THE ROLE OF AI AND STRATEGIC MANAGEMENT IN THE SUSTAINABLE DIGITAL TRANSFORMATION OF THE IRANIAN TELECOMMUNICATIONS INDUSTRY

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Dedication

This dissertation is dedicated to my family, whose unwavering support, patience, and belief in me made this journey possible.

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ABSTRACT

THE ROLE OF AI AND STRATEGIC MANAGEMENT IN THE SUSTAINABLE DIGITAL TRANSFORMATION OF THE IRANIAN TELECOMMUNICATIONS INDUSTRY

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According to the increase in the part of data and income of machinists, the telecommunications manufacturing has knowledgeable quick changes at the global level. While the mobile and mobile broadband development indicators in Iran are still lower than in many other parts of the world, they have shown signs of significant growth in recent years and have created great opportunities for newcomers and opportunists. Iran, as one of the largest markets in the Middle East, by implementing global technologies and improving the domestic situation, has great potential to increase the share of information and communication technology in the GDP and may enter an important digital transformation soon. Addressing the role of artificial intelligence and strategic management in the sustainable DT of Iran's telecommunications industry is very vital. This industry is very important in Iran because the use of artificial intelligence technology in Iran's telecommunications industry has advantages that can help improve various functions in this industry, including improving service quality, optimizing processes, predicting customer needs, and increasing Efficiency. Considering the high dynamism of the telecommunications industry and the need to quickly respond to market and technology developments, correct strategic management can help create appropriate strategies and

their efficient implementation. Paying attention to the forward trend of digital transformation and sustainability in the telecommunications industry, the use of new technologies to better manage resources, reduce costs, and increase the speed and quality of services is expected. Therefore, focusing on the task of artificial intelligence and strategic management in the sustainable DT of Iran's telecommunications industry can help improve the performance and competitiveness of this industry at the national and international levels. This exploratory study was developed in Swiss School of Business and Management with the primary goal of pinpointing evaluates the simultaneous effect of artificial intelligence and strategic management for sustainable digital transformation for Iranian Telecommunication companies.

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CHAPTER I:

INTRODUCTION

1.1 Introduction

In recent years, the telecommunications industry has undergone a profound transformation driven by rapid technological breakthroughs, particularly in the field of artificial intelligence. As the world grows more interconnected, the demand for efficient, dependable, and sustainable telecommunications services has never been higher. In Iran, the telecommunications sector plays a pivotal role in the nation's economic development and social progress. However, the industry faces numerous challenges, including regulatory constraints, infrastructural limitations, and the need for innovative solutions to address the evolving needs of consumers and businesses alike.

It is becoming clear that the primary force behind the pervasive change in the environment is digital transformation. The communications industry is at the center of this upheaval, both as an industry undergoing significant market changes and as a major driver of global digitization. Digital transformation within an organization cannot be achieved just by the use of technology and information technology advancements, since digital transformation is more akin to a strategy (Aghayari, Valmohammadi and Alborzi, 2023). The company's strategy has all been impacted by the digital transition. It had specifically impacted the two aspects of content and method. Additionally, every tactic at every stage was susceptible to several modifications (Gharib, 2019).

Recently, the term "digital transformation" has been recognized as a keyword in the field of strategic information systems research. According to experts, digital transformation is defined as the use of digital technology and its deep impact on society and industry (Gharib, 2019). At the organizational level, companies are trying to create strategies that bring high-efficiency operational performance by taking advantage of innovative solutions based on digital technology (Younus, 2022).

Digital transformation is a new phenomenon with many features that requires more studies to better understand its features and capabilities to help organizations improve their work performance and compete in the digital market at the lowest cost. Digital transformation is defined as a process of change, improvement and development in the characteristics of an organization that occurs through the use of systems, tools and methods of communication technology and helps to discover new ideas and products (Kraus *et al.*, 2021).

The volume of data stored in systems has increased as a result of the digital transformation techniques represented in systems and mobile devices, Physical Cyber Systems (CPS), Cloud Computing, Augmented and Virtual Reality, Artificial Intelligence (AI), Simulation, Internet of Things (IoT), Industrial Internet, Autonomous and Collaborative Robots, Smart Sensors, and many other technologies. Digital transformation is the concept used to describe the start of Industry 4.0 (Al-Alwan *et al.*, 2022).

Communication service providers face profound challenges as they are forced to transform from traditional communication service providers, such as voice and SMS, to digital providers, such as music, mobile TV, cloud services, IoT (Valdez-de-Leon, 2016). Communication service providers need to digitize the way they serve their customers, as this transformation affects not only customer relationships but also internal processes and company values (Valdez-de-Leon, 2016). Some factors are identified as key drivers for digital transformation, which include, High Tech, where everything is connected to the Internet or digitized; for example, smart vehicles and the use of electronic money (Egala *et al.*, 2024). Emergence of new companies that provide digital services and use communication infrastructures such as mobile networks and account for most of the production value; For example, Spotify and WhatsApp. Change in customer expectations towards a life that is always connected, personal and with digital services. The expansion of traditional communication services in the form of goods and as a result the reduction of income or obvious recession. Due to the complexity, variety, and volume of the data, the artificial intelligence is inevitable in this process (Brockhaus, Buhmann and Zerfass, 2023).

Digitalization and sustainability are two market features with important implications for the industrial environment. Numerous studies have examined how these two influences affect firms, managerial practices, and society at large. Nevertheless, research investigations have mostly ignored the intersection of these two phenomena.

The challenge of adopting digital transformation as a new strategic paradigm is one that modern organizations and enterprises are addressing. To survive in the complex and dynamic environment, organizations need new approaches to develop organizational strategy. These approaches can lead to sustainability and balanced performance of organizations. Today, two fundamental factors are explored in the industrial world: digitalization and sustainability. How these factors affect the performance of organizations, businesses and societies around the world has been widely investigated (Aghayari, Valmohammadi and Alborzi, 2023).

Today's global connectivity allows people to access all their business and social activities; from instant messaging to global currency transactions. In order to have an effective digital transformation plan, businesses must have a correct understanding of the digital strategy and operational model, and in the face of the day-to-day changes of the digital world, they must be accompanied by active competition in the digital market instead of a passive approach. In recent years, powerful factors such as technical capabilities, legal requirements, demographic and economic developments have significantly influenced business models (Aghayari, Valmohammadi and Alborzi, 2023).

According to the increase in the share of data and revenue of operators, the telecommunications industry has experienced rapid changes at the global level. While the mobile and mobile broadband development indicators in Iran are still lower than in many other parts of the world, they have shown signs of significant growth in recent years and have created great opportunities for newcomers and opportunists. Iran, as one of the largest markets in the Middle East, by implementing global technologies and improving the domestic situation, has a great potential to increase the share of information and communication technology in the GDP and may enter an important digital transformation in the near future. In the past, Iran was far behind the world's latest technology, but today,

looking at digital technologies, this gap has been reduced to the first level of the world to a great extent. According to statistics published in 2025, Figure 1.1 (Petrosyan, 2025), the Internet penetration rate in the world was 67.9%, while in Iran this rate was about 13.2% (معاونت توسعه و مدیریت منابع, 1403 and دفتر برنامه ریزی، بودجه و کنترل برنامه ها).

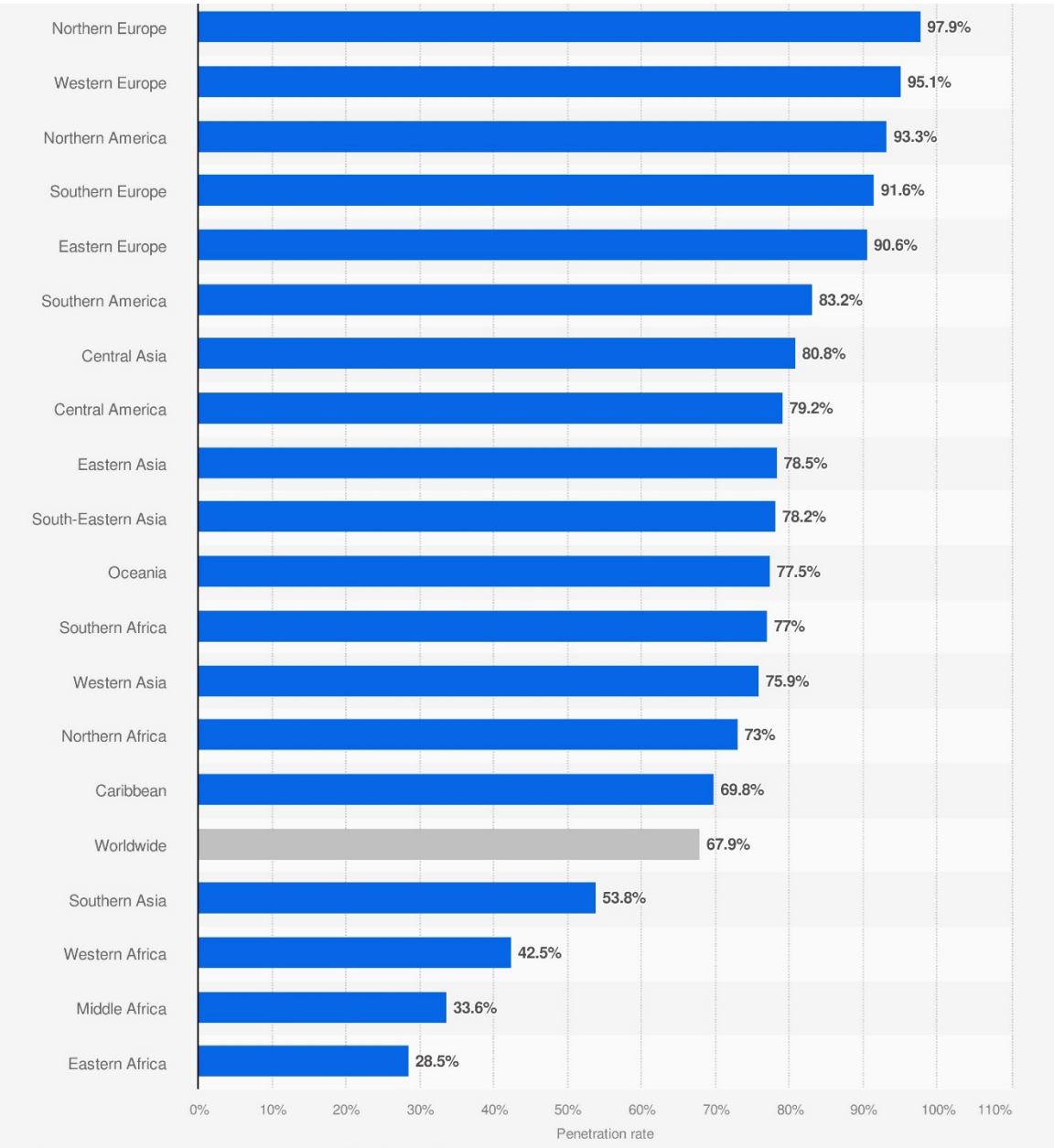

Figure 1.1
Global Internet Penetration Rate as of February 2025, by Region

Based on the above mentioned, addressing the role of AI and strategic management in the sustainable digital transformation of Iran's telecommunications industry is very vital. This industry is very important in Iran because the use of artificial intelligence technology in Iran's telecommunications industry has advantages that can help improve various functions in this industry, including improving service quality, optimizing processes, predicting customer needs and increasing Efficiency. In addition, strategic management is also very impressive in sustainable digital transformation.

