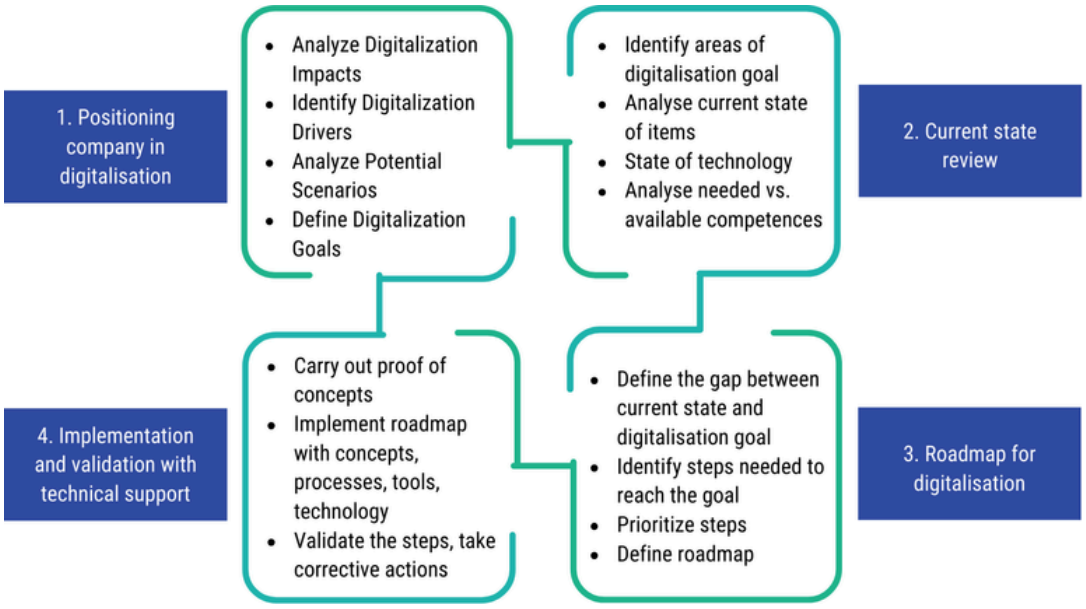

Figure 11. Model for tackling digital transformation (adapted from (Parviainen et al., 2017))

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ii. Business Model Roadmap

A case study literature review resulted in a detailed roadmap for digital transformation involving several phases (Figure 12): Digital Reality, Digital Ambition, Digital Potential, Digital Fit, and Digital Implementation. Each phase builds on the previous one, starting with understanding the current business model and value-added analysis for stakeholders and customers. As soon as reality is clear, objectives can be set, this is followed by identifying best practices and enablers, designing the business model to be. Evaluation of design options for digital alignment comes next, and finally, implementing the digital business model and integrating it with customer experiences and value-creation networks (Schallmo, Williams and Boardman, 2017). This strategic roadmap provides a clear path for organisations to follow in their digital transformation journey, as it is another project for an organisation to handle. A business model adoption and focus on value for a stakeholder are stressed in this roadmap.

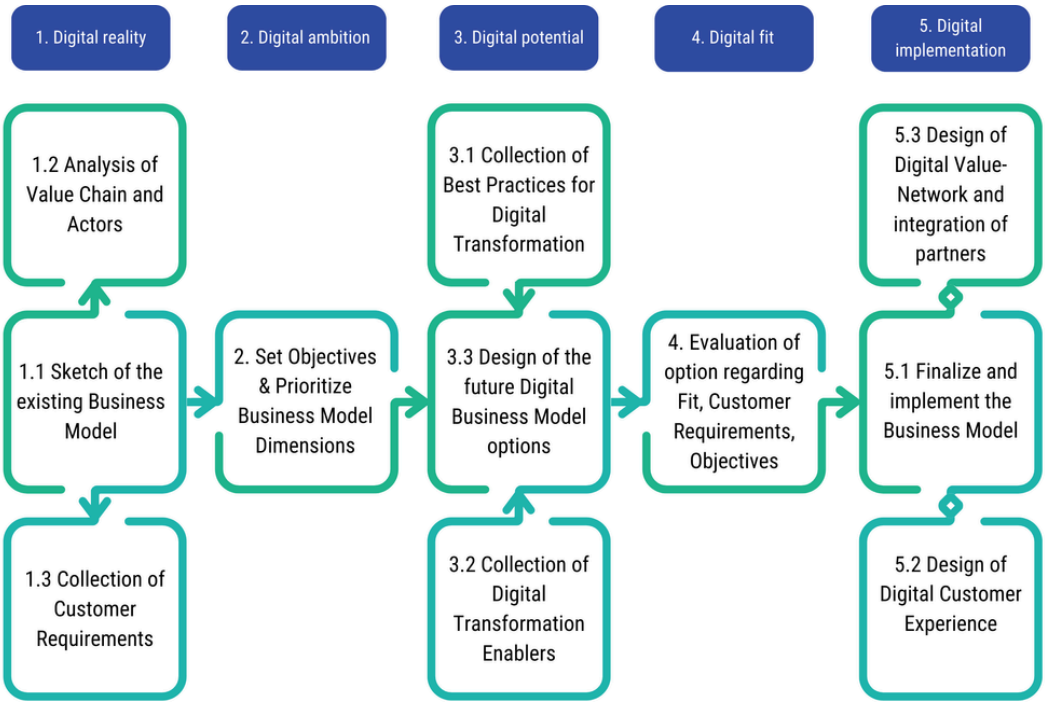

Figure 12. A business model innovation roadmap (adapted from (Schallmo, Williams and Boardman, 2017))

iii. Action-Oriented Strategies

Research with global digital leaders such as Amazon, Alibaba, and Google suggests three approaches to become successful in digital transformation (Figure 13). First, **experimentation and learning by doing** are used to adjust the strategy and guide implementation. Second, **small actions create major change**, starting with strategy and continually following and amending the plan. Third, **focusing on short term improvements** cumulatively creates sustainable advantages. These approaches treat strategy as a direction for action, emphasising short-term decisions and execution while keeping long-term goals in mind. This flexibility allows business leaders to explore alternative routes and adjust their strategic direction based on emerging intelligence from ongoing execution (Li, 2020). This adaptive strategy from tech-savvy companies in retail, e-commence and transportation ensures resilience and continuous alignment with market demands. It complements other frameworks by incremental actions, mitigating risks while pursuing digital initiatives.

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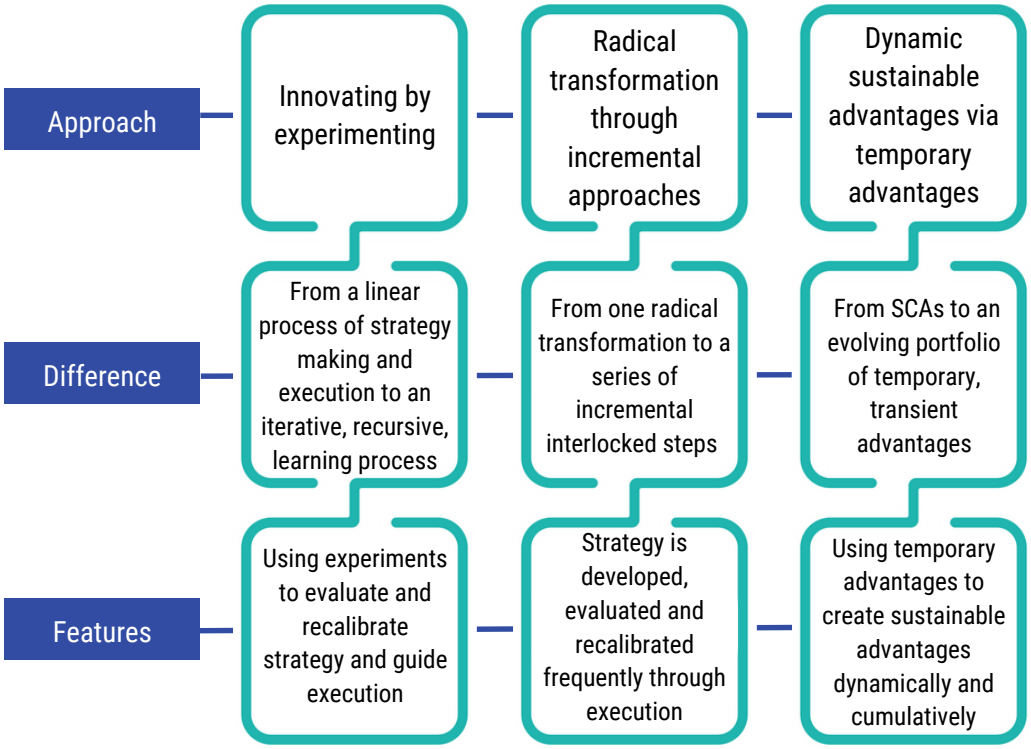

