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Architecting Business Solutions: Pillars and Challenges in Implementation

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Abstract

Digital transformation (DT) is an in-depth alteration of how organisations leverage technology to drive operations, customer experience, and emerging business models. The pandemic epidemic highlights the importance of digital transformation across a number of industries. Supporting teleworking and electronic education goes beyond healthcare. The pandemic accelerated the calls for companies across all sectors to embrace these digital technologies. COVID-19 has sparked a renewed focus on reaching digital transformation benchmarks and mandates that companies step up their transformation efforts. To implement that change, company executives face a number of challenges, including cultural resistance, skill shortages, and cost concerns. The strategy increases competitiveness and encourages digital inclusion. In the process of transforming the organisations, it is crucial to realise the multi-dimensional nature of digital transformation. This research paper applies a broad literature analysis research design to narrate the main pillars, challenges, and implications of the digital transformation DT as per the existing academic literature. DT is discussed from different perspectives then several remarks are concluded, and recommendations are proposed for further research.

Keywords: ***Business, Digital Transformation DT, Pillars, Challenges, Systems***

1 Introduction

Today, most firms are adopting digital technology to change existing business models or initiate new ones that cope with the modern structure of transformation toward digitalised business (Vial, 2019). The applied aspects of digital transformation extended not only to manufacturing processes but also to intra/interorganisation of vendors and customers (Majumder et al., 2022). Technology is gently shifting the community and corporate. Corporate modernisation is crucial for a business's comparative advantage and a country's economic growth, so it becomes mandatory for businesses to move to digital (Wang and Zhuo, 2022).

Digital transformation evolution was tackled with early studies of exploring the impact of IT adoption on business and its performance. Nowadays, digitalisation is addressed through a multidisciplinary concept covering IT, entrepreneurship, operations management, marketing, and strategic management (Dmitry et al., 2022). More research extended the critique to the urgency to change the organisational design to match the digitised business process format (Verhoef et al., 2021). Dmitry et al. (2022) focused on how digital transformation is affecting different organisational layers of the firm.

Many researchers attempted to define the meaning of digital transformation; some considered it the proper tool for business robotics, as digitalisation stimulates an automated business process. Others focused on the use of IT to have modern business models and get a better revenue. Mostly, the researchers focus on the impact of digital transformation (Wang and Zhuo, 2022) or elaborate more on its definition (Pagani and Pardo, 2017; Vial, 2019; Verhoef et al., 2021); how it affects the internal business process (Singh et al., 2021; Zhai and Chan, 2022); how to enhance operations management (Mourtzis, 2020); or its role in coordinating industrial supply chains (Warner and Wager, 2019; Nambisan et al., 2019). Digital transformation does not only include the technical complications of automated system conversion; the supporting pillars, which could facilitate that transition, have been tackled as well (Preko and Boateng, 2020). With no doubt, what digital transformation brings so far is mandatory to the economic system (Salvi et al., 2021). With the pandemic outbreak, the digital transformation plays a crucial role in the healthcare system (Drago et al., 2021; Tortorella et al., 2021). It improves the service quality and ensures the safety of patients.

Legalisation is critical to support the digital transformation process. Countries like China, the USA, and Germany initiated policies to facilitate the digital transformation: 'The Federal Big Data Research and Development Strategic Plan' in the United States, 'Digital Strategy 2025' in Germany, and 'Outline of Digital Economy Development Strategy' in China (Wang and Zhuo, 2022). The next section of the literature discusses in-depth the studies that grasp the digital transformation process, technologies and its obstacles.

2 Background

Digital transformation is the incorporation of digital technology in all business perspectives to change business operation and how to deliver value add to consumers. The rapid ability of technology to process data is the main motive behind the digital transformation move. Many exchange leaders, such as Amazon, Airbnb and Uber, adopted several technologies, such as artificial intelligence, cloud computing, social media platforms and the internet of things (IoT), to provide superior and customised service to their customers. Many benefits are paid back from digital transformation, such as improved productivity, enhanced responsiveness to the incoming demands and the provision of customised orders.

Moreover, Teresa Guarda et al.'s (2021) study indicates the technological developments of the latest digital tendencies as shown in the figure below: the existing trends in the Internet of Things (IoT), 5G mobile communication, WiFi 6 technologies, and machine learning. They underline the key aspects of digital transformation as follows: user experience, operational processes, and business model. The authors indicate the need to address such aspects to digitally transform the business and enhance its customer involvement, processes and business models.

Figure 1: Area of Digital Transformation; Source: (Teresa Guarda et al., 2021)

Companies are faced with obstacles to change the human mindset and admit to adapting the recent technology in order to enhance the business processes. Intelligence is the capability to perceive, forecast, and sort out an issue through the analysis of the situation. Artificial intelligence and machine learning can be implemented in many aspects, such as healthcare, manufacturing and business. There are more DT technologies in different fields that will be addressed in the following sections after the methodology illustration.

3 Research Methodology

The literature analysis research methodology associated with the comprehensive approach implies such aspects as identifying, analysing, and synthesising scholarly articles and empirical studies concerning issues of digital transformation. The following stages can be distinguished in this methodology:

3.1 Setting out Problem Statement and Research Scope

Although digital transformation (DT) has gained increasing awareness as a key competitive advantage driver and organisational resilience feature, there are a considerable number of companies that are unable to realise DT initiatives in an appropriate manner. The urgency of organisations to adjust to the digital technologies has also been greatly increased by the COVID-19 pandemic, but still, such barriers as the lack of skills, cultural resistance, and financial inabilities exist (Wang and Zhuo, 2022). The necessity of a complex picture of the difficulties and the pillars that should take place to ensure a successful transfer to the digitised business models has been underlined by the previous research (Pagani and Pardo, 2017; Vial, 2019). However, there still exists a very large gap in empirical research that formally examines how these challenges interact or interrelate with the strategies adopted by organisations to get rid of them. This paper aims to fill this gap by looking at which barriers are encountered by organisations in their DT processes and what the pillars are that can aid in a successful transition.

After defining the problem statement, the research goals are draughted to be clear in the following key questions:

What are the main factors driving and hindering transformation into digital?

In what way do the numerous technologies relate to the process of digital transformation?

What models and frameworks can be adopted to help companies in their digitalisation process?