Considering the high dynamism of the telecommunications industry and the need to quickly respond to market and technology developments, correct strategic management can help create appropriate strategies and their efficient implementation. Paying attention to the forward trend of digital transformation and sustainability in the telecommunications industry, the use of new technologies in order to better manage resources, reduce costs, and increase the speed and quality of services is expected. Therefore, focusing on the role of artificial intelligence and strategic management in the sustainable digital transformation of Iran's telecommunications industry can help improve the performance and competitiveness of this industry at the national and international levels.

According to those mentioned above, the research area concentrates on the intersection of AI, strategic management, and sustainable digital transformation within the Iranian telecommunications industry. The study explores how AI technologies can be strategically employed to drive sustainable digital transformation initiatives in the telecommunications sector in Iran. The motivation behind this research stems from the increasing significance of AI and strategic management in shaping the digital transformation landscape of the Iranian telecommunications industry.

As advancements in AI continue to revolutionize business operations and customer experiences, understanding the role of AI in driving sustainable transformation becomes crucial for the industry's growth and competitiveness. Moreover, strategic management practices play a pivotal role in guiding organizations through the complexities of digital transformation, ensuring alignment with business objectives, and fostering sustainable outcomes. By investigating the synergy between AI technologies, strategic management

principles, and sustainability goals within the Iranian telecommunications sector, the research aims to provide valuable insights for industry stakeholders, policymakers, and researchers. Therefore, the research on the role of AI and strategic management in the sustainable digital transformation of the Iranian telecommunications industry holds significant importance for several reasons:

Enhancing Competitiveness: By leveraging AI technologies strategically and aligning them with sustainable practices, telecommunications companies in Iran can enhance their competitiveness, innovate their services, and meet the evolving needs of customers effectively.

Driving Innovation: Understanding how AI can be integrated into strategic management processes can catalyze innovation within the industry, leading to the development of novel business models, products, and services that drive sustainable growth.

Ensuring Sustainability: Sustainable digital transformation is essential for long-term success and resilience in the telecommunications sector. By exploring the role of AI and strategic management in promoting sustainability, the research can help organizations in Iran navigate challenges and capitalize on opportunities in a rapidly evolving digital landscape.

Informing Policy and Decision-Making: Findings from this research can inform policy decisions, investment strategies, and operational practices within the Iranian telecommunications industry, guiding stakeholders towards more sustainable and future-ready approaches to digital transformation.

Overall, the research on the role of AI and strategic management in the sustainable digital transformation of the Iranian telecommunications industry has the potential to shape the industry's trajectory, foster innovation, and drive positive socio-economic impacts in the region. This thesis explores the critical intersection of AI and strategic management in facilitating sustainable digital transformation within the Iranian telecommunications industry. By leveraging AI technologies, organizations can enhance operational efficiency, improve customer experiences, and foster innovation. Strategic management, on the other

hand, provides a framework for aligning organizational goals with the dynamic landscape of the telecommunications market, ensuring that companies can navigate challenges and seize opportunities effectively. The integration of AI into strategic management practices is essential for driving sustainable digital transformation. This research aims to investigate how Iranian telecommunications companies can harness AI to develop and implement strategies that promote sustainability, enhance competitive advantage, and contribute to the overall growth of the industry. Through a comprehensive analysis of existing literature, case studies, and empirical data, this thesis will provide valuable insights into the role of AI and strategic management in shaping a sustainable future for the telecommunications sector in Iran. As the industry continues to evolve, understanding the synergies between AI and strategic management will be crucial for stakeholders seeking to foster innovation and sustainability. This thesis will contribute to the existing body of knowledge by offering a nuanced perspective on the transformative potential of AI in the context of strategic management, ultimately aiming to provide a roadmap for the sustainable digital transformation of the Iranian telecommunications industry.

1.2 Research Problem

The Iranian telecommunications industry faces a critical need to effectively integrate artificial intelligence (AI) technologies and strategic management practices to drive sustainable digital transformation. Despite the increasing global emphasis on AI and strategic leadership, the Iranian telecom sector lacks a comprehensive framework that aligns these advancements with sustainability goals. Although AI and strategic management are widely recognized as key enablers of transformation, their synergistic application within Iran's specific regulatory, economic, and technological context remains underexplored. Key issues that need to be addressed include:

1. Identifying optimal strategies for integrating AI into existing business frameworks that reflect local realities.
2. Developing sustainable digital transformation roadmaps that align with both industry regulations and environmental considerations;

3. Establishing governance mechanisms that ensure ethical AI deployment and strategic alignment with long-term sustainability goals.

Addressing these gaps is critical to ensure that digital transformation efforts do not merely result in technological upgrades, but also foster long-term socio-economic and environmental benefits. By exploring the role of AI and strategic management in sustainable digital transformation, this research aims to provide actionable insights and recommendations for industry stakeholders, policymakers, and researchers to navigate the complexities of digital innovation while fostering sustainability in the Iranian telecommunications landscape.

Integrating AI technologies into strategic management practices can optimize operational processes, automate tasks, and improve decision-making, leading to increased efficiency and productivity within the Iranian telecommunications sector. In addition, leveraging AI strategically can help telecommunications companies in Iran gain a competitive edge by offering personalized services, enhancing customer experiences, and differentiating themselves in a crowded market.

Furthermore, the synergy between AI and strategic management fosters innovation in service offerings, business models, and technological advancements, enabling Iranian telecom firms to stay at the forefront of digital transformation trends. By incorporating sustainability considerations into digital transformation strategies, the industry can reduce its environmental footprint, promote responsible practices, and contribute to long-term socio-economic development in Iran.

Strategic management frameworks coupled with AI solutions can assist Iranian telecom companies in navigating regulatory complexities, and ensuring compliance with industry regulations, data privacy laws, and ethical standards. AI-driven insights enable telecom operators in Iran to better understand customer needs, tailor services, and enhance overall customer satisfaction, fostering long-term relationships and loyalty. Strategic management practices coupled with AI tools can help identify and mitigate risks associated with digital transformation initiatives, ensuring a more robust and resilient operational environment for Iranian telecom organizations.

By recognizing and responding to these opportunities and challenges, Iranian telecommunications companies can position themselves for future growth, adaptability to technological advancements, and alignment with evolving consumer preferences in an increasingly digital world. Thus, AI and strategic management are not only tools for operational improvement, but also essential levers for sustainable transformation and national digital competitiveness.

The existing literature on the role of AI and strategic management in the sustainable digital transformation of the Iranian telecommunications industry exhibits several notable research gaps that warrant further investigation:

1. While studies on AI, strategic management, and digital transformation abound globally, there is a scarcity of research specifically addressing the Iranian telecommunications sector. The unique socio-economic, regulatory, and technological landscape of Iran necessitates tailored insights and strategies that consider local nuances and challenges.
2. Many studies explore AI and strategic management in digital transformation but overlook the crucial aspect of sustainability. The intersection of AI, strategic management, and sustainability in the Iranian telecommunications industry remains underexplored, highlighting a gap in understanding how these elements can be harmonized to drive environmentally and socially responsible transformation.
3. Existing research often lacks comprehensive frameworks or models that guide the effective integration of AI and strategic management for sustainable digital transformation in the Iranian context. A gap exists in the development of structured approaches that account for ethical considerations, regulatory constraints, and long-term sustainability goals in the industry.
4. The ethical implications of AI deployment within the Iranian telecommunications sector have not been extensively studied. Research gaps exist in understanding how ethical principles can be embedded into strategic decision-making processes concerning AI implementation, data privacy, algorithmic bias, and customer trust in the digital transformation journey.

Addressing these research gaps through empirical studies, case analyses, and theoretical frameworks can significantly contribute to both academic knowledge and practical applications. Closing these gaps will not only enrich academic discourse but also provide practical insights to industry practitioners and policymakers trying to navigate the complexities of digital innovation with a focus on sustainability.

1.3 Purpose of Research

The current study aims to contribute valuable knowledge, inform strategic decision-making, and catalyze positive change toward sustainable digital transformation in the Iranian telecommunications industry, positioning it for competitive advantage, innovation, and resilience in the digital age. According to above mentioned, the main benefits of current research are as follows:

1. The research can provide valuable strategic insights for telecom industry leaders in Iran, offering guidance on integrating AI technologies effectively within existing management frameworks to drive sustainable digital transformation.
2. Findings from the research can help Iranian telecom companies gain a competitive advantage by leveraging AI strategically, fostering innovation, and enhancing operational efficiency in alignment with sustainability goals.
3. The research can inform policymakers and regulatory bodies in Iran on best practices for promoting sustainable digital transformation in the telecommunications sector, contributing to the development of supportive policies and frameworks.
4. Industry stakeholders, including telecom operators, technology providers, and investors, can benefit from the research by gaining a better understanding of the role of AI and strategic management in achieving sustainable transformation outcomes.
5. The research contributes to the advancement of knowledge in the intersection of AI, strategic management, and sustainability within the Iranian context, filling a critical gap in the existing literature and expanding academic discourse in the field.

6. Implementing insights from the research can help Iranian telecom firms streamline operations, optimize resource allocation, and enhance decision-making processes through the adoption of AI-driven strategies aligned with sustainability objectives.
7. By focusing on sustainable digital transformation, telecom companies in Iran can improve customer experiences, tailor services to meet evolving needs, and build stronger relationships with their customer base, leading to increased satisfaction and loyalty.
8. The research can shed light on how AI and strategic management practices can be harnessed to reduce the environmental footprint of the telecommunications industry in Iran, promoting eco-friendly operations and contributing to sustainability efforts.
9. Insights from the research can help Iranian telecom organizations build resilience against future challenges, adapt to technological disruptions, and proactively address sustainability concerns about maintaining long-term viability and success in a rapidly evolving digital landscape.
10. The research findings can facilitate meaningful dialogue and collaboration among stakeholders in the Iranian telecommunications industry, fostering partnerships, knowledge sharing, and collective action towards the sustainable digital transformation goal.

1.4 Significance of the Study

Current study holds significant importance in several key areas. For example, by exploring the integration of AI and strategic management in the digital transformation of the Iranian telecommunications industry, the study can shed light on how these technologies can enhance operational efficiency, streamline processes, and optimize resource allocation. Understanding the role of AI and strategic management in sustainable digital transformation can provide insights into how Iranian telecommunications companies can gain a competitive edge in the rapidly evolving digital landscape, allowing them to successfully respond to market developments and client needs. The current study can highlight how AI technologies and strategic management practices can drive innovation within the Iranian telecommunications sector, fostering growth, and promoting

growth and allowing businesses to keep on top of technological improvements. By focusing on sustainable digital transformation, the study can address environmental concerns, resource optimization, and long-term viability within the Iranian telecommunications industry. It can explore how AI and strategic management can contribute to sustainable practices and reduce the industry's carbon footprint. The findings of the study can have implications for policymakers, industry stakeholders, and decision-makers in shaping regulations, investments, and strategies related to AI adoption and digital transformation in the Iranian telecommunications sector. Overall, this study has the potential to provide valuable insights into the transformative impact of AI and strategic management on the sustainable development and growth of the Iranian telecommunications industry, paving the way for informed decision-making and strategic planning in this dynamic sector.

The significance of this study lies in its potential to illuminate the critical role that artificial intelligence (AI) and strategic management play in the sustainable digital transformation of the Iranian telecommunications industry. As one of the important sectors driving economic growth and technological advancement in Iran, telecommunications is at a pivotal juncture where the integration of innovative technologies and strategic frameworks can significantly enhance its sustainability and competitiveness.

Addressing Industry Challenges: The Iranian telecommunications industry faces numerous challenges, including regulatory hurdles, infrastructural deficiencies, and the need for modernization. This study aims to provide insights into how AI can be leveraged to address these challenges, thereby contributing to the industry's resilience and adaptability in a rapidly changing environment.