Figure 13. Three new approaches to succeed in DT (adapted from (Li, 2020))

iv. Three Key Actions

Research involving in-depth interviews with top managers from 16 different industries reveals that successful digital transformation requires **understanding digitalisation, setting the formal context for digital initiatives, and leading change** (Figure 14). It starts by building a foundation through knowledge, technical affinity, and viewing digital transformation as a learning opportunity. Next, it stresses assessing the firm's digital status, benchmarking against competitors, and gaining external insights through expert engagement and trade fairs. As the second action, it suggests making digitalisation a strategic goal, integrating it into corporate strategy, securing management support, and redefining roles to support digital initiatives. It also highlights the need for adequate resources, such as budgets, digital talent, and IT infrastructure. The final dimension involves committing to digital goals, modelling behaviour, promoting employee participation, and fostering a culture of trust and learning.

Throughout the journey the support of top management teams is essential, as their strategic responses often reflect a cautious approach due to the uncertainties associated with digital transformation (Wrede, Velamuri and Dauth, 2020). This strategic approach adds the practices of continuous learning, technical and human resource management as well as openness of companies culture on top of previous years findings.

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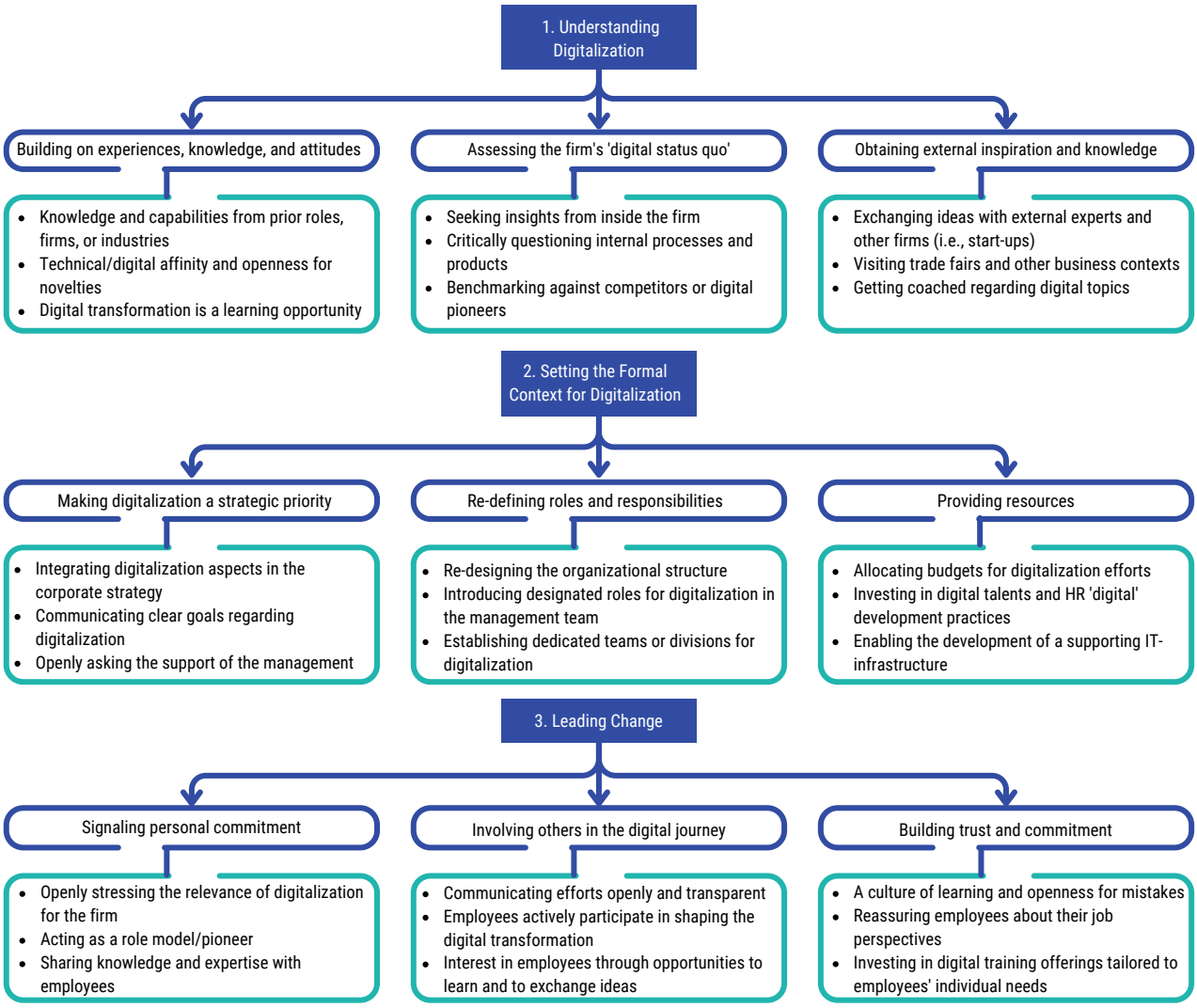

Figure 14. Three key dimensions responding to DT (adapted from (Wrede, Velamuri and Dauth, 2020))

v. Four Key Areas of Practice

Insights from IT and Digital leaders (IDL) across 23 companies in diverse sectors, including banking, insurance, consumer goods, agriculture, retail, and telecommunications, highlight four key areas of practices for managing digital transformation (Figure 15): **driving business change, mastering fluid and loose organisational structures, managing talent complexity, and prioritising learning** (Fernandez-Vidal et al., 2022). It begins by shifting IT and digital leaders to strategic roles within the organisation, promoting deep business know-how within IT, and staying alongside of new developments. Later, focus shifts to encouraging fluid organisational structures, integrating formal and informal teams, and promoting mobility within the organisation. This approach supports flexible and adaptive structures crucial for digital transformation. It is followed by the importance of managing a diverse and skilled workforce, ensuring talent alignment with business needs, and fostering an environment that supports continuous learning and development. Lastly, it highlights the necessity of prioritising learning through strategic training and lifelong learning initiatives, ensuring the workforce remains adaptable and innovative. In general, this framework improves others with the talent management and mobility. These areas are crucial for ensuring that digital transformation efforts are aligned with organisational goals and can adapt to the rapidly changing digital landscape.