3.2 Search Strategy of Literature

To conduct the systematic search over the literature, different scholarly databases are used (March and Ilis, 2020). Keywords start with searching the terms (digital transformation) and (digital technology adoption), the barriers to digital transformation, and (digital transformation frameworks). The research is narrowed to include peer-reviewed articles, conference papers, and relevant case studies published within the past ten years.

In order to make sure that the chosen literature is also relevant and of high quality, the following criteria are met; Inclusion Criteria: articles which are peer-reviewed and which are related with the sphere of digital transformation in different areas and analyses that deal with theoretical approaches as well as with empirical data., Exclusion Criteria: articles written in languages other than English that are not expressly dealing with digital transformation or older than ten years, with the exception of seminal works in the area.

Following the literature search, the research is subsequently synthesised in order to determine any patterns, themes, and research gaps within the already-existing research. This synthesis comprises thematic analysis and narrative synthesis.

3.3 Research Contribution

This study provides a theoretical contribution to the current knowledge in the field of digital transformation as it offers the empirical evidence on the practical nature of the mentioned problems that organisations are facing with and the strategic pillars that can help to implement the successful DT oriented initiatives. A detailed picture is presented of how organisations can adapt to the dynamics of DT by synthesizing insights of different industries. Moreover, it gives practicable guidelines to practitioners and policymakers in order to increase organisational readiness and resilience against digital disruption.

4 Digital Transformation Technologies

There are several technologies to be adopted by businesses; the main technologies that could be adopted for digital transformation, as

reviewed by TechTarget (2022) and Dragomirov and Boyanov (2021), are:

- **Cloud Computing**

The trend of cloud computing is still evolving to have more enterprises adopting it. It represents the conveyance of diverse services through the Web. It gives rapid access to new applications and features with no need for installed hardware requirements. It gives accessibility to data storage, remote servers, off-campus databases, networking, and software. Cloud-based_storage enables accessibility to a remote database. So, any interconnected device could have access to data and the software programs. It saves expenses of investing internally in technological infrastructure, improves productivity, and allows working remotely from any place.

The cloud services enable having central processors, memory, and application programs. Clouds offer either private or public ones. Cloud computing enables email accessibility, data storage, data processing, application development, and audio and video streaming. The cloud computing compromise: software-as-a-service (SaaS): give the license of a software application to customers, infrastructure-as-a-service (IaaS): a technique for conveying everything from operating systems to servers and storage through IP-based connectivity as part of an on-demand service and platform -as-a-service (PaaS): a platform to develop software to be conveyed via the net. The key players in cloud field include Google Cloud, Amazon Web Services (AWS), Microsoft Azure, IBM Cloud, Alibaba Cloud. The most commonly used cloud is Amazon Web Services (AWS); Microsoft Azure and Google Cloud Platform have their market share as well.

- **Big Data**

Big Data is defined through its three dimensions: volume, velocity and variety. Such dimensions cannot be processed with contemporary technologies. Big Data is unstructured data that requires more processing than the volume of conventional database systems (Mihova and Chukalov, 2019). Big data analytics is the process of exploring big data to uncover hidden patterns, correlations, market trends and customer preferences for informed decisions. Data analytics techniques give organisations a way to analyse datasets and gather new information. Big data analytics include complex applications with

elements such as projecting models, statistical algorithms and what-if analysis powered by analytics systems.

- **Blockchain**

It is a technology that defines an algorithm and distributed data structures, securing data movement with no centralised supervision (electronic cash transfers). Usually used for cryptocurrency, Bitcoin; the concept is to move against bank-organised payments ruled by governments. The early aspiration of the Bitcoin developers was to enable people to spend money without mediators or rules (Mihova and Chukalov, 2019).

- **Mobile Platforms**

It supports mobile application development. It allows connectivity between applications. These tools include measuring mobile analytics and initiating interfaces for profiling application performance.

- **Social Media**

A combined term for applications that focus on interactions, user feedback, content sharing and extended collaboration. It is used as a marketing tool for products or services to individuals and platforms to run promotion campaigns. It helps to provide construction feedback and share expertise with others. Crowdsourcing is a trend initiated by businesses to collect knowledge and expertise to have a better service provided. Several applications are available via social media, such as social media analytics and embedding, which gets data from blogs and social media websites to help in undertaking decisions. Sentiment analysis is usually used in social analytics; it inserts the adoption of data mining and artificial intelligence to give more insight for sentiment from unstructured data. Search engine optimisation is a common strategy for attracting users to a website. Adding social media links and status sharing will promote more for social media links.

- **Artificial Intelligence**

It adopts many tools that equip machines to sense, understand, blueprint, act, and acquire with human-simulated intelligence. Fundamentally, AI systems notice environments, identify objects, enable decision-making, resolve complex problems, study from previous experiences, and replicate patterns (Kanade, 2022). The AI ranges

across a spectrum of technologies such as machine learning, natural language processing, computer vision, and others. Such technologies enable systems to comprehend human language, learn from cases, and reach out for predictions. Most of the studies assure that adoption of AI and other technologies such as data analytics and automation will renovate business and optimise its business process.

The following constitute the main components of AI technology (Kanade, 2022):

1. **Machine learning: Machine learning is an artificial intelligence application that routinely learns and advances from former sets of practices with no need for programming. Its objective is to empower machines to emulate human-identical behaviour by training machines to learn from experience. It gets natural patterns to have forecasts for data-driven decision-making (Mihova and Chukalov, 2019). Machine learning uses learning power to extract knowledge from data, whereas a knowledge graph uses reasoning power to get new knowledge from current knowledge. Semantic web technology, ontology engineering, and linked data are the basis of knowledge graph development (Khamdi, 2020).**
2. **Deep learning: Deep learning is a subset of machine learning that acquires by dealing out data using artificial neural networks.**
3. **Neural network: Computer systems that are roughly modelled on neural connections in the human brain and assist deep learning.**
4. **Cognitive computing: Cognitive computing aims to re-develop the human thought process in a computer model. It aims to replicate and advance the interaction between humans and machines by understanding human language and interpretation.**
5. **Natural language processing is a tool that enables computers to understand, distinguish, construe, and get out human language and speech.**
6. **Computer vision: adopts deep learning and pattern identification to interpret images in-depth.**

- **Robotic Process Automation (RPA)**

It operates bots that can grip routine, repetitive tasks faster and more precisely than humans. It is a software script that automates other software. RPA software uses rules-based work tasks that depend on digital data. RPA intends to enhance the efficiency, uplift the productivity and save expenses. Robotic process automation software is a subcategory of business process automation (BPA), a general term for

the use of technology to perform the workflows included in a business task with slight human involvement (Techtarget, 2022).