Promoting Sustainable Practices: In an era where sustainability is crucial, this research emphasizes the importance of integrating sustainable practices within the telecommunications sector. By exploring the synergies between AI and strategic management, the study seeks to identify pathways for companies to adopt environmentally friendly practices, reduce their carbon footprint, and enhance their social responsibility.

Enhancing Competitive Advantage: The findings of this study will offer valuable strategies for telecommunications companies to gain a competitive edge in the market. By

understanding how AI can optimize operations, improve customer experiences, and drive innovation, organizations can position themselves as leaders in the industry, fostering long-term growth and profitability.

Contributing to Academic Knowledge: This research contributes to the existing body of literature on digital transformation, AI, and strategic management by focusing specifically on the Iranian context. It will provide a framework for future studies and serve as a reference point for scholars and practitioners interested in the intersection of technology and management in emerging markets.

Guiding Policy and Decision-Making: The insights derived from this study can inform policymakers and industry leaders about the transformative potential of AI in telecommunications. By highlighting best practices and successful case studies, the research can guide decision-making processes, encouraging the adoption of policies that support innovation and sustainability in the sector.

Fostering Collaboration and Knowledge Sharing: The study aims to promote collaboration among stakeholders, including government agencies, telecommunications companies, and academic institutions. By fostering a dialogue around the role of AI and strategic management, the research can facilitate knowledge sharing and partnerships that drive sustainable development in the telecommunications industry.

In summary, this study is significant not only for its academic contributions but also for its practical implications for the Iranian telecommunications industry. By exploring the interplay between AI and strategic management, the research aims to provide actionable insights that can lead to a more sustainable, innovative, and competitive telecommunications sector in Iran.

1.5 Research Questions and Objectives

The primary aim of this research is to examine the interplay between artificial intelligence (AI) technologies and strategic management in driving sustainable digital transformation in Iran’s telecommunications industry. As technological innovation accelerates, telecom companies face increasing pressure to adopt AI in ways that support long-term strategic and sustainability goals. This study explores how AI can be effectively

integrated into strategic frameworks to boost efficiency, drive innovation, and address ethical, regulatory, and environmental challenges. The findings aim to provide actionable insights for industry leaders, policymakers, and researchers navigating sustainable transformation in this sector.

The main questions of the current research are:

(RQ1): How the synergistic relationship between AI technologies and strategic management practices can be investigated and analyzed in the creation of sustainable digital transformation in Iran's telecommunications industry?

(RQ2): How do the environmental, social and economic effects of deploying artificial intelligence to make strategic management decisions affect the sustainable development of Iran's telecommunications industry?

(RQ3): How AI and strategic management principles can be adjusted to guide sustainable digital transformation strategies in Iranian telecommunications organizations with an emphasis on ethical considerations and regulatory compliance?

The primary objective of current research is to investigate and analyze the synergistic relationship between artificial intelligence (AI) technologies and strategic management practices in driving sustainable digital transformation within the Iranian telecommunications industry. Specifically, the research aims to achieve the following sub objectives:

(O1): Conducts a comprehensive assessment of the current state of AI adoption, strategic management practices, and sustainability initiatives within the Iranian telecommunications sector to understand existing challenges and opportunities.

(O2): Investigates how AI technologies, including natural language processing, machine learning, and predictive analytics, can be strategically utilized to enhance operational efficiency, customer experiences, and innovation in the industry.

(O3): Analyzes different strategic management frameworks and methodologies employed by Iranian telecom companies to guide digital transformation initiatives, identify best practices, and assess their alignment with sustainability goals.

(O4): Evaluates the environmental, social, and economic impacts of AI deployment and strategic management decisions on the sustainable development of the Iranian telecommunications industry, considering factors such as energy consumption, carbon footprint, and social responsibility.

(O5): Proposes integrated frameworks and models that outline how AI and strategic management principles can be harmonized to drive sustainable digital transformation strategies in Iranian telecom organizations, emphasizing ethical considerations and regulatory compliance.

(O6): Offers practical recommendations and actionable insights for industry stakeholders, policymakers, and researchers in Iran to navigate the complexities of digital innovation, foster sustainability practices, and achieve long-term success in the rapidly evolving telecommunications landscape.

1.6 Research Hypothesis

The following hypotheses are considered to examine the relationships between artificial intelligence, strategic management practices, and sustainable digital transformation within the Iranian telecommunications industry.

Hypothesis 1 (H1): There is a significant positive relationship between the integration of artificial intelligence technologies and the sustainable digital transformation of the Iranian telecommunications industry.

Hypothesis 2 (H2): Strategic management practices positively moderate the impact of AI technologies on sustainable digital transformation outcomes in the Iranian telecommunications sector.

Hypothesis 3 (H3): Higher alignment between AI implementation and sustainability goals (economic, social, and environmental) leads to greater organizational performance and innovation in Iran's telecom industry.

CHAPTER II:

REVIEW OF LITERATURE

2.1 Introduction

This chapter establishes the theoretical and conceptual groundwork for the research, focusing on the interplay of artificial intelligence (AI), strategic management, digital transformation, and sustainability within the context of Iran's telecommunications industry. It provides a comprehensive examination of these core concepts, exploring their definitions, significance, and applications to lay a robust foundation for the study. The chapter is structured into two primary sections: the theoretical background, which delves into the principles and features of digitalization, digital transformation, AI, and sustainability, and the theoretical framework, which integrates key theories to guide the analysis. Additionally, a review of prior research is presented to highlight existing knowledge and identify critical research gaps, positioning this study to contribute meaningfully to the field. By synthesizing these elements, the chapter aims to clarify how AI-driven strategies and sustainable practices can drive digital transformation in Iran’s telecommunications sector, addressing opportunities and challenges in a rapidly evolving technological and regulatory landscape.

2.2 Theoretical Framework

This section outlines the key theoretical foundations that guide the analysis of how artificial intelligence (AI) and strategic management contribute to sustainable digital transformation in the Iranian telecommunications sector. Given the interdisciplinary nature of the topic, this research integrates theories from innovation adoption, strategic capabilities, and sustainability management. The selected theories, Technology Acceptance Model (TAM), Resource-Based View (RBV), Dynamic Capabilities Theory, and Triple Bottom Line (TBL), offer a strong conceptual lens for understanding the technological, managerial, and sustainability aspects of digital transformation.

2.2.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), which was developed by Davis (1989), is a foundational theory for understanding user adoption of new technologies. It proposes that two primary factors**,** Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)**,** determine whether individuals will accept and use a new technology (Davis, 1989).

In the context of Iranian telecommunications, TAM helps explain how organizational actors, including managers, employees, and technical staff, adopt AI-driven tools. Since AI technologies such as predictive analytics or intelligent automation are central to this research, TAM allows us to investigate how these tools are perceived and accepted by users, and how their acceptance influences the success of strategic management initiatives aimed at digital transformation.

2.2.2 Resource-Based View (RBV)

The Resource-Based View posits that firms achieve sustainable competitive advantage by using valuable, rare, inimitable, and non-substitutable (VRIN) resources. In the context of AI, digital capabilities, such as machine learning, data analytics, and automation, are strategic assets that telecom firms can utilize to drive efficiency, customer engagement, and innovation. Strategic management enables the alignment of these resources with long-term business goals.

AI technologies serve as strategic resources, and when embedded within effective management practices, they help telecom companies create difficult-to-imitate digital capabilities. For Iran, where localized innovation and resilience are critical, RBV underscores the need to build and safeguard internal technological competencies (Barney, 1991).

2.2.3 Dynamic Capabilities Theory

The Dynamic Capabilities framework, introduced by Teece, Pisano, and Shuen (1997), refers to a firm’s ability to integrate, build, and reconfigure internal and external competencies to respond to rapidly changing environments (Teece, Pisano and Shuen, 1997).

Telecommunications companies in Iran operate in a fast-evolving environment marked by regulatory constraints, technological disruption, and growing demand for sustainable practices. The dynamic capabilities approach offers a strategic lens to assess how these companies adapt and evolve by incorporating AI into their core operations. It also supports the study of how strategic management practices enable agility, innovation, and transformation during digital transitions.

2.2.4 Triple Bottom Line (TBL) Theory

Proposed by Elkington (1997), the Triple Bottom Line framework evaluates organizational performance across three interdependent dimensions: economic viability, environmental stewardship, and social responsibility (Elkington and Rowlands, 1999).

This theory is central to the "sustainability" dimension of the thesis. It allows for an assessment of how AI technologies and strategic management contribute not only to operational and economic efficiency but also to environmental and social sustainability. For Iranian telecom firms, TBL provides the evaluative framework to measure the impact of digital transformation initiatives on broader societal and environmental goals.

Together, these theories align with the research objectives, which aim to investigate how AI and strategic management can be harmonized to enable sustainable, adaptive, and widely accepted digital transformation in Iran's telecommunications industry.

2.3 Background and Literature Review

This section outlines and critically examines some of the most pivotal concepts and theoretical foundations pertinent to this research.

2.3.1 Digitalization

Digitalization signifies a significant shift in how organizations, industries, and countries employ digital and computer technologies, as defined by the Oxford Dictionary (2016). This concept is grounded in the principles of effective media utilization and computer exchange. According to the Gartner Dictionary (2018), digitization extends beyond simply adopting new technologies; it includes the transformative potential of advanced digital tools to redefine operational processes and open new pathways for

revenue and value creation. The core of this process involves transitioning from traditional user models to innovative digital business models. Janowski, (2015) emphasizes that digitalization is not a passing trend; rather, it is a dynamic and ongoing journey that aims to discover new digital strategies for optimizing business operations. This journey encompasses all levels of an organization and crosses industry boundaries, instigating essential changes across various sectors (Janowski و Tomasz, 2015). These transformations include advancements in information technology, widespread social changes, improvements in infrastructure, and the evolution of business practices. Adopting digitalization is no longer optional; it is essential for organizations that wish to succeed in today's fast-paced, technology-driven environment.

There are numerous reasons to digitize information. Digitization can enhance the efficiency of businesses and organizations, preserve historical documents and photographs, and make information easier to access and utilize. by digitizing information, businesses and organizations can improve efficiency. This process can save time and money by reducing reliance on paper records and manual processes. Additionally, digitizing content can help automate tasks such as data entry.

Moreover, digitization is crucial for preserving information. For instance, digitizing historical documents helps ensure they are safeguarded for future generations. It also simplifies the process of accessing and using information. For example, digitizing a document allows for easier searching of specific information.

2.3.1.1 Digitalization Process Key Steps

1. **Collection:** The first step involves gathering the materials to be digitized, which can be done using a scanner or a digital camera.
2. **Conversion:** Next, the collected materials are converted into a digital format using a computer or an online digitization service.
3. **Storage:** The third step is to store the digital files, which can be accomplished on a computer, a digitization server, or in the cloud.
4. **Access:** Finally, the last step is to provide access to the digital files, which can be facilitated through a website or an application.

2.3.1.2 Digitalization Advantages

The process of digitization not only reimagines customer service capabilities using new technologies, but also has a deep-rooted obsession. This obsession means understanding every step of the buyer's journey, regardless of the communication environment, and reflecting on how digital capabilities provide the best possible experience at all points of the business. Digitalization does not mean following a sale, but refers to a dynamic cycle whose processes and capabilities are constantly changing according to the data obtained from customers, and which creates and strengthens customer loyalty to the product or service (Schweidel *et al.*, 2022).