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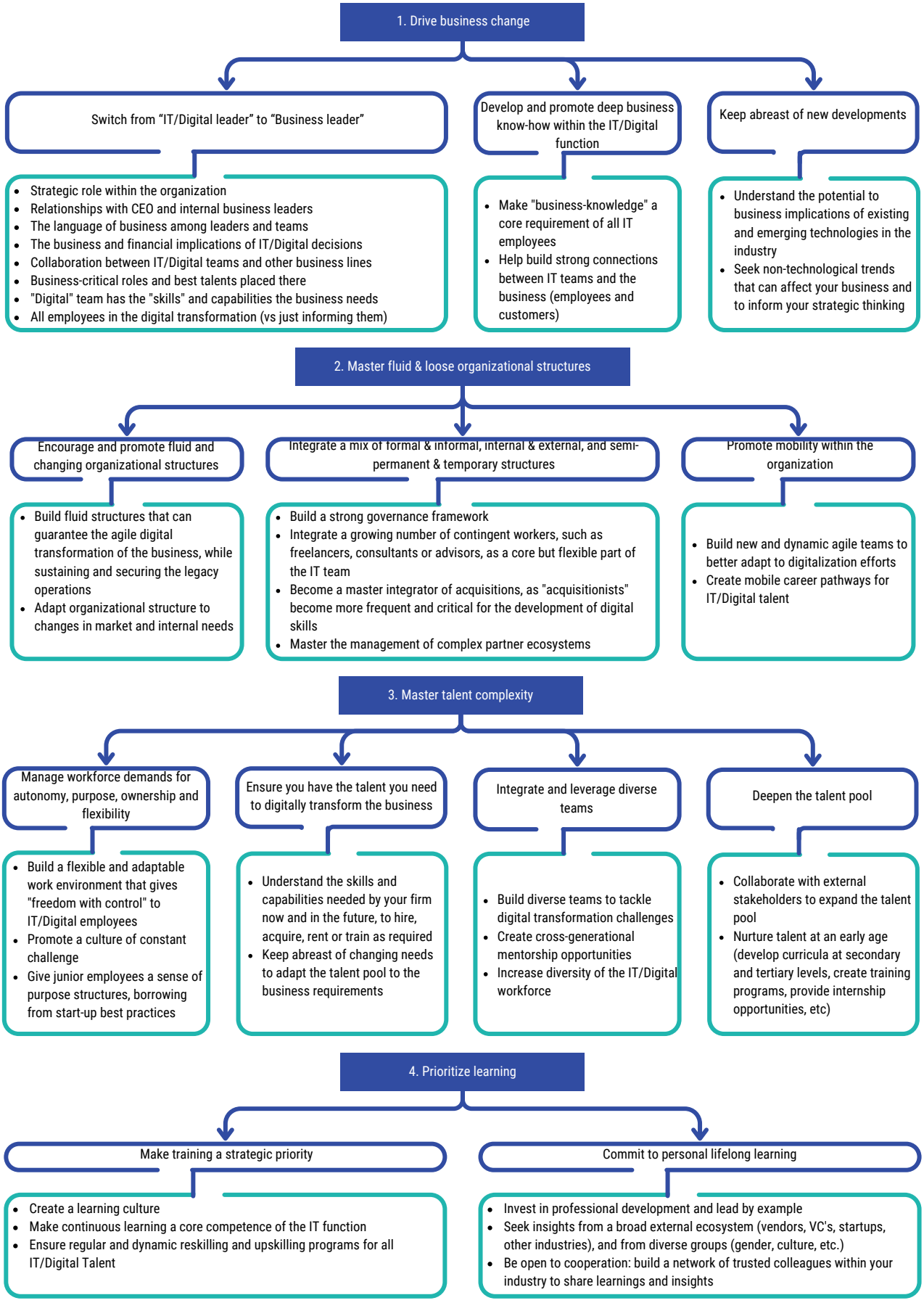

Figure 15. Four dimensions to manage DT (adapted from (Fernandez-Vidal et al., 2022))

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vi. Six Enterprise Capabilities

The practical lessons learned from working with over 200 large companies across various industries indicate that capturing value from digital and AI technologies requires building six critical enterprise capabilities (Figure 16). These capabilities enable companies to integrate new technologies, such as generative AI, and harness them to create value. Although many organisations understand this necessity at a high level, they often struggle with successfully building these capabilities and ensuring their seamless integration across the enterprise (McKinsey, 2023). The journey starts with the alignment of organisational values and strategic preparation, followed by delivery capabilities expansion that includes organisational upgrade and restructuring. Finally, change management is focused on maximising the value capture adopting and scaling the digital solutions. In general, these capabilities highlights the road mapping, focus on talents, operations, technology and data use followed by risk and progress management. Differently than other frameworks, it also adds emphasis on data collection and management.

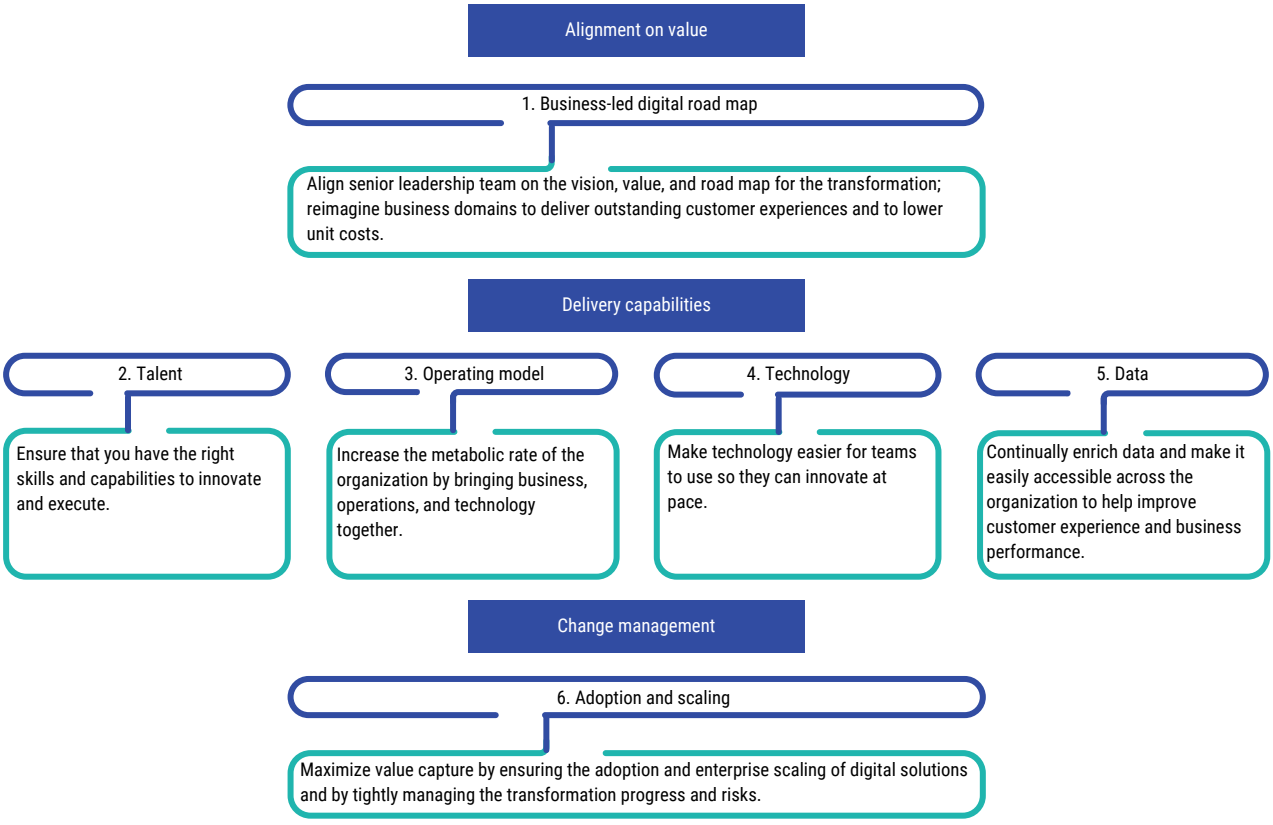

Figure 16. Six critical enterprise capabilities for successful Digital and AI transformations (adapted from (McKinsey, 2023))