- **The Internet of Things (IoT)**

A system of interconnected computers, power-driven and digital machines, substances, and individuals that are equipped with unique identifiers (UIDs) to move data over a network with no need of human interaction. It enables the business to have enhanced customer service and improve decision-making. It uses web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to acquire data from their environments. IoT devices share the collected data with the IoT gateway to have data sent to the cloud for analysis or processed internally. IoT can be incorporated with artificial intelligence (AI) and machine learning for faster data collection. Although IoT reduces the need for human interaction, it has to deal with massive numbers -- maybe even millions – moving around. Lack of an international standard of compatibility for IoT imposes obstacles in data transmission and interruption. The Internet of Things represents the apparition of the physical and digital worlds – smart objects are interconnected through the Web. IoT is the perception of linking any device to the Internet. It includes smart devices along with original dumb devices designed to be smart and interconnected (Mihova and Chukalov, 2019).

- **Edge Computing**

It handles data processing and storage closer to the internal devices instead of connecting remotely to external devices. It helps to avoid latency issues of performance. Reducing the amount of data to be sent remotely to the cloud will save more cost for the enterprise. The Enterprise attempts to control the bandwidth costs related to sending data remotely or to a centralised repository. Additionally, unpredictable network disruptions will interfere as a further challenge in data transmission. Businesses are managing such data challenges with the adoption of edge computing. A Gartner report expected that 75% of enterprise data will be initiated out of data centres by the end of 2025. Dealing with such a massive amount of data poses the issue of disruption and will require the adaptation of edge computing.

5 Digital Transformation Studies

Several studies discuss the move toward digital transformation (DT) and its aspects. A model of digital transformation suggested by Verhoef et

al. (2021) explains the motive/driver toward digitalisation, phases of digitalisation and strategic imperatives of digitalisation, and external factors driving the need for digital transformation as demonstrated below.

Initially, several technologies popped up: broadband internet, smartphones, Web 2.0, cloud computing, speech recognition, online payment systems, and cryptocurrencies. Then with these technologies' adoption, an aggressive competition in the market led to a changing pattern of consumer behaviour, the third driver.

To achieve DT, there are three phases to take place: Digitisation, which means moving all data into digital format; digitalisation, which means how the adoption of digital technologies will change current business processes; and lastly, digital transformation, which indicates the initiation of modern business models. To support that transaction, the management should acquire digital resources, storage of data, and telecommunication infrastructure. Digital agility is mandatory to seize the digital market prospects; organisational change is essential as well to have a flexible structure for the digital move. Management should also define its growth strategies across digital transformation phases (market, product or platform growth strategies). In conclusion, digital firms should assess their performance enhancement based on KPIs to evaluate the existing business model.

Moreover, a reference to exploratory case studies was conducted in the Schallmo et al. study (2017). The study proposes that despite DT being a popular concept nowadays, there is no clear approach to having a structured DT and the way to adopt its business models. They propose a more structured definition of DT business models. Another study by Hanelt et al. (2021) provided a comprehensive review. They reach out for a comprehensive, multi-dimensional framework of DT as illustrated in the figure below. It encompasses three categories – contextual conditions, mechanisms and outcomes.

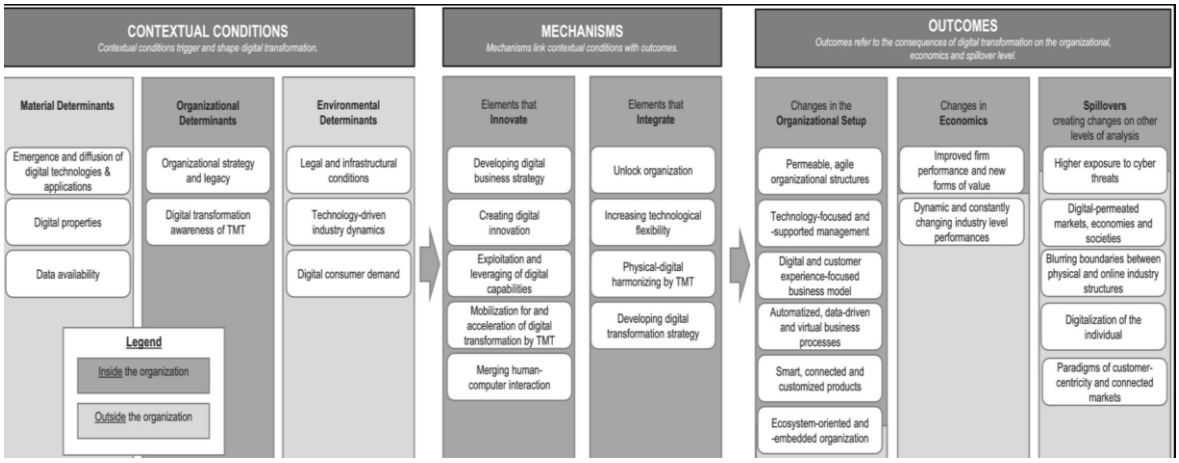

Figure 2: Multi-dimensional Framework of DT; Source: (Hanelt et al., 2021)

Contextual conditions define the onset of digital transformation. Material, organisational and environmental anteceden ts which trigger and shape DT development and dissemination of a variety of digital technologies. Digital properties are crucial as well to be considered for material. The diffusion of digital technologies was detained to ensure data availability. The adoption of digital technologies affects organisational and managerial characteristics. Organisational characteristics encompasses organizational strategy and legacy; managerial characteristics indicate the digital transformation awareness.

Material and organisational factors are interrelated with environmental antecedents. It represents the legal and infrastructural conditions of a country – regulatory frameworks, technology-driven industry dynamics – and the dynamic of technology trends. Moreover, digital consumer demand, which is growing over time.

Mechanisms: the study defines two organisational mechanisms to perceive DT: innovation and integration, enabling new capabilities to be captured and aligned with existing processes.
For innovation mechanisms, developing a digital business strategy is a key essence linked to strategy. It identifies business and technological prospects. Mobilisation and acceleration of digital transformation are required by senior management; the exploitation and leveraging of digital capabilities are urgently required; and managing human-machine interaction is desirable by that stage.