The benefits of digitalization are different for different audiences. Factors such as the number of branches, company size, geographic location, and business model also affect the importance and implementation of the digitalization process. There is a positive effect of company size, as 15% of large companies specify their strategies for digitalization, indicating how they are dealing with these changes. They 18% to achieve more goals such as quality and speed of work, 26% to improve performance (more than double the use of digital tools) and 19% to increase online sales (Calderon-Monge and Ribeiro-Soriano, 2024). Digitization means using advanced methods in data generation, computing power and communication. Artificial intelligence and the Internet of Things are examples of digitization that not only create new opportunities, but also pose serious cyber security threats. Digitization is not the same for everyone. Factors such as the number of branches, company size, geographic location, and business model also influence the importance and implementation of the digitalization process (Rachinger *et al.*, 2019). When companies were asked what they were aiming for with digitalization, an interesting pattern was identified for the relationship between current production, the digital supply chain, and the level of maturity of activities using value levers. Maturity levels of activities are determined through 5 stages. In the initial stage, only procurement activity is initiated from suppliers and no real added value is created. When procurement activity reaches the minimum required, the new objective is to reduce costs. In the next step, operational

dimensions such as trust, speed and especially quality are also optimized. The act of preparation becomes an enabling feature (Siedler *et al.*, 2021).

2.3.1.3 Features of Digitalization

Digital transformation refers to significant changes in technology, as well as in social, organizational, cultural, creative, and managerial skills. These changes enable organizations to redesign their business activities through the use of digital technologies. To ensure the long-term effectiveness of technology within organizational processes, it is essential to conduct a thorough and comprehensive analysis, with a focus on understanding the evolution of innovation over time (Foerster-Metz *et al.*, 2018; Nugraha, Rusu and Perjons, 2025). In the past, most organizational operational activities were performed independently in conventional organizational structures, but today most of these tasks cannot be performed alone due to technological developments. Consequently, supply chain management does not violate this rule when it benefits from the significant impact of digital transformation. Therefore, the way materials, information and financial flows are managed in an integrated business network will change significantly due to the effects of digital technologies. Innovative concepts of technology, including cyber-physical systems, artificial intelligence and cloud computing can be argued as factors contributing to digital transformations (Hofmann *et al.*, 2019).

While many of the world's most successful organizations excel in managing their components, some believe that competition between organizations is actually competition between their components (Downie, 2022). Today's organizations are evolving and changing towards a new and innovative environment based on digital transformation. Gone are the days when traditional organizations did their processes in traditional ways. Today, organizations require a large number of complex activities that require coordination and follow-up for their success. Therefore, embracing the digital flow enables the evolution of the next generation of organizations that promotes flexibility and efficiency. Given that digital solutions are transforming traditional structures, some of the distinguishing features of digital transformation are imaginable alternatives to traditional supply chains. These

characteristics refer to eight main features that are the goal of digitalization (Tavana *et al.*, 2022). In Figure 2.1, the features of digital transformation are shown.

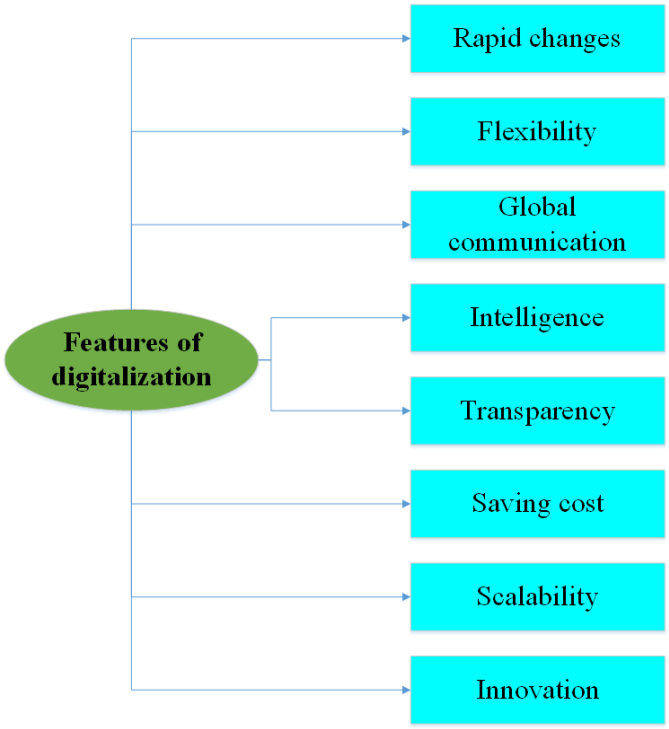

Figure 2.1
Features of Digitalization

Rapid Changes: In the digital era, rapid changes have become an inherent aspect of organizational operations. Digital transformation accelerates the pace at which businesses must adapt, innovate, and respond to market dynamics, customer expectations, and technological advancements. Organizations today operate in an environment where change is not only constant but increasingly unpredictable, driven by disruptive technologies, globalization, and shifting consumer behaviors. Digitization helps businesses traverse these rapid changes more efficiently by giving real-time access to data, improved decision-making capabilities, and agile operational models. Digital technologies such as IoT, cloud computing, and big data analytics enable businesses to monitor market signals, identify emerging trends, and quickly alter their plans. The ability to adjust quickly to external and internal changes is crucial for maintaining competitiveness and long-term viability. Without embracing rapid change, organizations risk becoming obsolete as more

agile competitors seize emerging opportunities. Furthermore, rapid digital changes empower organizations to launch new products, enter new markets, and reconfigure supply chains at a speed previously unimaginable. However, this acceleration poses new issues, such as greater complexity, technical obsolescence, and increased demands on organizational learning and innovation capacities. To compete in today's fast-paced world, firms must foster a culture of change, invest in ongoing learning, and cultivate technical agility at all levels.

Flexibility: In today's dynamic business landscape, flexibility has emerged as a cornerstone for organizational success, particularly within the context of digital transformation. Flexibility refers to an organization's capacity to quickly and effectively modify operations in response to changing market conditions, consumer demands, and supply chain interruptions. While traditional management systems included elements of adaptation, the digitization of processes has significantly enhanced organizations' ability to respond to challenges in real time. Digitization does not prescribe rigid methods for delivering goods or services; rather, it empowers organizations to address problems proactively, leveraging data-driven insights to minimize disruptions (Scholz, 2021). Through technologies such as real-time monitoring, predictive analytics, and automated decision-making, organizations can anticipate potential issues and implement corrective actions rapidly (Kashem, Shamsuddoha and Nasir, 2024; Hossain *et al.*, 2025). Predictive analytics, for example, enables businesses to forecast supply chain bottlenecks and adjust sourcing strategies before crises emerge (Baycik and Gowda, 2024). Digital twins—virtual models of operations—further enhance flexibility by allowing companies to simulate scenarios and optimize strategies (Amos, 2024). Traditional methods often involve delays due to manual data processing, whereas digital platforms allow instantaneous adjustments to evolving situations (Menon *et al.*, 2022). However, this transformation also introduces challenges, including the need for significant investments in digital infrastructure, change management, and cybersecurity measures (Sargiotis, 2024). Organizations that successfully integrate digital tools and foster flexible cultures are better equipped to survive and thrive amid uncertainty, ensuring continuous operational excellence.

Global Communication: The internet has radically altered the way people and businesses communicate, removing geographical obstacles and allowing for seamless, real-time interactions all over the world. Organizations must deliver goods and services globally at high speed. This requires a global supply chain that allows organizations not only to operate locally, but also to ensure the authenticity and quality of delivery. For example, if a European product is requested and needs to be sent to America, it is necessary to transport it from Europe to America, which may result in high cost and time. Therefore, a digital supply chain solution allows organizations to move goods and services globally instead of locally (Farfán Chilicaus *et al.*, 2025).

The internet has fundamentally changed the way individuals and organizations communicate, breaking down geographical barriers and enabling seamless, real-time interactions around the world. This global connectivity has transformed the landscape of commerce, allowing businesses to reach customers well beyond their local markets. As the demand for fast delivery of goods and services increases, it has become essential for organizations to develop strong global supply chains. These supply chains enable them to operate locally while ensuring the authenticity and quality of their deliveries.

In today's interconnected world, a global supply chain is vital for organizations seeking to compete effectively. The ability to provide products and services swiftly and efficiently is critical to client satisfaction and overall corporate success. A global supply chain allows organizations to source materials, manufacture products, and distribute goods on an international scale. This capability is especially important for businesses in industries where speed and reliability are critical, such as e-commerce, electronics, and consumer goods.

When a customer in America requests a product from Europe, the logistics of transporting that product can be complex and expensive. Several factors, including shipping times, customs regulations, and transportation costs, can complicate the process. Therefore, organizations must strategically manage their global supply chains to minimize delays and costs while ensuring that products meet the necessary quality standards.

Digital supply chain solutions have become essential for organizations looking to enhance their global operations. These solutions utilize advanced technologies such as data analytics, the Internet of Things (IoT), and artificial intelligence to streamline processes and improve decision-making. By incorporating digital tools into their supply chain management, organizations can achieve greater visibility, flexibility, and responsiveness.

One major advantage of digital supply chain solutions is the capability to track and monitor shipments in real-time. This function allows organizations to gain insights into the status of their deliveries, enabling them to proactively address potential challenges before they escalate. For example, if a shipment is delayed due to unforeseen circumstances, organizations can promptly adjust their logistics strategies to minimize the impact on customers (Allem, 2025).

Additionally, digital supply chain solutions enhance communication and collaboration among stakeholders. By facilitating seamless information sharing throughout the supply chain, organizations can coordinate their efforts more effectively, ensuring that all parties are aligned and working toward common goals. This collaborative approach improves overall supply chain efficiency and contributes to higher customer satisfaction.

As organizations expand their operations globally, ensuring the authenticity and quality of their products has become increasingly important. Consumers are more discerning than ever and expect the items they purchase to meet specific standards. Therefore, a global supply chain must implement measures to verify product authenticity and maintain quality throughout the delivery process. Digital supply chain solutions are crucial for achieving organizational goals. For example, organizations can use blockchain technology to create a transparent and unalterable record of each product's journey throughout the supply chain. This technology enables organizations to verify the origin of products, monitor their movement, and ensure that they meet quality standards at every stage of the process. By providing consumers with access to this information, companies can build trust and enhance their brand reputation. Quality control measures can be incorporated into the digital supply chain to monitor products during different stages of production and distribution. Automated systems can detect any anomalies or deviations

from quality standards, allowing organizations to take prompt corrective actions. This proactive approach to quality management helps uphold high standards and minimizes the risk of delivering subpar products to customers (Jahani, Raji and Zojaji, 2024).

While the benefits of a global supply chain and digital solutions are evident, organizations encounter several challenges in their pursuit of efficiency and effectiveness. A significant challenge is the complexity of managing logistics across different countries and regions. Variations in regulations, customs procedures, and transportation infrastructure can complicate the movement of goods, increasing the risk of delays. Geopolitical factors can also impact global supply chains. Trade policies, tariffs, and political instability can disrupt the flow of goods and create uncertainty for organizations operating internationally. To mitigate these risks, organizations must stay informed about global developments and adapt their supply chain strategies accordingly. Another challenge is the need for investment in technology and infrastructure. Implementing digital supply chain solutions requires significant resources, and organizations must be ready to allocate the necessary funding and expertise to ensure successful implementation. This investment is crucial for organizations that wish to remain competitive in a rapidly evolving marketplace.

In conclusion, the internet has profoundly changed the landscape of global commerce by allowing organizations to communicate and operate on an international scale. The significance of a global supply chain has become increasingly apparent as businesses strive to deliver goods and services quickly and efficiently. Digital supply chain solutions provide the essential tools organizations need to manage the complexities of global logistics while ensuring the authenticity and quality of their deliveries.

As organizations continue to embrace digital transformation, they must remain vigilant in addressing the challenges that accompany global supply chain management. By investing in technology, fostering collaboration, and prioritizing quality, organizations can position themselves for success in an interconnected world. The future of global supply chains depends on their ability to adapt, innovate, and respond effectively to the ever-changing demands of consumers and markets.