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vii. Structured DT Management Process

The final framework was developed by integrating insights from literature analysis and comparing several digital transformation process models for digital transformation. Based on Figure 17 a reality scan assesses the current market and the company's capabilities. This assessment helps in creating a digital strategy that outlines the company's goals and action plans. Senior leadership support is crucial at this stage to ensure alignment with the company's vision and values. Next, innovation efforts are prioritised to develop pilot projects that test new ideas and establish proof of concept. This involves acquiring the necessary digital skills and establishing a robust IT infrastructure. As these innovation projects take shape, the framework emphasises the importance of maintaining business agility and fostering a digital culture within the organisation. Over time, the core business evolves into the future core business, supported by continuous improvements and adjustments to the organisational structure (Veldhoven and Vanthienen, 2023). This framework advocates for the ambidexterity best practices, ensuring that both innovation and the core business are protected and nurtured. This structured approach ensures that digital transformation is both strategic and sustainable.

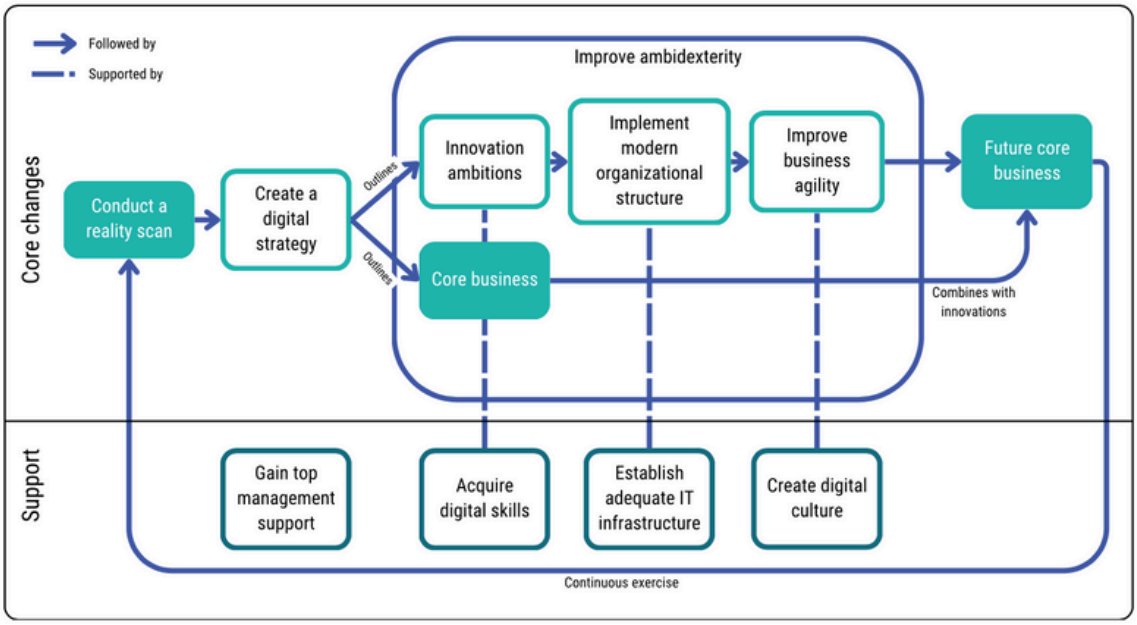

Figure 17. A process model to embark on DT based on DT best practices (from (Veldhoven and Vanthienen, 2023))

Research Based Suggestions For Digital Transformation Management Practices

The analysis of the selected frameworks for digital transformation highlights both shared elements and distinct differences, reflecting the evolution and key areas of interest in the field. These models share the emphasis on the importance of understanding digitalisation, setting a strategic context, and leading change. They all recognise the need for **integrating technology, strategy, and human resources, underlining the critical role of leadership and organisational support in driving successful transformation. Furthermore, frameworks suggest open innovation collaborating with different stakeholders, data and skill utilisation, and continuous learning building and sharing know-how.**

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However, differences are evident in their specific approaches and emphases. Some frameworks prioritise iterative and adaptive strategies, focusing on continuous learning and flexibility, while others stress structured, phased approaches to systematically address the transformation journey. The methodologies range from emphasising experimental and agile practices to more formalised, strategic alignment and resource allocation processes. **Key areas of interest across these frameworks include enhancing digital capabilities, fostering a digital culture, re-defining organisational roles, and ensuring robust IT infrastructure.**

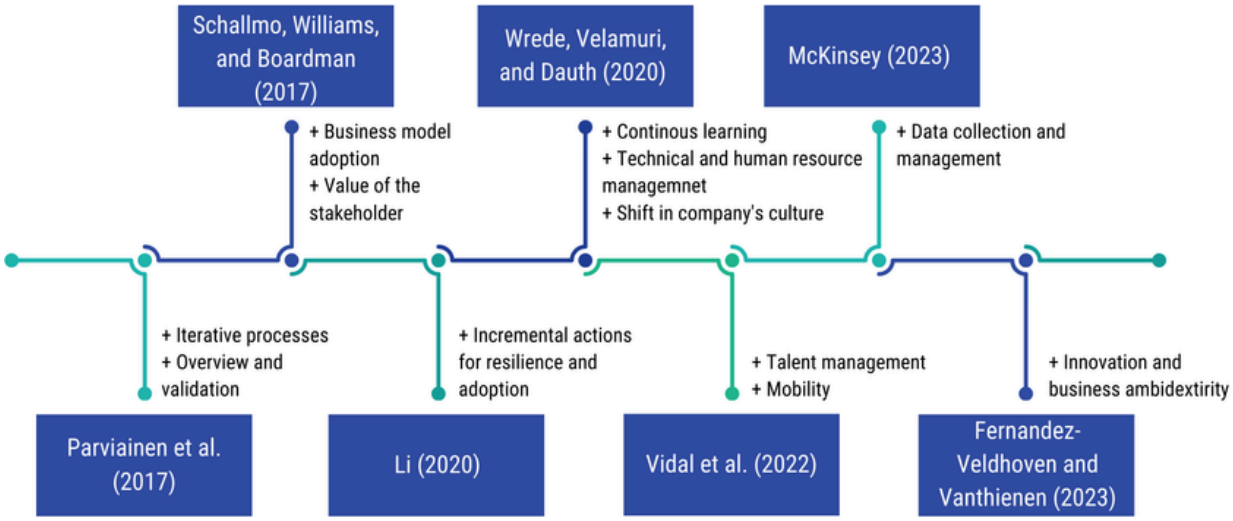

Figure 18. Evolution of understanding practices for managing digital transformations

These frameworks collectively show **an evolution from linear transformation processes to more dynamic and iterative approaches, reflecting the fast-paced and unpredictable nature of digital innovation** (Figure 18). For transitioning to the next section, it is crucial to investigate how these frameworks inform changes in organisational structures, ensuring alignment with the digital transformation goals and strategies.

3.2. ORGANISATIONAL STRUCTURE TRANSFORMATION

From a technological view, since 2010 early-stage technologies like social media shifted to more advanced and recent technologies such as blockchain and AI, meanwhile, thematically, there is growing focus on the implications of digital technologies for **management, governance, organisational structure, employees, and leadership** (Schneider and Kokshagina, 2021). This section explores how digital transformation requires changes in organisational structures, including shifts towards more agile, decentralised models.