The integration mechanism is responsible for the alignment process. Developing a digital transformation strategy is a need to unlock

organisations' enhanced learning capabilities. Organisations need an increasing technological flexibility – agile enterprise and physical-digital harmonising – to enhance cross-process coordination.

Outcomes are represented in the environmental surroundings in which the organisation is embedded and the resulting economic consequences. Accordingly, differentiation between *organisational setups*, *economics* and *spill-overs* is desired.

Outcomes relating to *organisational setups* refer to organisational change. The technological change and crowdsourcing triggered *ecosystem-orientated and embedded organisations,* so organisations initiate *permeable, agile organisational structures*. Furthermore, management styles changed towards *technology-focused and supported management; digital and customer experience-focused business models* emerged based on that.

Finally, the DT outcome of *automatised, data-driven and virtual business processes* is represented through an enhanced adoption of digital technologies and development of *smart, connected and customised products*. From *an economics perspective*, DT may result in *improved firm performance and new forms of value*, caused by an improved service quality or cost reductions. It led to *dynamic and constantly changing industry-level performance* with competitive pricing and better market engagement.

***Spill-overs* – The trend toward customisation pops up with *paradigms of customer-centricity and connected markets*. So, the market strategy changed to a *digital-permeated market, economy and society.* It promotes for the brick-and-mortar model a *blurring of the boundaries between physical and online industry structures.* Security issues are a major concern to be considered a *higher exposure to cyber threats and the digitalisation of the individual* to an adequate user for the system.**

Vial (2019) proposes a framework which focuses on digital transformation as a process where *digital* technologies cause disruptions that require strategic action from firms intended to optimise their value add. It manages the internal organisational changes smoothly and overcomes expected obstacles of the process. The impact of DT on enterprise and how it shifts internal aspects has been discussed by Dmitry et al. in (2022). It defined a layered model for DT as shown in figure 3 below: (1) organisational core (e.g., corporate headquarters); (2) organisational periphery (business units);

and (3) external environment (e.g., customers and competitors). The study proposes that enterprises having DT experience different issues internally and externally. Moreover, the enterprise increasingly moves to embrace external factors to have tighter interrelated interaction with the external environment. This complies with the expected change from a centre-focused organisation to an extended organisation approach that operates collaboratively to achieve value. The researchers believe that the digital firm should move beyond its boundaries. A change in organisational core to cope with recent technologies and anticipate that in organisational structure and culture. Similarly, the change in organisational periphery internally to improve business products and processes with a digital move. The change of external environment as well impacts the adoption of digital technologies into the business and vice versa.

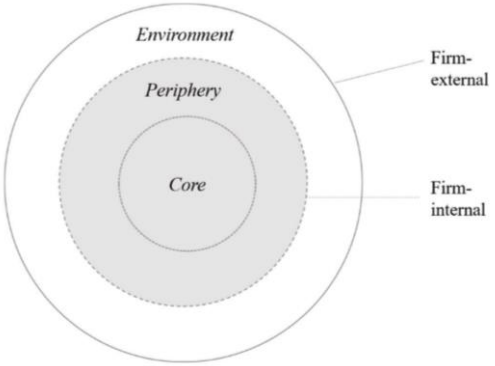

Figure 3: Multi-layered model of the firm; Source: (Dmitry et al., 2022)

5.1 Digitalization in Healthcare

The Tortorella et al. (2021) study discusses the digital transformation in the healthcare sector to indicate three perspectives: 1) the implemented technologies; 2) the value adds from implemented technologies; 3) the obstacles of adopting digital technologies. The study defines the main digital technologies adopted so far in healthcare: biomedical-digital sensors, cloud computing, remote control or monitoring machines/deep learning, augmented reality/simulation, 3D printing and collaborative robots.

Studies of DT in healthcare show benefits in regard to scope, stage of development and teaching status of healthcare. Theoretically, such determinants affect the digital transformation plans and approaches in the Italian context, as referred to in the study of Raimo et al. (2022). The study demonstrates that more investment in financial assets and having

skilled human resources help more in embracing digital technologies in healthcare. Digital health solutions offer several features, such as digital health records, monitoring equipment, telehealth, electronic communications, data analysis, and web- and cloud-based tools.

5.2 Digital Transformation in Governmental Service

Digital transformation in the public sector is considered a gradual development of technology by the government to enhance service provision, remodel existing organisational processes, and restructure its business process to be a smoother one to engage more with citizens and stakeholders. DT in public service is more dependent on the government's dynamics and human capabilities for digital transformation.

Studies investigating DT in public sectors focus on a number of factors or technology itself, which did not provide the broader approach to make the digitalisation succeed. Mergel et al. (2019) define the process as "processes, people, policies, and especially leadership need to be fundamentally changed to accomplish digital transformation in the public sector." The study by Hernandez et al. (2022) focuses on human capacity as a key determinant for government transformation to digital trends; it emphasisesits importance for a framework of digital transformation.

The World Bank – as a partner for financing and technical support for digital transformation – launched the GovTech Initiative to support the reform process of low- and middle-income countries demanding a radical digital transformation program, as shown in the figure below, to improve the effectiveness and excellence of government service conveyance, enhance government-citizen transactions, reduce fraud, and remodel government business processes (Dener et al., 2021).

The World Bank introduced "The GovTech Maturity Index", which assesses characteristics of four GovTech focus areas: core government, improved service conveyance, facilitated citizen communication, and provision of government innovation. The GovTech approach represents the final stage of government digital transformation to be addressed by countries of interest toward digital transformation.

The automation stages begin with e-government that focuses on a user-centric approach but with a one-way transaction. The successor phase is having the digital government, whose procedure is designed digitally

and has a proactive administration approach. Reaching out to the last phase of GovTech.

The main perspectives of that phase of digitalisation are as follows:

• Citizen-centric services.

• A comprehensive-of-government method to public sector digital transformation.

• Simple, efficient, and transparent government systems.