Intelligence: The new generation of technological tools have the ability to provide smart products that have significant computing ability; in such a way that self-learning and independent decision-making based on defined algorithms are known as their prominent features. A digital supply chain provides features that improve decision-making, automated execution, and innovation in operations (Ivanov, Tsipoulanidis and Schönberger, 2019).

The emergence of advanced technological tools has marked the beginning of a new era for smart products, revolutionizing various industries. These tools are distinguished by their tremendous computer skills, which enable them to complete complicated tasks that were previously assumed to require human intelligence. One of the most striking qualities of these smart devices is their ability to learn autonomously and make independent judgments based on predetermined algorithms. This shift toward intelligent systems is transforming supply chain management by enhancing efficiency, improving decision-making, and fostering innovative operational practices. Smart products are designed with advanced sensors, data processing capabilities, and connectivity features that allow them to gather and analyze information in real time. This technological advancement enables these products to adapt to changing conditions and user preferences, making them more responsive and efficient. For example, smart appliances can learn from user behavior, optimizing their performance to improve energy efficiency and enhance user convenience (Zhang, Yang and Yang, 2023).

The ability of smart items to learn on their own is an important feature. These devices use machine learning algorithms to analyze massive volumes of data, detect trends, and improve their performance over time. This continuous learning process enables them to fine-tune their operations and make intelligent decisions without requiring human intervention. For example, a smart thermostat can learn a household's temperature preferences and automatically adjust settings to maintain comfort while minimizing energy consumption. Smart products can independently make decisions, which is transforming various applications. Using predefined algorithms, these products assess situations, evaluate options, and take actions based on the data they gather. This level of autonomy

decreases the need for manual input and enables faster responses to changing circumstances (Sarker, 2021).

In supply chain management, independent decision-making can significantly enhance operational efficiency. Smart inventory management systems, for example, can monitor stock levels in real time and replace goods automatically when they fall below a predefined threshold. This proactive approach minimizes the risk of stockouts and ensures that organizations can meet customer demand without delays.

Furthermore, the algorithms that govern these decision-making processes can be continuously refined based on new data and insights. This adaptability is crucial in a dynamic business environment where conditions can change rapidly. By leveraging data-driven decision-making, organizations can optimize their operations and respond effectively to market fluctuations.

Digital supply chains are at the forefront of this technological transformation, integrating smart products and advanced tools to enhance overall performance. These supply chains use digital technologies to improve decision-making, automate execution, and foster innovation in operations. The integration of smart products into the supply chain allows organizations to achieve greater visibility, flexibility, and responsiveness. A key feature of a digital supply chain is its capacity to support data-driven decision-making. By collecting and analyzing data from various sources, organizations can gain valuable insights into their operations, customer preferences, and market trends. This information helps decision-makers to make informed choices that align with their strategic goals (Wu, 2025).

Additionally, digital supply chains enable the automation of processes, reducing the need for manual intervention. Automation can improve several parts of the supply chain, including order processing and logistical management. For example, automated systems can manage inventory replenishment, shipment tracking, and customer communication, allowing human resources to focus on more strategic tasks. The integration of smart products with digital supply chains fosters innovation in operations. Organizations can utilize advanced technologies to create new business models, enhance

product offerings, and improve customer experiences. Companies can leverage data analytics to identify emerging trends and understand customer needs, which enables them to innovate their product lines and stay competitive. Additionally, the collaborative nature of digital supply chains promotes innovation by encouraging partnerships and knowledge sharing among stakeholders. Organizations can collaborate to develop new solutions, share best practices, and leverage each other's strengths. This teamwork not only drives innovation but also increases resilience in the face of challenges.

While the benefits of smart products and digital supply chains are substantial, organizations must also tackle various challenges during implementation. A key concern is the need for robust data security measures. As organizations increasingly depend on data-driven decision-making, protecting sensitive information from cyber threats becomes essential. Therefore, organizations must invest in cybersecurity measures to secure their data and maintain customer trust.

Furthermore, integrating smart products into existing supply chain processes may require significant changes to infrastructure and operations. Organizations should be prepared to invest in technology, training, and change management to guarantee a smooth transition. This investment is essential for realizing the full potential of smart products and digital supply chains.

In conclusion, the new generation of technological tools is transforming supply chain management through the development of smart products with significant computing capabilities. These products, characterized by their self-learning and autonomous decision-making features, enhance decision-making, automate execution, and foster innovation in operations.

As organizations increasingly adopt digital supply chains, they must be mindful of the challenges that come with this transition. Organizations can fully realize the potential of smart products and digital supply chains by investing in technology, prioritizing data security, and cultivating an innovative culture. The future of supply chain management depends on the ability to leverage advanced technologies to create agile, responsive, and innovative operations that meet the ever-evolving demands of customers and markets.

Transparency: In the process of transparent digitization, communication links are recognized and implemented by observing the behaviors and needs of other links. In case of a lack of transparency, the order in the circulation of activities in the organization will be severely disturbed. Digital transformation enables organizations to predict, model network structure and create adaptive scenarios for ongoing changes, to act transparently and to be better prepared to face any disruption (Zoppelletto, Bullini Orlandi and Rossignoli, 2020).

Saving Costs: In fact, digital technologies can reduce costs in a wide range of subjects. Reducing the amount of initial investment costs, especially when the time is limited, can be in our favor. Digital transformation is actually a cost-effective method for organizations that can improve productivity and reduce costs for organizations not only because of the benefits of technological capabilities, but also because of the optimization of supply chain processes through digitalization (Pflaum *et al.*, 2023).

Scalability: Scalability of digital organizations, according to the requirements, often creates huge challenges for organizations. When traditional organizations are integrated with digitalization, scalability becomes less of an issue. This brings optimization and duplication of processes, and easier discovery of anomalies and errors (Hofmann, Samp and Urbach, 2020).

Innovation: Growth and excellence in digital processes have become a vital feature. In today's world, with the increasing speed of introducing new technologies, the doors of continuous change are open. In the path of digital transformation, new ways must always be looked at to integrate these innovations into processes so the competition will continue and ensure the organization's growth and excellence. Today, current innovations are evolving into passive and active technologies of the future. Examples of this evolution include the evolution of televisions from black and white to smart televisions and the transformation of paper and pen into smart glasses. Technologies are necessarily subject to change, and this is the attractive feature of innovation. Today, people who think that big data is only about improving past information processes are the same as those who think

that a date stone is essentially the same as a tablet or a laptop or a supercomputer (Capurro *et al.*, 2022).

In the contemporary landscape, growth and excellence in digital processes have emerged as essential characteristics for organizations striving to remain competitive. The quick rate of technological advancements has opened the doors to continuous change, compelling businesses to adapt and innovate constantly. Digital transformation is no longer an option; it has become a requirement for enterprises seeking to thrive in an increasingly digital world. As this shift is negotiated, new methods will be sought to incorporate innovations into existing processes, assuring long-term growth and quality. The process of digital transformation necessitates a proactive approach to accepting change.

The journey of digital transformation requires a proactive approach to embracing change. Organizations must be watchful and sensitive to emerging technology, understanding that the landscape is in perpetual flux. The ability to adapt to new tools and methodologies is critical for maintaining a competitive edge. This adaptability not only enhances operational efficiency but also fosters a culture of innovation within the organization. As new technologies are introduced, they often bring with them new opportunities for integration into existing processes. Companies must be willing to experiment with these innovations, exploring how they can enhance productivity, streamline operations, and improve customer experiences. This ongoing quest for integration is essential for ensuring that organizations can continue to compete effectively in their respective markets (Omol, 2024).

The evolution of technology is a testament to the dynamic nature of innovation. Historical examples illustrate how technologies have transformed over time, often in ways that were once unimaginable. For instance, the evolution of televisions from black-and-white screens to smart televisions equipped with internet connectivity and advanced features exemplifies this transformation. Similarly, the transition from traditional paper and pen to smart glasses highlights the shift towards more integrated and interactive technologies.

These examples underscore the fact that technologies are inherently subject to change. This characteristic of innovation is what makes it so compelling. As new capabilities are developed, organizations must be prepared to adapt their processes and strategies to leverage these advancements fully. The fascination with innovation is often inspired by how work is transformed, communication is reshaped, and interaction with the world is redefined.

In the context of digital transformation, the concept of big data has gained significant attention. However, there is a common misconception that big data is solely about improving past information processes. This perspective limits the understanding of its true potential. Just as individuals who equate a date stone with modern computing devices fail to grasp the evolution of technology, those who view big data merely as a tool for historical analysis miss the broader implications of its application.

Big data refers to the enormous volumes of information generated from a variety of sources, including social media, sensors, and transactional data. Its true power lies in delivering insights that support informed decision-making and strategic planning. By analyzing patterns and trends within this data, organizations can gain a deeper understanding of customer behavior, market dynamics, and operational efficiencies. Furthermore, big data enables predictive analytics, which allows organizations to anticipate future trends and proactively adjust their strategies. This forward-thinking approach is crucial for organizations that want to stay ahead in a rapidly changing environment. By embracing big data as a strategic asset, organizations can continuously innovate and respond effectively to emerging challenges.

Innovation is a key driver of competitive advantage in today's digital landscape. Organizations that prioritize innovation are better equipped to adjust to evolving market conditions and fulfill customer expectations. a commitment to investing in research and development is essential. This involves exploring new technologies and fostering a culture of creativity and experimentation (Capurro *et al.*, 2022).

To promote growth and excellence, organizations must create an environment that encourages collaboration and knowledge sharing. This can be achieved through cross-

functional teams, innovation labs, and partnerships with external stakeholders. By leveraging diverse perspectives and expertise, organizations can generate new ideas and approaches that enhance their digital processes.

Furthermore, organizations should recognize that innovation is not limited to the development of new products or services. It also encompasses improvements in processes, systems, and customer interactions. By continuously seeking ways to enhance existing operations, organizations can drive efficiency and deliver greater value to their customers.

In conclusion, the growth and excellence of digital processes are vital for organizations navigating the complexities of the digital age. Embracing change and integrating new technologies into existing processes are essential for maintaining competitiveness and ensuring sustained growth. The evolution of technology serves as a reminder that innovation is a dynamic and ongoing journey.

As organizations continue to explore the potential of big data and other emerging technologies, they must adopt a forward-thinking mindset that prioritizes innovation and adaptability. By fostering a culture of creativity and collaboration, organizations can unlock new opportunities and drive meaningful change. Ultimately, the ability to embrace digital transformation will determine the success of organizations in an increasingly interconnected and rapidly evolving world.

2.3.1.4 Digitalization Strategy

Digitization is a tool used to achieve various goals. Creating a strategy before investing is essential to ensure the goals are achieved. However, the future is difficult to predict, and digital innovations are emerging in many forms; Therefore, companies must react with agility (Chan *et al.*, 2019). Optimizing and increasing speed in internal processes is a constant necessity, but digitization refers to the importance of simultaneously optimization of internal and external processes. Also, companies that require new technology capabilities, although customers do not care about the technology itself, they care about the value it produces for them (Riasanow *et al.*, 2019). Platforms are very important. The importance of innovation in processes, progress and efficiency is not reduced. But the new strategic reality is that platform innovation drives and defines process

capabilities, and this may be more impactful than any other approach. The increasing volume of data generated by new platforms can be useful for predictive insights, which help to improve forecasting and digitization efficiency. Creating a digital transformation strategy that is integrated with an enterprise resource management system perspective is the key to finding higher benefits from processes and systems. Most companies struggle with all these concepts in the early stages (Wang *et al.*, 2014).