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The evolution of digital transformation frameworks from 2020, the advancement of a digital strategy, and increased need for digital culture suggest necessity of significant changes in organisational structures across different stages of digital maturity. As companies progress through digital maturity stages, adapting their organisational structures becomes crucial for optimising agility and enhancing collaboration with stakeholders. Given the high failure rate of digital transformation initiatives, it is unwise to gamble everything on a single strategy (Li, 2020). **A hybrid approach, blending centralisation and decentralisation**, is recommended for organisations aiming to unify and optimise their operations while advancing agility and collaboration (Fischer et al., 2020). This hybrid structure allows firms to benefit from the initial coordination facilitated by centralisation while gradually shifting to a more decentralised model as digital transformation processes mature.

Research indicates that success in digital transformation tends to be higher when starting from a centralised organisational structure, as it aids initial process coordination. During organisational change processes, firms tend to utilise practices associated with the preparation stage more frequently than those related to the implementation stage (Raineri, 2011). However, as the transformation progresses, a less centralised structure often yields better outcomes (Sabljic, 2024). Over time, the urgency of transformation diminishes, and the need for coordination increases, which strengthens the presence of a Chief Digital Officer (CDO). The influence of transformation urgency on CDO presence decreases, while the necessity for coordination enhances their role in managing strategic changes (Firk et al., 2021). This temporal change reflects how CDOs role evolves to sustain and advance their digital transformation efforts.

Implementing digital transformation strategies requires sociotechnical system thinking. Joint optimisation of identified social elements is crucial for incumbent organisations to achieve common goals (Imran et al., 2021). Every organisation, regardless of size, market, history, or location, recognises the need to become more agile, flexible, and responsive to customer needs and expectations. Early-stage companies often require a separate and autonomous digital unit due to distinct requisite skills, such as data science expertise, which are best clustered in a centralised group. More digitally mature companies integrate digital operations across the organisation. In the first step of digitising information or in a phase when data is managed in a centralised repository, organisational structures tend to be opportunistic or centralised (Iansiti and Nadella, 2022; IPC swiss, 2023). As companies evolve into the Decentralised and Fully Integrated phases, their business processes mature into eliminating inefficient process automation and analytics, achieving operational and cross-functional processes or transforming processes for advanced analytics to fully align with business needs.

An organisation's openness to change significantly impacts its approach to digital transformation. Companies with a culture open to change can pursue an integrated approach more easily. On the contrary, firms with a resistant culture may benefit from establishing a separate digital unit or a central unit to complement business units and ensure progress. The level of integration of digital initiatives within the organisation also plays a critical role in determining the appropriate structure. The following section presents the supportive mechanisms that facilitate the successful implementation of these frameworks, ensuring organisations can effectively manage their digital transformation journey.

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3.3. SUPPORTING MECHANISMS FOR DIGITAL TRANSFORMATION MANAGEMENT

Supportive mechanisms are essential elements that drive the outcomes of digital transformation under specific conditions. These mechanisms explain how certain effects are generated within a given setting (Hedström and Swedberg, 1996). Unlike other scientific fields that seek absolute relationships, social sciences focus on how different antecedents, whether contextual or structural, influence the likelihood or magnitude of specific outcomes due to the inherent complexity of human behaviour (Ogink et al., 2023). This complexity underscores the need for adaptable mechanisms in digital transformation, reflecting temporary or permanent changes. **This section explains the role of supportive mechanisms in digital transformation, emphasising how these mechanisms connect contextual conditions with desired outcomes.** It focuses on the **importance of dynamic capabilities and open innovation in supporting digital transformation.**

Two main types of mechanisms serve as the link between contextual conditions and output within the digital transformation. Innovation - involve utilising new resources, processes, and capabilities within the organisation, while integration - focuses on aligning these innovations with existing resources, processes, and capabilities (Figure 8). This comes down to dynamic capabilities that are particularly critical in the context of digital transformation and allows organisations to remain agile and proactive amid rapidly evolving digital environments (Urbinati et al., 2022). In general, dynamic capabilities is a firm's ability to reconfigure its resources in response to and anticipation of environmental changes, thus fostering the development of new value-generating strategies (Teece, Pisano and Shuen, 1997; Warner and Wäger, 2019; Kraus et al., 2021). Furthermore, these dynamic capabilities are integral to the broader concept of open innovation, highlighting the mutual connection between open innovation (OI) and digital transformation.

> **"Open Innovation** - a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organisation's business model."
> Chesbrough and Bogers, 2014

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Innovation process does not happen in isolation, rather, it unfolds within a complex network of resource, idea, and technology exchanges within the interconnectedness of various actors (Urbinati et al., 2022). Therefore, OI is a digital transformation driver by encouraging collaborations that lead to new digital tools, discoveries, and innovations. In turn, DT facilitates sustainability by enabling and driving open innovation. It is a key change that organisations need to embrace for continued development and growth. By fostering new business models and allowing organisations to operate within new ecosystems, digital transformation not only promotes sustainability but also further drives open innovation (Robertsone and Lapiņa, 2023). The literature on open innovation identifies a wide variety of mechanisms from management, sociology, economics, and psychology. These mechanisms fall into four main categories: governance and policies, environmental dynamics and interactions, knowledge, skills, and capabilities, and learning by doing (Ogink et al., 2023). **Governance and policies** involve structural and procedural processes such as formal contracting, organisational permeability, and risk reduction, mainly established in the pre-execution stage to guide and govern OI activities. **Environmental dynamics and interactions**, including mechanisms like entrainment and innovation intermediation, influence how OI projects operate and perform, drawing from various academic disciplines and affecting all levels except the individual. **Knowledge, skills, and capabilities** encompass a range of enabling mechanisms like absorptive capacity and collaborative trust, derived from psychology and sociology, and occurring at all analysis levels, enhancing and being enhanced by OI activities. Lastly, **learning by doing** focuses on experiential learning through mechanisms like implicit knowledge transfer and collaborative prototyping, crucial during the execution stage and supported by organisational learning theories. These categories collectively provide a comprehensive structure for managing and executing digital transformation initiatives through OI. These categories illustrate the multifaceted nature of digital transformation, emphasising the importance of diverse and integrated approaches.

The outcomes of organisational setups in the context of digital transformation involve significant changes in how firms operate internally and engage with external stakeholders. DT drives a shift towards ecosystem-oriented and embedded organisations through open innovation and crowdsourcing, leading to more agile, adaptable, and boundaryless structures such as Holacracy (Berman and Marshall, 2014; Schwer and Hitz, 2018). Management styles evolve to incorporate technology, with increased reliance on artificial intelligence and decision support systems. Business models also adapt, emphasising digital and customer experience-focused approaches, either by creating new models or modifying existing ones. The automation and data-driven nature of DT result in enhanced business processes and the development of smart, connected products (Hanelt et al., 2021). Economically, DT can improve firm performance through better service quality or cost reductions but also leads to dynamic industry-level changes due to fluctuating prices and market reactions (Hanelt et al., 2021). Finally, beyond organisational impacts, DT influences broader environments, including shifts towards customer-centricity, connected markets, and the convergence of physical and digital realms. According to Hanelt, this transformation also brings increased exposure to cyber threats, necessitating enhanced security measures, and necessitates adaptation to the digitalisation of individuals who expect greater flexibility and access to information.

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KEY TAKEAWAYS

Digital transformation is not just a technological change but a **comprehensive organisational shift**. Effective management involves linking **contextual conditions** (e.g., market demands, technological readiness) with **innovation mechanisms** (e.g., data automation, decision-making improvements), leading to **outcomes** that enhance operational efficiency, customer experience, and competitiveness.