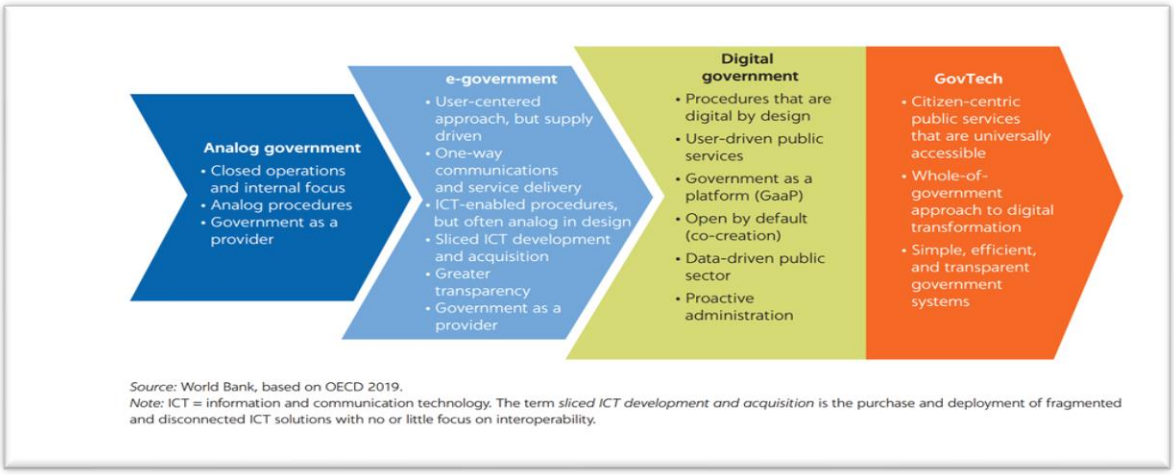

Figure 4: Digital Transformation of the Public Sectors; Source: (Dener et al., 2021)

The following table indicates the ranks of countries according to degree of significance on GovTech; it shows that Egypt is considered one of the countries of high significant focus on GovTech.

Table 1: Overview of GovTech Maturity 2020; Source: (Dener et al., 2021)

GROUP	GTMI	COUNTRIES OR ECONOMIES IN GROUP	Economies		Regions	
			No.	%	No.	%
A	Very high: GovTech leaders	Argentina; Australia; Austria; Belgium; Brazil; Canada; Chile; Colombia; Croatia; Denmark; Estonia: Finland; France: Germany; Greece; Hong Kong SAR, China: India; Israel; Italy; Japan: Korea, Rep .: Lithuania: Luxembourg: Malaysia; Malta: Mexico; Netherlands: New Zealand; Norway; Peru;	43	21	23	14

GROUP	GTMI	COUNTRIES OR ECONOMIES IN GROUP	Economies		Regions	
			No.	%	No.	%
		Portugal; Singapore: Slovenia: South Africa; Spain; Sweden; Switzerland; Thalland; Turkey; United Arab Emirates: United Kingdom; United States, Uruguay				
B	High: significant focus on GovTech	Albania: Armenia; Azerbaijan: Bahrain: Bangladesh; Belarus; Bhutan; Bolivia; Bulgaria; Cabo Verde; China; Costa Rica; Cyprus; Czech Republic; Dominican Republic: Ecuador; Egypt. Arab Rep .: El Salvador; Georgia; Ghana; Honduras; Hungary; Iceland; Indonesia; Ireland; Jamaica; Jordan; Kazakhstan; Kenya: Kyrgyz Republic: Latvia; Mauritius; Moldova: Mongolia; Montenegro; Morocco; North Macedonia; Nepal; Oman: Pakistan; Panama; Paraguay: Philippines: Poland; Qatar; Romania; Russian Federation; Rwanda; Saudi Arabia; Serbia; Slovak Republic; Sri Lanka; Taiwan, China: Tanzania: Tunisia: Uganda; Ukraine; Uzbekistan; Vitenam	59	30	56	33

5.2.1 Smart Cities

Digital transformation in government includes the concept of smart city. Smart cities are functioning within a comprehensive perception to have waste management, traffic regulation and water management. Smart cities implement a dual approach, one technological and one human-related. The technology is vital to build the smart city to serve the citizens of the smart city it is developed for. So urban governance and involvement processes require investments in human and social capital as integral aspects of a smart city. The development of smart cities led to the enhancement of city operations and having a better quality of life.

Hernandez et al. (2022) propose to measure how the governments can improve their managerial ability to reach the digital transformation. The authors conducted a study on three smart cities in Europe: Milan (Italy), Barcelona (Spain), and Munich (Germany). The study sets the criteria of assessment, including the context, its features and prophecy of digital transformation in the decision of adoption of digital transformation. A smart city undergoes three levels of smart city domination, defined by Meijer & Rodriguez Bolivar (2016): smart decision-making, smart administration, and smart urban collaboration.

Within smart decision-making, the lowermost level of transformation, organisations remodel the decision-making with digital process data using technology. For smart administration, organisations incorporate data, business processes, and existing infrastructure to oblige citizens and communities. Lastly, through smart urban collaboration, the top level of transformation, organisations endorse coordination across business units and with societies and develop a centric model of citizens.

The study findings indicate that smart cities are converging on the magnitudes of coordination. The three countries invested resources to assure good management of smart cities, having a proper strategy and a vibrant organisational structure of city government. Developing a smart city requires a huge investment that governments will hardly afford and needs further collaboration between the public and private sectors, such as public organisations, SMEs, start-ups, universities and non-profit organisations, to design and implement the smart city strategy. Setting a clear strategy is crucial for smart city initiatives; having human, technological, organisational, and financial resources is essential for smart city development.

5.3 Digitization in Manufacturing

Industry depends on the adoption of advanced technologies; they can move the factory into a smart one. Those technologies are the industrial internet of things, cloud computing, cybersecurity, big data and analytics, horizontal and vertical system integration, advanced robotics, additive manufacturing, augmented reality, and simulation. Digital twin is one of the key technologies in industry. Digital twin is considered an upgrade of Cyber Physical Systems (CPS). CPS gets data from physical objects and uses computational intelligence to optimise its operations. Digital twin provides 3D modelling and 4D visualisation of the physical object.

Camarinha et al. (2017) emphasise that the digital transformation move does not reflect only the technological aspects; the ongoing change will take place with the remodelling of production processes and restructuring of the organisation. The restructure of markets where the new products will be promoted, even the change of interactions and boundaries of business, government and community.

Industry is considered as on-time control of operation using information technology; it aims to improve process efficiency and enhance the productivity of day-to-day operations. Intelligent systems help to perform routine daily work so the labour force will be redirected to do value-added activities (Cheng and Zhang, 2020). It enables the firm to adopt the smart technologies and offer products that are more agile and flexible. It is a horizontal integration of the process to make production fully automated. The smart management system is based on the integration of machinery, personnel, and devices that communicate with each other (Fotouhi and Sorooshian, 2020). AI and IoT are predictable ones to flourish as manufacturing industry technology in regard to its operational improvements (Ullah et al., 2025).