Digitization has emerged as a transformative tool that organizations leverage to achieve a myriad of goals, ranging from operational efficiency to enhanced customer engagement. As companies navigate the complexities of the digital landscape, the importance of formulating a coherent strategy before making significant investments cannot be overstated. This strategic foresight is crucial for ensuring that the intended objectives are met and that resources are allocated effectively. However, the unpredictable nature of the future, coupled with the rapid emergence of digital innovations in various forms, necessitates that companies adopt an agile approach to adapt to changing circumstances (Chan *et al.*, 2019).

Before starting a digitization journey, organizations need to create a clear strategy that outlines their goals and the methods to achieve them. This strategy should include not only the technological aspects of digitization but also the wider organizational implications. A well-defined strategy acts as a roadmap, guiding companies through the complexities of digital transformation and helping them avoid common pitfalls.

The fast-paced evolution of technology requires companies to stay alert and ready to adapt to new trends and innovations. As new digital tools and platforms emerge, organizations need to be willing to change and adjust their strategies. This flexibility is crucial for retaining a competitive advantage in the growing digital marketplace.

While optimizing and increasing speed in internal processes is a constant necessity, digitization also emphasizes the importance of simultaneously optimizing both internal and external processes. Internal processes refer to the operations and workflows that occur within an organization, while external processes involve interactions with customers, suppliers, and other stakeholders.

Digitization provides opportunities for enhancing both types of processes. For instance, automation tools can streamline internal workflows, reducing the time and resources required to complete tasks. At the same time, digital platforms can facilitate better communication and collaboration with external partners, improving customer service and satisfaction. By focusing on both internal and external optimization, organizations can create a more cohesive and efficient operational framework.

In the context of digitization, it is crucial to recognize that customers do not inherently care about the technology itself; rather, they are concerned with the value that technology produces for them (Riasanow *et al.*, 2019). This perspective shifts the focus from merely adopting new technologies to understanding how these technologies can enhance the customer experience and deliver tangible benefits.

Organizations must prioritize the development of technology capabilities that align with customer needs and expectations. This involves not only investing in the right tools and platforms but also ensuring that employees are equipped with the skills and knowledge necessary to leverage these technologies effectively. By focusing on the value generated for customers, companies can drive greater engagement and loyalty.

Platforms play a critical role in the digitization landscape. They serve as the foundation for innovation in processes, progress, and efficiency. The strategic reality today is that platform innovation drives and defines process capabilities, often proving to be more impactful than traditional approaches. Platforms enable organizations to integrate various functions and services, creating a seamless experience for users and stakeholders.

The increasing volume of data generated by new platforms presents significant opportunities for organizations. This data can be harnessed for predictive insights, which help improve forecasting and enhance the efficiency of digitization efforts. By analyzing data trends and patterns, companies can make informed decisions that drive innovation and optimize processes.

Creating a comprehensive digital transformation strategy is crucial for organizations aiming to fully leverage the advantages of digitization. This strategy should be aligned with an enterprise resource management (ERM) system perspective, ensuring

that all processes and systems work together effectively to meet organizational objectives. Adopting an ERM approach enables companies to align their resources, data, and workflows, establishing a cohesive framework for managing operations.

A successful digital transformation strategy includes several essential components:

1. **Assessment of Current Capabilities:** Organizations should assess their current processes, technologies, and resources to identify areas for enhancement and opportunities for digitization.
2. **Setting Clear Objectives**: Setting defined, quantifiable goals is critical for steering the digital transformation process. These goals should be consistent with the overall business strategy and address client needs.
3. **Investing in Technology**: Companies should prioritize investments in technologies that improve operational efficiency and provide value to customers. This may include automation tools, data analytics platforms, and customer relationship management systems.
4. **Fostering a Culture of Innovation**: Fostering a culture that promotes innovation and agility is crucial for effective digitization. Employees must be encouraged to try new ideas and approaches, cultivating a mindset of continuous improvement.
5. **Monitoring and Evaluation**: Organizations should set up methods to track progress and evaluate the efficacy of their digital transformation programs. This includes measuring key performance indicators and gathering feedback from stakeholders.

Despite the potential benefits of digitization, many companies encounter challenges during the early stages of their transformation journeys (Zhu, Ge and Wang, 2021). Common obstacles include resistance to change, a lack of clarity regarding goals, and insufficient resources for implementation. Additionally, organizations may struggle to align their digital initiatives with their broader business strategies.

To address these challenges, companies need to prioritize communication and collaboration throughout the organization. Involving employees in the digitization process and offering training and support can help reduce resistance and promote a sense of

ownership. Additionally, organizations should consider forming partnerships with technology providers and industry experts to gain insights and access resources that can aid their transformation efforts.

In conclusion, digitization is a powerful tool that organizations can leverage to achieve a wide range of goals. However, the success of digitization efforts hinges on the development of a clear strategy that aligns with organizational objectives and customer needs. By optimizing both internal and external processes, focusing on the value generated for customers, and embracing platform innovation, companies can navigate the complexities of the digital landscape effectively.

Creating a comprehensive digital transformation strategy that integrates an enterprise resource management perspective is key to unlocking the full potential of digitization. While challenges may arise in the early stages, organizations that prioritize agility, innovation, and collaboration will be better positioned to thrive in an increasingly digital world. As technology continues to evolve, the ability to adapt and respond to change will be critical for long-term success.

2.3.2 Digital Transformation

In recent years, the term digital transformation has been widely used in scientific and economic literature, and the concept of digital goods and services was formed in the 1990s and 2000s. From 2000 to 2015, the increased use of smart devices and mass media has caused significant changes in the relationship between customers and organizations (Gharib, 2019). Customer expectations for response time and multi-channel accessibility have also gradually changed, as business owners have realized that real-time communication with their customers is not limited to physical presence. Also, the spread of digital payment methods such as PayPal and the increase in online and web-based sales have also increased (Pantano *et al.*, 2020). Overall, at the time, many organizations saw the digital economy as both a problem and an opportunity to take advantage of at the same time. Some companies recognized the problems and obstacles of the digital economy due to the lack of infrastructure and well-outcome (Younus, 2022). But they saw the digital economy as a great opportunity to improve their skills, infrastructure and competitiveness,

which will enable them to be exposed to the future competitive landscape and be stronger. It was clear that achieving full digitalization requires increasing technological capabilities, which is considered one of the best ways to achieve various competitive advantages, including reducing business and operational costs, transportation costs, and dependence on full-scale technological systems. Also, analyzing big data and understanding customer needs is also very important (Paul L. Drnevich and David C. Croson, 2013).

The 2020 Digital Maturity Model highlights the importance of essential digital enablers for organizations. These enablers include governance and leadership, strategy, culture and skills, innovation, technology, and data. They form the foundation for achieving critical digital outcomes, such as new business models, enhanced digital customer experiences, improved digital employee experiences, and optimized digital processes. The interaction between these enablers and outcomes ultimately transforms an organization into a digital expert.

"Digital governance" refers to the framework established for managing digital transformation within an organization. It encompasses the policies, structures, processes, and mechanisms needed to realize digital value and benefits. "Digital leaders" are individuals who effectively identify and tackle the challenges of the digital age, providing solutions focused on transformative technologies while coordinating various elements within their organizations to drive digitalization (Weill and Ross, 2004).

A "digital strategy" utilizes transformative technologies to develop capabilities that allow an organization to adapt to changing market conditions. The aspect of culture and skills is crucial for sustainable digital transformation; fostering a culture that embraces technology is vital for organizations embarking on a digital journey. This digital culture must be nurtured to ensure successful navigation through the transformation process.

Strong "technology" infrastructure is essential for advancing digital transformation. Beyond simply acquiring technology, effective leadership and management of information technology are also critical. In today's environment, "data" enables organizations to make informed predictions and continuously test hypotheses, moving away from reliance on

intuition and emotions for decision-making. Data provides essential insights that support informed choices.

"Digital innovation" involves developing new products, processes, or business models using digital technologies. It seeks to address existing business challenges through these technologies. "Digital business models" are strategies designed to create value by leveraging digital technologies, with impacts ranging from minor improvements to significant transformations.

Advancements in information technology and the development of digital tools have greatly enhanced the effectiveness of "organizational processes." These technologies streamline, simplify, and automate processes within organizations, leading to improved performance.

The rise of "employee experience" marks a significant shift in human resource management, where organizations begin to see their workforce not merely as assets but as individuals with unique needs. "Employee experience" encompasses all factors that influence employees' perceptions and feelings about their work environment and job roles. Additionally, digital technologies have significantly transformed the "customer experience." They create engaging and interactive environments that enhance customer satisfaction and effectively meet expectations in innovative ways. Here are five trends that organizations can leverage to prepare for the digital journey in 2022 (Culot *et al.*, 2020).

Trend 1: Digital Transformation is Becoming a Way of Life

Transformation began in the right context before the COVID-19 pandemic, but now digital initiatives are rapidly expanding. Due to the circumstances created by COVID-19, organizations have accelerated their investments in digital technologies and most have permanently revised their organizational strategies. Many leaders believe that transformation is here to stay. So instead of trying to achieve a perfect end state, they are focused on making their organization more responsive. It can be said that operational agility and flexibility will become a priority for organizations in the coming years. Since technology plays a key role in creating flexibility and adaptability, they should pay more attention to it than to external forces that affect their business in the short term (such as

market factors and regulatory concerns). Among them, IoT, cloud computing, and AI are the top technologies that are expected to deliver business benefits. It is clear that executives will increasingly want to participate in business ecosystems in 2022. However, to invest in ecosystem partnerships, companies need a strong technology core. They must reassess how they manage their assets, infrastructure, and talent. In addition, organizations must address critical actions that were not prioritized, underestimated, or ignored in the early days of the COVID-19 outbreak due to lack of focus and haste (Verhoef *et al.*, 2021).

Trend 2: Human Capital is Precious and Scarce

Many believe that a wave of job resignations is imminent, with millions of positions expected to remain vacant in the coming years due to a global shortage of skilled talent. This talent deficit could lead to significant revenue losses for organizations. While the virtualization of jobs allows companies to access a broader pool of global talent, effective talent management will require increased attention.

Organizations must assess their internal capabilities and human capital, making necessary adjustments to attract potential employees. Recognizing and encouraging employees for their valuable contributions, along with prioritizing their well-being, are crucial steps in this process. Managers need to understand that if they fail to meet the needs of their employees, they risk losing them to other opportunities within the organization.

In the post-pandemic era, employees particularly desire greater flexibility in their work arrangements. Additionally, working for an organization that aligns with their personal values has become an essential criterion for job selection. It is important to note that those who remain with a company may not necessarily feel satisfied; many believe their employer does not care about their mental and physical well-being, as well as their financial stability.

In today's competitive job market, individuals want to work on their own terms and take pride in their contributions. Top talent will gravitate toward organizations that prioritize the well-being of their employees (Carnevale and Hatak, 2020).

Trend 3: Sustainability and Transparency are Essential Priorities

The traumatic events of the past two years have forced people to rethink their priorities. When it comes to sustainability in particular, it is clear that the pandemic has impacted the views of most global consumers. Consumers have come to the conclusion that sustainability and health are closely linked, so sustainability and health and wellness benefits are becoming more important to them when choosing a brand. While sustainability has historically been viewed as a luxury, many people are now willing to pay more or even take a lower salary for a sustainable future. People are increasingly likely to apply for jobs with environmentally friendly and socially responsible organizations in the future. On the other hand, there is a huge gap between what consumers say they want to do and how they spend their money. A small portion of consumers' shopping carts are made up of sustainable or environmentally friendly products, which means that organizations have valuable opportunities to capitalize on this unmet demand. But to do so, organizations need to convince people. Many consumers do not trust organizations' claims about environmental sustainability, and many do a lot of research before making a purchase. So if organizations are to communicate with consumers in a meaningful way, they need to provide clear and accurate information about their initiatives. Many organizations have significant information gaps that need to be addressed, given the importance of this issue (White, Habib and Hardisty, 2019).