Linking contextual conditions with mechanisms and outcomes, frameworks help understand how digital technologies interact with internal and external factors, guiding strategic decision-making. The holistic view helps organisations navigate the complexity of digital transformation, ensuring **alignment across all organisational levels**. A combination **of leadership, strategy, and culture** are essential across frameworks. Multiple frameworks offer **step-by-step guidance** for managing transformation and help **align digital initiatives with business goals.**

These frameworks emphasise iterative approaches, action-oriented strategies, and organisational agility. By comparing these frameworks, it becomes clear that **digital transformation is a multi-faceted journey,** requiring a balance of **technological advancement** and **organisational change.**

While **some frameworks advocate for structured, phased approaches, others stress agility and adaptability.** What unifies these frameworks is the recognition that successful transformation hinges on **leadership, continuous learning, and alignment of digital initiatives with core business goals.** Collectively, they show an **evolution from linear to more dynamic processes**, reflecting the unpredictability of the digital landscape.

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As companies evolve through different stages of digital maturity, they must **adapt their organisational structures** to enhance **agility and stakeholder collaboration.** Companies start with centralised models but should gradually adopt **hybrid structures** that balance coordination and decentralisation as they mature in digital transformation. Hybrid organisational structures (centralised initially, decentralised later) enhance agility and coordination during digital transformation. Structurally, companies that **integrate digital initiatives across all levels** are more likely to succeed in transformation. Furthermore, structures are **supported by the role of the Chief Digital Officer,** which has evolved over time, transitioning from urgent transformation leadership to sustained strategic management.

Innovation and Integration are key mechanisms for aligning digital resources with organisational capabilities, ensuring agility. **Dynamic capabilities** allow organisations to adapt to environmental changes and sustain continuous innovation. **Open innovation** plays a central role in driving digital transformation through collaboration, enabling businesses to evolve and operate within new ecosystems. Other **supportive mechanisms** – such as governance, knowledge, environmental dynamics, and experiential learning collectively form a **comprehensive approach to managing digital transformation efforts.**

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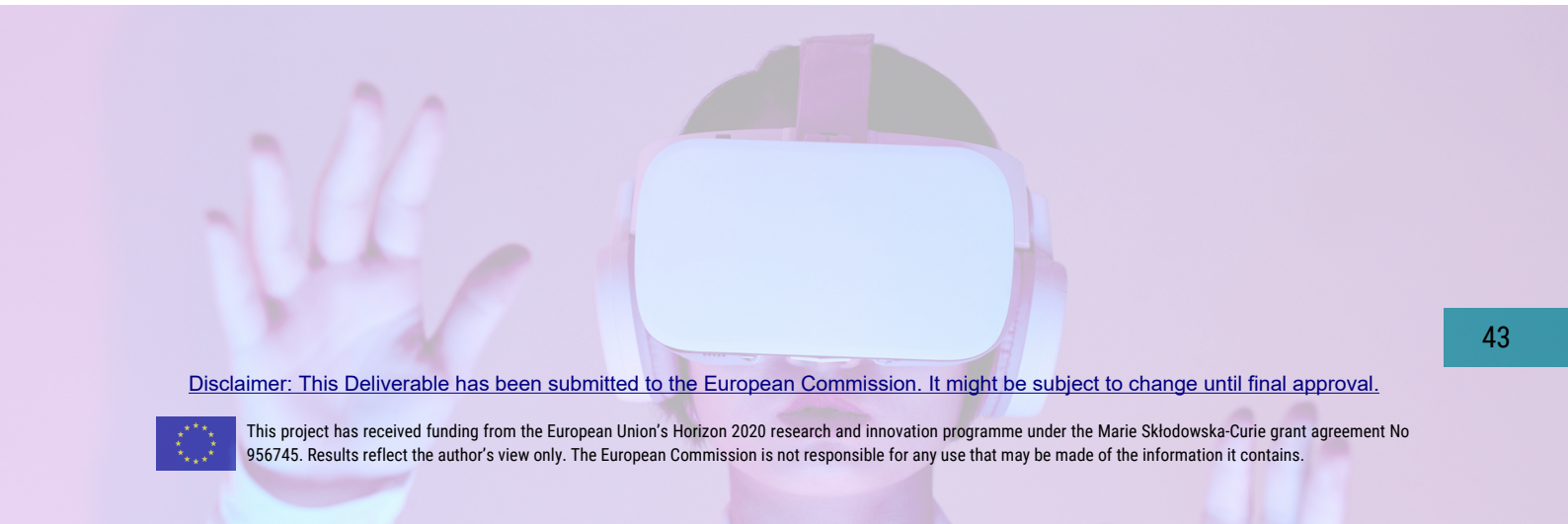
4. THE FUTURE OF DIGITAL TRANSFORMATION

Over the past two decades, digital transformation has significantly impacted various aspects of human life and work. In this report, DT is examined as a fundamental change process enabled by digital technologies. Organisations, industries, and societies are improved by strategically leveraging key resources and capabilities. This process also redefines business value propositions for stakeholders. While smaller firms focus on acquiring specific digital skills, larger firms and digital leaders are advancing quickly. Overall, in the DT race, the gap between more and less digitally mature organisations is widening.

The analysis of current practices in managing digital transformation reveals shared elements and distinct differences. Common ideas include understanding digitalisation, setting a strategic context, and leading change. These models emphasise integrating technology, strategy, and human resources, highlighting the role of leadership and organisational support in driving transformation. Key areas of interest are enhancing digital capabilities, fostering a digital culture, redefining organisational roles, and ensuring robust IT infrastructure. An organisation's readiness to change impacts its approach to digital transformation. Companies with a change-friendly culture can more easily integrate digital initiatives, whereas resistant firms might benefit from separate digital units. Further mechanisms supporting DT include governance and policies, environmental interactions, knowledge, skills, and learning by doing. Furthermore, in DT context, high importance is drawn on dynamic capabilities which facilitates integrating technology, organisation, and social interaction as drivers of change. Similarly, key external enablers such as digital data, automation, digital customer access, and networking trigger digital transformation, leading to more streamlined operations, enhanced customer engagement, and greater efficiency across business processes.

Enabling technology such as digital twins, blockchain, big data and AI, and the metaverse are expected to combine cognitive skills with technological support, fostering a value-driven industrial model (Leng et al., 2022). In this rapidly evolving of technology landscape, digital transformation is no longer a mere option, but a necessity for organisations aiming to remain competitive.



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The Moving towards more Sustainable Organisations

The focus is shifting from solely technological advancements to a more holistic approach that centres on human well-being, sustainability, and resiliency – ambitions which are at the core of industry 5.0 (Ivanov, 2023). With the emergence of **artificial intelligence (AI)**, the changes in DT are expected to be even more radical and fast-paced. For instance, the integration of **generative AI** has already had great impact on business innovation (Bilgram and Laarmann, 2023). However, as we move towards the development of Artificial General Intelligence (AGI), which refers to AI systems capable of performing any intellectual task that a human can (Torres, 2019), there is hope that AGI will be deployed to help achieve the human-centric, sustainable, and resilient goals of Industry 5.0.

At the ten-year mark of Industry 4.0's introduction, the European Commission named Industry 5.0 as a value-driven era, distinct from its predecessor. Unlike Industry 4.0, which centres on technological advancement and efficiency, Industry 5.0 is forward-looking and harmonises industry with emerging societal trends and needs (Xu et al., 2021). It also emphasises human-centricity, sustainability, and resiliency, seeking to reorganise technology to pay attention to human values in technological innovation (Leng et al., 2022). Industry 5.0 aims to transform the world's industrial system by accelerating production processes and changing worker roles.