Many countries shift to industry 5.0; for instance, Russia moved toward digital transformation and adoption of industry 5.0. The common adopted technologies include Cyber Physical Systems (CPS), the industry Internet of Things, Big Data and Business Intelligence, Augmented Reality, cloud storage technologies, autonomous operation, information security (protected data, access authentication system, full control of management networks), additive manufacturing, digital modelling, and internal and external organisational interaction of the enterprise (Camarinha et al., 2017; Piardi et al., 2024).

5.4 Digitization in Transportation

The digital transformation for transportation should ensure a smooth transition by adopting recent technologies. Several technologies should be adapted for such a transition (Rathore et al., 2021):

- **The adoption of Internet of things technologies is required to have constant communication in the framework of a single transport and logistics system;**
- **The deployment of "intelligent transport" system to undertake intelligent decision-making, which control the whole transport system;**
- **Initiation of artificial intelligence system that enable monitoring the operation of the transport-logical system;**

- **Deployment of GPS systems to track each freight and passenger means of transportation;**
- **Development of a data protection system and the safe digital operation of the transportation complex.**

Tolkachev et al. (2020) propose that any developed model for digital transformation in transportation complexes should have identities, operations that should be digitalised, the digital transformation process, and tools for digital transformation.

6 Discussion

After reviewing several studies deliberating the digital transformation trend, it is quite obvious that the digital transformation process has multidisciplinary aspects that incorporate many pillars or factors to ensure the environment's readiness and restructuring toward such transformation. One of the potential studies proposes a realistic model to move toward digitalisation (Morze and Strutynska, 2021); this model identifies the different perspectives that such a transformation should address:

The motive behind such a move toward digitalisation should consider the potential impact of digital technologies' adoption and a new type of service to be offered in a digital society. The model indicates the pillar for transformation as follows:

- **Process: the impact of such transformation is to enhance its efficiency, automate the business process and shit to paperless one, more interrelated and integrated business processes.**
- **People: skill development, change of mindset and managing user resistance to become technology adequate: the author believes that user resistance to change is the key issue that has been experienced in most of the cases that could not fully utilise the information system. Involvement of potential users from the early days of system adoption and promotion of awareness of the value-add of digital movement will indeed support such a transition phase. Culture is another perspective to be considered: change readiness and employee motivation toward learning new skills. The technology enables personalization: providing personalisation serves users.**
- **Effective use of data & its analysis using AI & big data to provide customer insight & customer analytics.**
- **Technologies: adoption of digital tools and their integration. Cybersecurity is essential to be considered.**

The model demonstrated in the next figure concluded that the outcome of digital transformation is to provide new products, services, policies, markets, and environments as part of digital society (Morze and Strutynska, 2021).

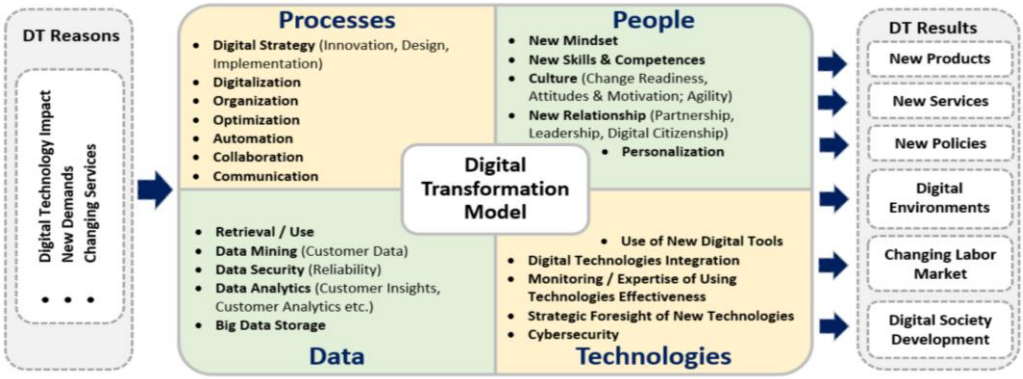

Figure 5: Digital Transformation Model; Source: (Kırmızı et al., 2022)

Moving to digital transformation does not ensure the success of the process without having tangible outcomes such as business process optimisation or further reduction. That is why measuring the maturity of the transformation process becomes more doable for that. The maturity model is an analytic tool to assess the existing level and provide a guiding tool to develop a roadmap for the anticipated one (Kırmızı et al., 2022).

Kırmızı and Kocaoglu (2022) advised a more comprehensive maturity model of digital transformation with several dimensions, as shown in the table below. Setting a strategy is essential for any ICT adoption, setting a digital vision and roadmap, planning for investment and setting measurable objectives. Management has a crucial role as well in managing the transformation process: top management participation, managing the transformation project, outsourcing consultancy service to succeed in the digital transformation project, strategic collaboration with digital leaders for know-how transfer, ensuring the human capacities are trained to be adequate with technological change, ensuring the government regulation facilitates the digital transformation process, and critical and sensitive data and information. The dimension of corporate culture is based on managing user resistance toward new system adoption by encouraging employees to try new practices, promoting team spirit toward common goals, and supporting creativity and innovation. Mid-level management is required as well. How to adopt a lean and productive process and an agile structure. Measuring the smartness of digital adoption is based on

cyber security and data analytics capabilities. The employee dimension focuses on soft skills and hard skills (IT), while the existing maturity models mainly refer to hard skills. The capability items in the smart process are to be flexible, automated and integrated vertically and horizontally. The last dimension is related to customer integration and how to create value for the end customer.