Trend 4: Technology Must Transform Business Operations

An incremental approach to technology is no longer enough. Businesses must fundamentally reshape their operations to reap the full benefits of digital transformation. Rather than delivering discrete innovations that simplify individual workflows, executives should focus on building integrated systems that transform business models. Failures ahead should not scare them, because taking risks is the price of technology-driven gains. Organizations that don't penalize failure will see much higher revenue growth in technology adoption and digital transformation. During the COVID-19 pandemic, many organizations have been building the necessary technology capabilities across their

departments. Cloud, hybrid cloud operations, artificial intelligence, and intelligent workflows are among the most in-demand. It's clear that investing in technology will yield huge returns for organizations. IoT, AI, and cloud are at the top of the list of technologies that are most profitable for organizations. Investing in ecosystems and innovation has also created multiple revenue streams for organizations (Culot *et al.*, 2020).

Trend 5: Trust and Security Underpin Sustainable Innovation

While cloud-based technologies, platforms, and ecosystems expand the reach of organizations and create new opportunities for innovation, they also create new threats. Some organizations are unable to secure data that is moving across multiple cloud environments and within on-premises environments. Many believe that the majority of cyber incidents originate in the cloud, and that this vulnerability stems from the inability to adapt security practices to a more open environment. It is clear that many organizations are unable to deliver and extend new cloud capabilities to their internal and external partners. As organizations expand their cloud to enable remote work, integrate supply chains, and enhance customer experiences, they must also evolve their approach to cybersecurity. "Zero trust" is a proactive approach to security that assumes that malicious actors are everywhere. It requires authentication and approval for every transaction of value, allowing organizations to open their borders more securely. Open and secure cloud networks can create a cycle that enables innovation and collaboration. Organizations with the most mature cloud security practices (meaning organizations that integrate their cloud and security strategies) outperformed their peers by more than 2x in both revenue growth and profitability (Wang *et al.*, 2023).

2.3.3 Artificial intelligence (AI)

Artificial intelligence is an applied field of computer science that uses computer algorithms to help organizations perform tasks. This field is often associated with the study of human intelligence. The importance of customer participation in product development and features is evident based on research (Younus, 2022). As a result, the use of digital technologies as an effective tool to communicate between customers and businesses is vital

in the process of creativity and innovation. Many researchers agree that the use of technological tools and systems is essential to develop administrative, operational and industrial contexts for the implementation of strategic plans, which are able to develop specific product development plans (Nambisan, Wright and Feldman, 2019). The artificial intelligence tool is used as one of the technology techniques to support managers and decision makers in collecting, analyzing and using all the information of the online repository. It allows businesses to use and implement innovative business models to implement change and create innovative products with increased customer loyalty, increased ability to transform and grow, and gain market share and competitive advantage (Shrestha, Ben-Menahem and von Krogh, 2019).

2.3.3.1 Machine Learning

Machine Learning is a subfield of artificial intelligence that enables machines to learn from data and improve their decision-making capabilities. This field encompasses various algorithms that allow machines to utilize input data for making predictions or decisions. The common types of machine learning algorithms are as follow.

Linear Regression: Model Linear regression is considered the first machine learning algorithm for data science. Linear regression is considered one of the machine learning algorithms with a supervised learning approach that determines the relationship between the input variable (independent variable) and the output value (dependent variable). The linear regression algorithm determines the relationship between the independent variables (height and dimension variables) and the dependent variable (row of shelves) by determining a line in the coordinate space (Montgomery, Peck and Vining, 2021). The main goal of linear regression algorithms is to find the best-fitting line and optimal values for the separators and coefficients, including minimizing errors. The error in linear regression algorithms is the difference between the actual value and the predicted value, and the goal of the algorithm is to reduce this difference (Montgomery and Runger, 2010).

Logistic Regression: The logistic regression model is known as one of the machine learning algorithms that can be used to classify data into two classes. Like the linear

regression algorithm, this model, following the supervised learning approach, seeks to find weights for the input features (data) in order to be able to separate the data into two categories by finding a linear function. It should be noted that, unlike the linear regression algorithm, this model uses a nonlinear function to convert the output value in the range of zero to one (Dube, Nzimande and Muzindutsi, 2023).

Decision Tree: The decision tree can be considered as one of the most important machine learning algorithms with the supervised learning approach. In constructing the decision tree classifier, binary representation is used. Also, the problem features can be used to build the decision tree nodes and define the tree leaves as determinants of the model output (category type). Upon receiving new data, the decision tree decides based on the nodes (features) which branch of the tree to follow and which category to assign to the data. The most important feature of the decision tree algorithm is that it requires little time to train and predict for new data. The image below shows a decision tree model for the rainfall prediction problem, which places the data into two categories based on predefined features. In the decision tree, to predict the desired classes of the problem dataset, the algorithm's approach starts from the root node of the tree. This algorithm compares the values of the root features with the data features and, based on this comparison, follows the branches and goes to the next node. For the next node, the algorithm again compares the data feature value with other sub-nodes and advances the tree creation process. This approach continues until reaching the leaf node or the end node of the tree (Safavian and Landgrebe, 1991).

Support Vector Machine: The support vector machine is considered as another machine learning algorithm with a supervised learning approach. This model seeks to find a hyperplane that separates similar data from dissimilar data. In other words, the support vector machine model selects a hyperplane that can best place the data in separate categories and has the greatest distance from each data from different categories. The data that is considered as a criterion for measuring the distance to the hyperplane in the support vector machine model is called support vectors. In two-dimensional space, the hyperplane can be represented as a line. The support vector machine model is effective in solving

problems with high-dimensional data. However, if the number of features in the problem exceeds the number of training samples for the model, this model will not perform well (Pisner and Schnyer, 2020).

Naive Bayes Algorithm: The Naive Bayes model is known as one of the machine learning algorithms that is designed based on the Bayes probabilistic model and is used for classification problems with a supervised learning approach. It is a classification method based on Bayes' theorem with the assumption of independence among predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is not related to the presence of another feature. The most important assumption that this model makes about the data is that the features are independent of each other and that changing the values of the features does not affect the other values (Chen *et al.*, 2020).

KNN Algorithm: Another simple machine learning algorithm is the KNN model, which uses a supervised learning approach to classify data. This algorithm stores all training data in its memory and considers the similarity of the data to each of the training data to determine the class of new data. The KNN model uses distance measurement criteria in coordinate space, such as calculating the Euclidean distance, to determine the similarity of new data to the training data. In the KNN algorithm, there is a parameter called k that determines the number of neighbors of the new data (Zhang *et al.*, 2018).

Random Forest Algorithm: The Random Forest model stands out as one of the most formidable and sought-after machine learning algorithms, rooted in the innovative "Ensemble Learning" technique. Unlike conventional machine learning methods that depend on a singular model trained on a specific dataset, Random Forest harnesses the power of multiple decision trees, each contributing to the predictive capability. Each tree is crafted using a random subset of the training data and a diverse selection of features, ensuring a robust and varied approach to problem-solving.

The brilliance of Random Forest lies in its ability to aggregate the predictions from all these decision trees, resulting in enhanced accuracy that far surpasses the performance of individual models. Moreover, this approach effectively mitigates the risk of over fitting—a common pitfall in machine learning, where models excel on training data but fail

to generalize to new, unseen scenarios. With Random Forest, you gain a powerful tool that not only delivers precise predictions but also adapts seamlessly to the complexities of real-world data (Schonlau and Zou, 2020).

K-Means Clustering Model: The K-Means algorithm is an iterative algorithm that attempts to define a data set into distinct, non-overlapping subgroups, called clusters, in which each data point belongs to only one group. This algorithm attempts to make the data points within a cluster as similar as possible, while at the same time defining the clusters as different (distant) from each other as possible. This model attempts to divide the training data into separate clusters. This division is done in such a way that the data in each cluster is very similar to each other and different from the data in other clusters (Ahmed, Seraj and Islam, 2020).

Linear Discriminant Analysis Model: Another supervised machine learning algorithm is the linear discriminant analysis model, which is used for machine learning classification problems. This model seeks to find a linear combination of features that best separates data classes from each other. Unlike the logistic regression model, which is used to classify two classes, the linear discriminant analysis model can be used to classify data into multiple groups. The linear discriminant analysis model can also be considered a dimension reduction model because it transforms the input data to a space with lower dimensions so that the separation of data categories can be better done. This model seeks to find (linear) separators that maximize the ratio of the variance between classes to the variance within classes (Zhao *et al.*, 2024).

Neural network: A neural network is a set of algorithms that mimic the functioning of the human brain. These networks are modeled on the structure and function of the human brain and are made up of interconnected nodes called neurons that are used to process and analyze data. Artificial neural networks are nonlinear statistical models that represent a complex relationship between inputs and outputs to discover a new pattern. Various applications such as image recognition, speech recognition, machine translation, and also medical diagnosis use artificial neural networks. An important advantage of artificial neural networks is that they are trained by sample data sets. Its most common application

is the approximation of a random function. Using these types of tools, a cost-effective method can be used to arrive at solutions that define the distribution of a function. ANN is also able to use sample data to provide an output result instead of using the entire data set. Using artificial neural networks, existing data analysis techniques can be enhanced due to their advanced predictive capabilities. In other words, when the human brain is faced with new information, it tries to compare this information with its previous and known concepts in order to better understand the new information. The goal of neural networks is to recognize patterns and classify new information based on its previous knowledge. Real-time learning of patterns is done in the form of numerical vectors. In other words, all real-world data such as images, audio, and text must be converted into numerical vectors and provided as input to the neural network so that the artificial intelligence model can understand them. Neural networks can model nonlinear problems, and because of this feature, they can be used in many different problems such as "Pattern Recognition", "Dimension Reduction", machine translation, "Anomaly Detection", "Computer Vision", "Natural Language Processing", disease diagnosis, stock price prediction, and others (Dube, Nzimande and Muzindutsi, 2023).

2.3.3.2 Deep Learning

Deep learning is a subfield of machine learning that employs artificial neural networks to address complex problems. These algorithms empower machines to recognize intricate patterns by analyzing complex data, such as images and sounds. Deep learning methods are generally classified into four main categories, each with its distinct characteristics and applications (Alzubaidi *et al.,* 2021). Below are these categories along with their definitions:

Supervised Learning: Supervised learning is a machine learning approach that aims to statistically identify patterns in data and establish relationships between input and output data. This method relies on labeled data, where each label corresponds to a target value. Supervised machine learning algorithms learn the relationship between the features (input data) and the target values to solve various problems. This approach can be applied

to two main types of problems, both of which require labeled training data (Alloghani *et al.*, 2020). These two types of problems are:

- **Classification:** It is a supervised machine learning method used to categorize data into predefined groups set by the programmer and data analyst. Common tools utilized for classification include Naive Bayes, K-Nearest Neighbors (KNN), Decision Trees, Random Forests, and Support Vector Machines (Zhang and Lou, 2021).
- **Regression:** It is a statistical method used to predict the relationships between dependent and independent variables. This technique is particularly useful when the target variable is continuous. By performing regression analysis, insights into how changes in predictor variables impact the criterion variable can be gained. There are several types of regression techniques, each designed for specific data types and varying relationships between the variables (Vimal and Kumar, 2020; Montgomery, Peck and Vining, 2021). The main regression methods in machine learning include:
    - Linear Regression
    - Polynomial Regression
    - Stepwise Regression
    - Ridge Regression
    - Lasso Regression
    - ElasticNet Regression
    - Bayesian Linear Regression

Unsupervised Learning: This learning method is considered one of the machine learning approaches aimed at discovering hidden structures in an unlabeled dataset and organizing raw data into new features or clustering similar data. Unlike supervised learning approaches, unsupervised learning algorithms do not require mapping input data to output values (or data labels). Problems that require unlabeled training data can be broadly categorized into three groups (Alloghani *et al.*, 2020).