There are increasing types of technologies driving innovation and sustainability across industries that are being integrated in the operations and management of companies. In particular, the maturation and adoption of AI in all its forms is expected to bring DT to a new level. Different types of AI are increasingly substituting human functions and their integration with human systems, and companies operations, are altering even how organisations are managed and run (Trunk, Birkel and Hartmann, 2020). This is one of the trends which is expected to impact on DT in the future. In particular, the advent of the most creative form of AI - Generative AI is expected to change the most creative aspects of industry, with tasks being affected including strategy and innovation (Cooper, 2024). However, the shift in human-AI interaction stresses an important observation: while humans have theories to explain their understanding of intelligent behaviour in others, they lack a comprehensive theory to explain intelligent behaviour by AI systems. This gap is particularly significant in co-creation environments where AI does not follow a simple task delegation pattern (Feuerriegel et al., 2024). **Understanding and cooperating with AI behaviour create synergy between human and technology that allows integrating AI into business operations.**

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The scaling up of Digital Transformation: impacts at the macro level

Digital transformation is not only about technological change within organisations and its impact on individuals and broader society, but also about how these changes interact with a broader network of interconnected organisations, technologies, and stakeholders. This ecosystem collaborates to create value through digital innovation and integration. Technologies are shaped by ecosystems, and, in turn, are influenced by social acceptance and legitimacy (EINST4INE, 2023b). Initially, the understanding of these ecosystems was rooted in studies of competition within high-tech industries. Here, decisions made by third parties, such as complementers, scaled these ecosystems and shaped competitive outcomes between rival ecosystems. Furthermore, the specific digital technologies adopted by these ecosystems play a role in their development. Some technologies may lead to more decentralised governance systems, while others may drive the opposite trend (EINST4INE, 2023b). However, in recent years, particularly with digital technologies, many of these ecosystems have begun to show signs of contraction or even potential collapse. Successful ecosystem orchestration requires addressing the needs and interests of all stakeholders while managing key tensions between maintaining control and fostering openness within the ecosystem (EINST4INE, 2024). To understand these evolving dynamics, a more sociological perspective has become necessary, focusing on social acceptance or legitimacy rather than profit, loss, scale, or scope.

Digital transformation also acts as a geopolitical driver, influencing global power dynamics. As global powers compete for technological dominance, digital transformation is increasingly influenced by national security concerns, trade policies, and international collaborations. At the same time, technological innovation fuels global geopolitical tensions, as countries compete for dominance and security in the digital realm (Khan et al., 2022). This interplay is key to the concept of digital sovereignty, which refers to a nation or region's ability to control and regulate its digital infrastructure and data. In the European Union, digital sovereignty projects, despite facing contradictions and tensions, are pivotal in shaping the EU's identity as an agile and forward-looking global actor in the digital economy (Monsees and Lambach, 2022). These dynamics highlight how technology and sovereignty are increasingly critical to geopolitical influence and global positioning in the modern world.

4.1. FUTURE RESEARCH AVENUES

As organisations continue to navigate the complexities of digital transformation, many aspects of managing this transformation remain underexplored or poorly understood. The following avenues represent critical areas where **future research** can contribute to exploring Industry 5.0 and advancing the state of digital transformation across industries. As this report follows socio-economic dimensions suggested by the EINST4INE Consortium (Dąbrowska et al., 2022), future research can be tailored around **individual, organisational, ecosystem and geopolitical** magnitude.

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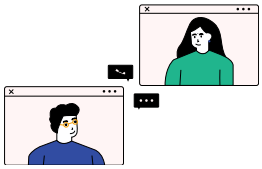
INDIVIDUAL

Managing Hybrid and Remote Workforces

The COVID-19 pandemic accelerated the adoption of hybrid and remote work models, but the long-term impacts of this shift remain under-researched. Future studies should explore how organisations can balance productivity, collaboration, and employee well-being in these new work arrangements. Furthermore, research can investigate the impact of remote work on organisational culture, leadership styles, and team dynamics and individual creativity and innovation outcomes. Understanding how different industries manage hybrid models and the role of digital tools in fostering inclusive and engaged work environments is another critical area for exploration. The research can be expanded by exploring the role of advanced tools like AI-driven project management platforms, virtual reality (VR) meeting spaces, and their combination.



ORGANISATIONAL

Digital Skills, Workforce Transformation and Generation Gap

As automation, AI, and other digital tools transform industries, the workforce transformation and the need for its upskilling are becoming critical areas for research. Future studies should investigate the effectiveness of different approaches to unlearning, digital upskilling, reskilling, and lifelong learning, especially in industries where technological disruption is rapid and profound. These issues become increasingly important with coexistence of multiple generations in the workplace, from Baby Boomers to Generation Z (and in the near future, also Generation Alpha). This presents both challenges and opportunities in upskilling and reskilling employees across industries, and demands that organisations adopt nuances strategies to address distinct learning preferences and skills gaps of each age groups. Additionally, research can explore how organisations can foster a culture of continuous learning, and what role educational institutions and industry partnerships can play in preparing the workforce for future digital demands.

Governance and Digital Leadership

Future research should focus on how organisations can design governance structures that are agile enough to respond to rapid technological changes, yet robust enough to manage risks associated with digital transformation. Studies can also explore the evolving role of digital leaders and how organisations can develop leaders with the necessary skills to manage digital transformation efforts.

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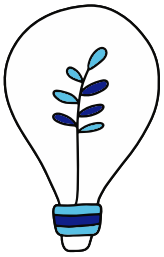
Sustainability and DT

The intersection of sustainability and digital transformation is an emerging field of study that seeks to understand how digital technologies and tools can support sustainable business practices. A significant challenge lies in the growing energy and resource demands of technologies, raising concerns about their environmental impact. Therefore, research should investigate how digital technologies, such as AI, IoT, and blockchain, can be leveraged to optimise resource use, reduce carbon footprints, and support circular economy models. Future studies can also explore the role of digital transformation in addressing global challenges like climate change, and how businesses can integrate sustainability goals into their digital strategies.

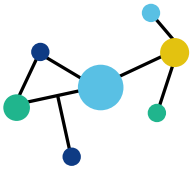


(Gen)AI Integration and Ethics

While AI is already playing a pivotal role in digital transformation, future research should further explore the ethical challenges, scalability, and human-AI collaboration models that are emerging. Key questions remain about how organisations can balance AI-driven decision-making with human oversight, ensuring transparency, fairness, and trust in AI systems. Ethical concerns around AI bias, data privacy, and the implications of AI on workforce dynamics also require comprehensive exploration. The novelty of AI, with its rapid advancements and wide-ranging applications, makes it necessary to conduct thorough research exploring all its types, development trends, possibilities, and potential effects on industries and society, both positive and negative.

ECOSYSTEM

Future research should investigate how businesses can successfully build and manage **digital ecosystems**, including how they can ensure seamless data sharing, interoperability, and collaboration across industries and geographies. Successfully leveraging open innovation and understanding the governance and trust mechanisms that enable successful digital ecosystems, and the role of blockchain in ensuring secure transactions between ecosystem participants, are required further research.