Table 2: Maturity Model of Digital Transformation; Source: (Kırmızı and Kocaoglu, 2022)

Dimension	Sub-Dimension	Capability Items	Operational Definition
Strategy & Governance	Strategy	S1.1-Digital vision & Roadmap	A digital vision and roadmap, which includes how the digital transformation is communicated, how the processes are carried out, and how the company structure looks after the transformation, is determined.
		S1.2-Investment planning	The project investment plan is prepared and prioritized to include internal and external digitalization projects.
		S1.3-Measurable objectives	Clear, comprehensible, and measurable goals are determined according to the vision, and communicated with stakeholders.
	Governance	S1.4-Top management participation	Top management eliminates bottlenecks at digitalization projects, motivates staff, and makes them believe in change.
		S1.5-Project Management	The assignment of the Chief Digital Officer (CDO) and the project team with technical and managerial abilities, the creation of project plans that include time, cost, scope, and the coordination of internal and external stakeholders administratively should be achieved with the project management philosophy.
		S1.6-Consultancy	The contribution of the consultancy services to success in digital transformation projects is important, and consultancy

Dimension	Sub-Dimension	Capability Items	Operational Definition
			services should be taken in different processes.
		S1.7-Strategic collaboration	To realize know-how transfer and increase project success by strategically collaborating with digital leaders that have achieved digital transformation success.
		S1.8-Corporate social responsibility	Companies take responsibility and act proactively in raising the future workforce.
		S1.9-Regulations	The companies should follow and abide by the regulations (tax, incentives, labor rights, etc.) related to the digitalization efforts.
		S1.10-Data & Information Sovereignty	The companies should ensure that internal and external partners protect the critical data and information, and legal measures are taken to protect the data sovereignty
Organization and Corporate Culture	Corporate Culture	S2.1-Experiencing the fault and risk	Employees are not afraid of trying new practices, taking measurable risks, and making mistakes. Therefore, the organization can tolerate employees making mistakes.
		S2.2-Being in the same boat	To have a business culture with a transparent and open communication culture, where employees can see themselves as a part of the whole, have a relationship of trust with their managers, work in a team towards a common goal.
		S2.3-Supportive in change	In an organization where employees trust and adopt digital transformation, their fears and concerns are eliminated, they do not resist change, and on the contrary, they embrace change.

Dimension	Sub-Dimension	Capability Items	Operational Definition
		S2.4-Open innovation	An organization where employees do not hesitate to declare, develop and experience innovative ideas internally and externally.
	Mid-Level Management	S2.5-Active support of mid-level managers	Mid-level managers embrace the digital vision, understand and effectively communicate the change, have a unified goal, actively engage in digitalization efforts.
		S2.6-Actions of mid-level managers	Mid-level managers follow best practices, examine the success/fail stories, communicate with employees, develop incentive systems for the motivation of employees, and follow digitalization activities within the unit they manage.
		S2.7-Required employee skill	Employee skills required for digitalization projects are determined.
		S2.8-Training	Determining, planning, and realizing the training needed by the in-house employees and SC partners for successful digitalization projects.
		S2.9-Decentralized decision-making	An organization where decisions on repetitive/programmable functions are carried out autonomously or decision-making power is delegated to become decentralized
	Organizational Structure	S2.10-Lean	Efforts to continuously improve and increase productivity, eliminate waste in processes, promote the employees' creativity, and embed lean thinking and lean leadership concepts in the organization.
		S2.11-Agile	Establishment of an organizational structure that is flexible and responsive to the fast-changing market dynamics, where the organization is purified from hierarchical silos, where the employees are appointed based on

Dimension	Sub-Dimension	Capability Items	Operational Definition
			their expertise, where employees are empowered.
Smartness	IT Cyber Security	S3.1-IT Cyber security	IT Cyber Security
		S3.2-IT Cyber security applications	System security is carried out by the company internally and ensured by SC partners to establish trust.
	Data Analytics	S3.3-Data collection	Data Analytics
		S3.4-Data analytics	It is aimed to propose the highest value to the customer by analyzing the collected data in real-time utilizing technological tools such as Al, ML, cloud computing, big data processing etc., for better decision-making and optimizing processes.
		S3.5-Data analytics team	The company's vision is to see the dedicated data analytics team as a strategic asset to perform data analysis in-house.
		S3.6-Decentralized data Analytics	The ability to analyze the data using smart sensors or CPS with its own microprocessors and control manufacturing or business processes by making autonomous decisions with the generated information.
		S3.7-Data management	Combining data sources in a scalable, autonomous, and central database system within a data management plan and strategy.
Employee	Talented Employee	S4.1-Talented Employee	Talented Employee
		S4.2-Self-earming for digital knowledge	Employees have a self-training plan, self-develop in digital literacy, follow recent technological innovations, and have sufficient IT technology knowledge.

Dimension	Sub-Dimension	Capability Items	Operational Definition
		S4.3-Digital collaboration	The ability of employees to cooperate and collaborate, take a participatory approach innovative processes, share knowledge, and work as a team.
		S4.4-Technology acceptance	Employees believe that the company benefits from digital technologies, which increase their performance. Besides, digital technologies are user-friendly and easy to use.
		S4.5-Skilled IT team	The skilled IT team is a strategic asset for successfully executing digitalization projects.
Processes	Smart Processes	S5.I-Smart Processes	Smart Processes
		S5.2-Process flexibility	The flexibility of operations, processes, and business functions enable companies to respond to the fast-changing market environment and provides strategic superiority and competitiveness.
		S5.3-Process automation	The ability to automate repeatable processes to accelerate and standardize daily tasks and prevent User-induced errors by utilizing digital tools such as Al, ML, etc.
		S5.4-Horizontal &Vertical Integration	Business functions, processes, and operations are digitally integrated within the company (vertical) and across supply chain stakeholders (horizontal).
Customer	Customer Integration and Value	S6.1-Customer Integration	Customer Integration and Value
		S6.2-Digital value proposition	The ability to propose added value and create a digital revenue stream by including complementary digital products and services to existing ones.

The degree of maturity should be defined as well to give a clear map for businesses to move forward with digitisation. The level of maturity of digital transformation was defined by five maturity levels as follows (Kırmızı et al., 2022):

- **Level-1, Awareness, aims to promote awareness across the organisation of what will be the exact process of digital transformation. For instance, early awareness of Industry 4.0 pre-adoption makes users ready for innovative technologies.**
- **Level-2 pilots practise the digital transformation by having an experimental application. It can be considered as proof of concept toward the need for digitalisation and indicators to shift to the larger investment.**
- **Level-3, Engagement: the digitalisation projects are to be undertaken using experience, knowledge and pilot trials.**
- **Level-4, Supply Chain Integration, network integration using digital tools to integrate the business partners.**
- **Level 5, Optimisation, is the mature level where the organisation adopts digitalisation, integrates business functions into digital processes and optimises processes.**

Organisational readiness toward the transformation process differs; that's why different businesses will be disrupted by digital transformation in regard to their level of readiness. Studies propose pillars to positively applying ICT edges (Lalic and Marjanovic, 2011):

Leadership: **the management should set vision and objectives that lead the business to adopt ICT smoothly. The management should comprehend how to manage the transition and promote that culture across the organisation. The management should empower the business to use ICT as a strategic asset. Without strong leadership skills, organisational readiness will be defective, and business will not be able to run a smooth transition.**

Governance: **is the functioning structure of business, including its power, responsibilities, and liabilities; systematizes and launches an effective operational model to organize, fund, and implement IT initiatives; Organizations with high organizational readiness should have a new governance that embed flexible models. They will not depend on non-flexible hierarchies and bureaucratic procedures.**

Competencies: **It addresses the market need; it defines which capabilities are needed to compete with strong competencies and react to customer**

needs and manage transition automatically. Strong competencies within organisations led to having a competitive advantage and customer value.

Technology: **Success with IT requires a strong enterprise technological structure platform that facilitates external integration and implementing the new system. The platform should ensure security, standardisation, flexibility, scalability, and reliability. This makes it easier for employees to collaborate and develop new capabilities.**

The organisational readiness improvement plan proposed by Young & Jude (2008) gives a roadmap to develop an enhancement plan: Examine the results, list the weaknesses for each pillar, discuss the solutions and other actions that might be taken to address issues, and create a plan: develop a diminutive readiness plan to manage the weakness points.

As reflection remarks on the comprehensive model of digital transformation, the proposed models incorporate the process of transformation and should be more orientated to the industrial sector adopted too. The applied applications and technologies will differ from sector to sector based on their benefits there. Moreover, it is deeply reflected in the organisation's size and its capabilities. Having a generic framework for adoption is not applicable in any context. The industrial sector, size of the organisation, in addition to paying consideration to country context (developed or developing countries)

The digital transformation models and framework should emphasise as well the emergence of organisational readiness and its impact on having a smooth transition toward a digitised platform. The digital platform status of being well-connected in terms of interconnectivity, cooperation tools and regulations. It is expected to have a large organization ready in term of digital platform and financial resources to cope with the transformation. SMEs will be flexible to cope with radical changes in terms of size and ability of rapidly shifting its business models online channels (Kamel, (2021).

Since seventy eight percent of businesses failed in digital transformation initiatives (Everest Survey), the reasons behind such an unsuccessful roadmap toward digitisation should be addressed in-depth with further studies. The disruption of transformation projects is referred to as unmaintainable benefits, inadequate user acceptance and abandoned projects (Everest Survey). The common issue behind digital transformation disruption/failure case are ranged from: Absence of employee engagement, insufficient management support, Poor cross-functional collaboration, Absence of liability, Security concerns,

financial restrictions, limited technical expertise, regulatory changes to improper digital culture. Such reasons should be investigated and addressed with further researches to have a proper roadmap that manage the digital transformation of business.

Focusing on developing countries' context, the main obstacle of digital transformation impacting economic growth in such countries is the digital divide (Kamel, 2021): how to manage the digital divide issue to clear the social inequality gaps. The digital divide is the inequality in having internet accessibility and access to ICT. The statistics reflect that, according to the Internet portal World Stats 2021, only 43.1% of Africa's inhabitants had Internet Access, compared to 88.4% of Europeans and 93.4% of Americans. Since the internet penetration rate of the Middle East is around 76.4% then further research should tackle that issue to ensure a smooth transformation in such countries.

7 Key Findings

The conducted comprehensive literature review deduced the following key findings on digital transformation:

The key factors driving DT are still technological advancements, as the emergence of big data analytics, cloud computing, artificial intelligence, and the Internet of Things (IoT) greatly accelerates efforts at digital transformation. Additionally, customer demands and shifting consumer behaviour, along with the need for personalised service, force businesses to implement digital solutions in order to enhance the customer experience.

These are some of the major pillars to digital transformation. Employee reluctance to embracing new technology is a common one of cultural resistance in organisations. Additionally, there are skill gaps since there are no professionals with the necessary digital skills to prevent digital efforts from being implemented successfully. Another issue is financial constraints because organisations, especially SMEs, are discouraged from pursuing digital projects due to the high cost of digital transformation technology and infrastructure.

Various frameworks have emerged highlighting the strategic actions to address disruptions caused by digital technologies and emphasizing contextual conditions, mechanisms, and implications of digital transformation and identifying pillars like people, technology, processes, and utilization of data as most important to transformation success.

The study suggests that though there are numerous benefits of digital transformation, organizational readiness is the success factor for digital transformation. Organizations must accord proper significance to cultural transformation, talent creation, and strategic investment in technology to resolve the challenges of digital transformation effectively.

The intricacy of digital transformation and the necessity for organisations to take a methodical approach to navigating this process are highlighted by this thorough literature study. Future studies should address the digital gap in emerging economies, create industry-specific frameworks, and investigate how the digital transformation affects labour markets and organisational structures.

8 Conclusion & Future Research

Technological revolution gives the motive for businesses to shift digitally regardless of industry, size, or geographical location. It is a value-add to the economic growth by every means: job offering, human capital development, and inequality reduction. Currently, digital transformation is a challenging operation for government and private sector businesses to cope with technological change. Having a clear roadmap of the digital transformation plan emerges with a focus on many perspectives: human capacities, adequate technical skills, capacity building, policies and regulations, reliable IT infrastructure, and implementing an integrated ERP system. The existing literature lacks a holistic and modular framework that mandatory pillars of ensuing a smooth transformation toward digital transformation

Further studies are urged to tackle:

- **Clear roadmap of digitisation in the developing-country context.**
- **Discuss how to implement the digital transformation with the existence of the digital divide in the context of developing countries.**
- **Propose a maturity model, provide an industry-related one, and measure its maturity level.**
- **Emerge the organisational readiness on the track to tackle the failure cases of digital transformation.**
- **Guide for the policymakers when building their own digital transformation-based models**
- **Recent technologies roles such as collaborative commerce, the Internet of Things, big data analytics, social media data analytics, blockchain and smart sensors.**
- **Technical challenges during the digital transformation process, such as cybersecurity and big data analytics.**

- **Digital transformation challenges for SMEs, especially in developing countries.**
- **Adoption of digitalisation and the implications on labour productivity and performance.**
- **Developing a nationwide strategy for digital transformation to address the digitalisation of public services.**

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