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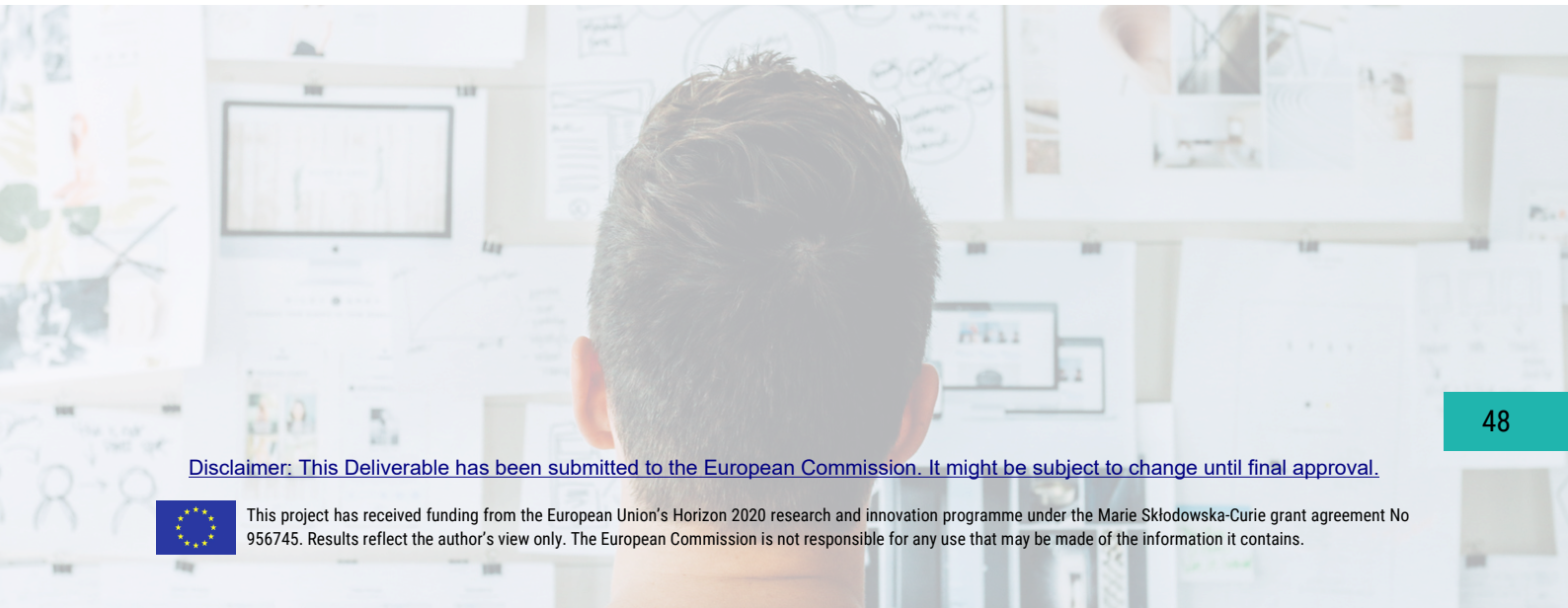
Future research should explore how digital technologies shape **geopolitical landscapes** and the implications for international relations and global competitiveness, also how geopolitical tensions, such as the U.S.-China tech rivalry, affect the development of emerging technologies like 5G, AI, and quantum computing. For instance, restrictions on cross-border data flows, export bans on key technologies, and protectionist policies may limit global collaboration and slow the diffusion of innovation. Another crucial area of research is the impact of digital sovereignty. Countries are increasingly focusing on maintaining control over their digital infrastructure, raising questions about the future of global digital ecosystems. Studies can examine how regional frameworks, such as the European Union's push for digital sovereignty with initiatives like the General Data Protection Regulation (GDPR) and cloud initiatives, influence corporate digital transformation strategies and practices. These issues are particularly relevant in sectors such as finance, healthcare, and telecommunications, where digital infrastructures are vital for national security.

Industry 5.0 as an umbrella paradigm

Despite the distinct analysis of each Industry 5.0 element mentioned before, future research on the phenomenon itself could benefit from several key areas of exploration. A comparative analysis of related concepts like Industry 4.0, Society 5.0, Operator 5.0, and Industry 5.0 (Leng et al., 2022) would help identify the commonalities and differences between these paradigms, offering clearer insights into their unique contributions. Researchers could also investigate the interplay between specific enabling technologies and key features of Industry 5.0, conducting detailed studies to explore their practical applications in achieving goals of the Industry 5.0. Lastly, it is crucial to focus on real-world scenarios to ensure that research on Industry 5.0 remains practical and avoids overly theoretical or unrealistic visions.



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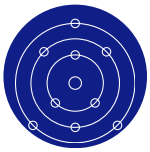
KEY TAKEAWAYS

Future transformations will prioritise **human-centricity, sustainability,** and **resilience**, with AI and machine collaboration becoming more prominent in shaping industries. The future lies in Industry 5.0, where human-centricity, sustainability, and resilience take precedence over pure technological efficiency (Industry 4.0).

AI, blockchain, big data, digital twins, and the metaverse are transforming industries, while generative AI (e.g., ChatGPT, Copilot, Bard) will be a major driver, enhancing innovation, creativity and decision-making, with impacts extending beyond individual organisations to broader ecosystems and geopolitical dynamics. Overall, companies need to shift from **operational efficiency** to **innovation-led cultures.**

Effective digital transformation requires **strong leadership, organisational readiness,** and **a culture open to change**, with attention to governance, policies, and human resources integration.

The push for digital sovereignty, especially in regions like the EU, influences geopolitical dynamics. It reflects competition for control over digital infrastructure and data, shaping national security and global power balances.



Digital transformation extends beyond individual organisations, involving ecosystems that shape and are shaped by technological advancements, emphasising **the need for balancing control and openness**.

Future avenues can be tailored around inclusive ecosystem and geopolitics of digital transformation, balanced (Gen)AI integration and ethics, effective workforce transformation and management in hybrid and remote settings, optimal DT and sustainability integration, resilient digital leadership, and practical exploration of Industry 5.0 as an umbrella paradigm.

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APPENDIX

Research Approach

The research approach for this report is designed to ensure a rigorous and comprehensive examination of digital transformation mechanisms and practices. Literature was selected exclusively from high-ranking, peer-reviewed journals to guarantee the credibility and relevance of our sources. The frameworks were chosen based on their citation frequency, innovativeness and the expertise of their authors, reflecting their impact and acceptance within the research community.

The definitions and topics were derived from current research trends and the broader innovation ecosystem, ensuring that this work is aligned with the latest developments and practical realities in the field. To enhance the clarity and accessibility of the writing, generative AI tools were utilised for copywriting. This approach not only streamlined the drafting process but also helped in maintaining a consistent tone and style throughout the report, making it more engaging for the chosen target audience.

The aim was to provide a robust and insightful analysis by integrating high-quality sources, recognised frameworks, and advanced AI tools that can effectively guide organisations through their digital transformation journeys.

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Acknowledgement: We would like to thank Prof. Anne-Laure Mention, Nicola Felicini, Constanze Leeb and Kerry O'Connor for contributing to the development of this report.

About the EINST4INE Project

The European Training Network for InduStry Digital Transformation across Innovation Ecosystems (EINST4INE) is a consortium of universities, research organisations and industry partners working in the domain of industrial digital transformation. EINST4INE aims to develop new concepts, approaches and methods in the area of digital transformation and brings together a unique group of world-leading experts in the areas of Open Innovation, Industry 4.0, digital transformation and innovation ecosystems.

About the Work Package 2: Organisation and decision-making

The general focus on assisting senior management in making informed decisions on emerging technologies, which can often be challenging. EINST4INE will examine how digital tools and methods, such as augmented reality, can enhance digital transformation and support decision-making. Additionally, WP2 will investigate which organizational capabilities, structures, and processes may impede this transformation.

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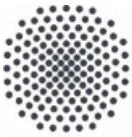
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 956745. Results reflect the author's view only. The European Commission is not responsible for any use that may be made of the information it contains.

PARTNERS & FUNDING



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