- **Clustering Problems:** Clustering is a data mining technique that uses an unsupervised learning approach. Its main goal is to group unlabeled data based on their similarities and differences. Essentially, clustering involves identifying patterns within unlabeled datasets, which makes the data easier to interpret. This method produces subgroups, or clusters, where each cluster contains data points that are closely related to each other but differ from those in other clusters. Various methods exist for clustering data, as listed below (Omran, Engelbrecht and Salman, 2007):
    - Hierarchical Clustering
    - Centroids Based Clustering
    - Distribution Based Clustering
    - Density Based Clustering
    - Fuzzy Clustering
    - Constraint Based Supervised Clustering
- **Association Rules Problems**: Association rule mining is one of the unsupervised learning approaches in machine learning that seeks to discover interesting relationships between features in a dataset and the association rules among the data. The most common algorithm for extracting association rules is the "Apriori" algorithm. However, other algorithms such as "ECLAT" and "FP-growth" also exist for this type of unsupervised learning (Hegland, 2007; Heaton, 2016; Srinadh, 2022).
- **Dimensionality Reduction Problems**: Dimensionality reduction is another unsupervised learning method used to reduce the number of features in a dataset while preserving important information. In other words, this method is a process for transforming high-dimensional data into a lower-dimensional space while maintaining the essential nature of the original data (Jia *et al.*, 2022).
- **Reinforcement Learning:** Reinforcement learning represents a groundbreaking approach in the realm of machine learning, centered on the art of making sequential decisions. At its core, it consists of three essential components: the agent, the

environment, and a feedback mechanism that shapes the agent's behavior. The agent navigates the environment with a singular mission: to maximize a cumulative reward signal, which serves as the driving force behind its learning and performance.

As the agent engages with its surroundings, it receives invaluable feedback in the form of rewards or penalties. This feedback is instrumental in guiding its development and honing its decision-making skills. The ultimate goal of reinforcement learning is to establish an optimal policy that consistently secures maximum cumulative rewards over time. To achieve this, the agent embarks on an exploratory journey, embracing trial and error while making informed decisions based on its current state.

This vital feedback loop empowers the agent to refine its strategies, fostering increasingly effective decision-making for the future. Through this dynamic and adaptive learning process, reinforcement learning equips agents to excel in complex and ever-evolving environments, paving the way for innovation and success in diverse applications (Mehta, 2020; Hu *et al.*, 2021).

Semi-Supervised Learning: Semi-supervised learning is a type of machine learning where the algorithm is trained on a combination of labeled and unlabeled data. Typically, this combination consists of a very small amount of labeled data and a large amount of unlabeled data. In semi-supervised learning, the main approach is to first cluster similar data using an unsupervised learning algorithm and then use the available labeled data to label the remaining unlabeled data (Zhang and Lou, 2021).

2.3.3.3 Natural Language Processing (NLP)

Natural Language Processing (NLP), a vital subfield of artificial intelligence, enables machines to interpret, understand, and generate human language in a meaningful way. It underpins a wide range of applications, from real-time language translation to sentiment analysis and conversational agents. One of its most prominent uses is in the development of intelligent voice assistants such as Apple’s Siri and Amazon’s Alexa, which rely on NLP to comprehend user queries and provide contextually appropriate responses (Kang *et al.*, 2020). As NLP technologies continue to evolve, they are

increasingly being integrated into business, healthcare, and education systems, improving human-computer interaction and automating complex communication tasks.

2.3.3.4 Computer Vision

Computer Vision (CV), a pivotal subfield of artificial intelligence, enables machines to interpret and analyze visual data, such as images and videos. In the communication industry, CV technologies are increasingly being utilized to enhance network monitoring, optimize infrastructure maintenance, and improve user experience. For instance, CV can facilitate real-time surveillance of network equipment, allowing for prompt detection of anomalies and reducing downtime. Additionally, CV-powered analytics can assist in managing the vast amounts of visual data transmitted over communication networks, ensuring efficient data handling and improved service delivery. The integration of AI and CV in communication networks is instrumental in advancing towards more intelligent and responsive systems, capable of adapting to the dynamic demands of modern digital communication. As highlighted by Adel (2023), the fusion of AI technologies, including CV, within smart city infrastructures exemplifies the transformative impact of these tools in creating more efficient and adaptive communication systems (Adel, 2023).

2.3.4 Concept and Evolution of Sustainability

Sustainability is a widely adopted concept across politics, media, and scientific literature. While its roots lie in ancient cultures that emphasized human-environment harmony, recent decades have witnessed its expansion into economics, philosophy, organizational management, and public policy (Vaseei *et al.*, 2023). Originally meaning continuity and stability, sustainability today refers to the harmonious coexistence of human life and the environment. Sustainable development specifically means meeting present needs without compromising future generations' ability to meet theirs.

The modern articulation of sustainable development emerged prominently through the “Brundtland Commission's report” in 1987, defining sustainable development as development that satisfies present needs without endangering future generations. Other

early influencers, such as Donella Meadows, Edward Goldsmith, and Barbara Ward, played a role in popularizing the term. Global milestones like the "1972 Stockholm Declaration" and the "1992 Earth Summit in Rio de Janeiro" positioned sustainability at the core of global policy agendas (Simonis, 2017).

The concept attempts to more clearly consider the future consequences of current behavior. Sustainable development addresses various areas, including:

- Greenhouse gas impacts
- Climate change
- Ozone layer depletion
- Land degradation
- Depletion of non-renewable resources
- Urban air pollution

Sustainability is a state in which existing utility and facilities do not decrease over time and is related to the ability of ecosystems to continue to function indefinitely without leading to resource depletion or overuse. Sustainability is a condition in which social and natural systems work together in an inextricable way. However, the concept is still used by some international organizations such as the World Bank in the context of the growth perspective. Sustainable development is a broad idea and term that has different meanings, which has provoked different reactions in this field. The concept of sustainable development is an attempt to combine the concepts of a growing field of environmental issues with socio-economic issues. The concept of sustainable development can be seen as a change in the understanding of the relationship between humans and nature and humans with each other. This is in complete contrast to the views of humans of the past two centuries. In the past two centuries, the environment has been considered an external and separate issue to humans. In this view, the relationship between humans and the environment can be seen as the belief that humans should live in complete domination over nature and that humans should overcome all environmental obstacles with the power of their thinking and knowledge and rule nature for themselves. This perspective also

continued to have an impact on the development of capitalism and the fourth industrial revolution (Vaseei *et al.*, 2023).

2.3.4.1 Different Areas of Sustainable Development

A sustainable society for its people, for life to remain healthy, effective and enjoyable, must be based on economic, environmental and social characteristics. It has different types of funds. Evaluating progress towards sustainable development requires a variety of indicators whose definitions and technical terms are still somewhat ambiguous. There should be a clear and agreed definition for the indicator as well as related concepts such as level, profile, target and standard. These agreements should not be approved only in the political field, but also in terms of logic and values. Some specific definitions for indicators that have been presented in various references are: a hypothetical variable that represents another unit that is not granular and a criterion for examining information related to a specific phenomenon or an independent effector for measuring that phenomenon. An indicator helps you understand where you are, in which direction you are heading, and how far away you are from what you want. A good indicator will warn you of a problem before it occurs and help you solve the problem. Sustainable society indicators are used when the relationship between the economy, environment and society is weak. Sustainability indicators show the fact that the three basic parts in this field are related to each other. Sustainable development is undoubtedly a complex concept that includes various dimensions, including environmental, social and economic, as shown in Figure 2.2 (Shahrabi-Farahani *et al.*, 2024).

In sustainability studies, it is necessary to consider the goals in the three axes at the same time. Social development must be evaluated in a way that meets the needs of all people, also the environment must be protected effectively and use natural resources carefully to ensure sustainable economic growth.

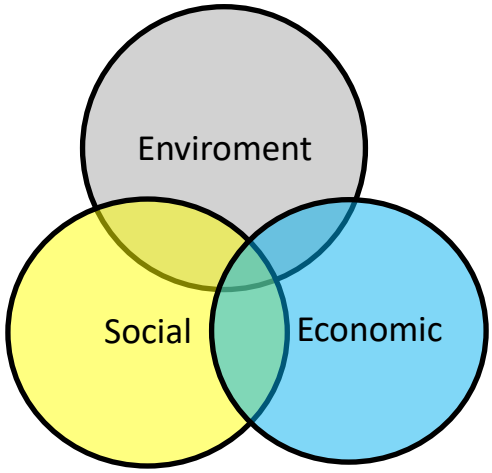

Figure 2.2
Features of Sustainability

A sustainable society is one that effectively meets the needs of its people while ensuring that life remains healthy, effective, and enjoyable. This concept is rooted in the integration of economic, environmental, and social characteristics, which together form the foundation for a thriving community. Achieving sustainability requires a multifaceted approach that recognizes the interdependence of these three dimensions. Each aspect plays a critical role in shaping the overall well-being of society, and neglecting any one of them can lead to imbalances that threaten sustainability.

Economic sustainability index: Economic sustainability refers to the ability of an economy to maintain and improve its performance over time while ensuring that natural, financial, and human resources are used efficiently and responsibly. It is not merely about maximizing profits or short-term growth but about fostering an economy that supports social equity, protects environmental systems, and enhances the overall quality of life for all members of society (OECD, 2019). A robust and sustainable economy must generate stable employment, encourage innovation, and support long-term growth without compromising the needs of future generations.

To evaluate and guide this balance, the economic sustainability index serves as a comprehensive framework for assessing how well an economy aligns its growth strategies

with environmental and social objectives. This index typically comprises a sequence of economic variables and sub-indices that measure the performance and impact of various sectors, such as industrial output, employment rates, resource efficiency, income distribution, and public investment in innovation (Böhringer and Jochem, 2007). These indicators provide a nuanced view of how economic activities influence and are influenced by environmental pressures and societal well-being, supporting the integration of sustainability into macroeconomic planning (Dewan, 2006).

By utilizing economic sustainability indicators, policymakers and stakeholders are empowered to make data-driven decisions that stimulate economic performance while promoting long-term sustainability. For instance, if an indicator, highlights increasing income inequality, governments may implement targeted policies to expand access to education and employment opportunities in marginalized communities. Similarly, if resource efficiency is shown to be declining, industries and regulators can adopt technologies or practices to reduce waste and optimize production processes (Zhang *et al.*, 2021). In this way, the index functions not only as a monitoring tool but as a driver of continuous improvement and adaptive governance.

Businesses also benefit from incorporating sustainability indicators into their strategies. Companies that align their operations with economic and environmental sustainability standards are better equipped to respond to shifting consumer preferences, regulatory changes, and global market dynamics. Embracing sustainable practices often leads to innovation, cost reductions, and the creation of new revenue streams, enhancing both competitiveness and resilience (Hugé, 2014). This alignment with sustainability principles allows firms to meet present needs while building capacity for future growth.

Despite its utility, the application of the economic sustainability index faces challenges. One of the most significant issues is the lack of consistent and reliable data, particularly in developing or low-resource regions. Environmental and social indicators are often poorly documented or inconsistently reported, which limits the ability to form a complete and accurate sustainability assessment. To improve the utility of these indices,

governments and institutions must invest in better data collection, standardized reporting frameworks, and cross-sector collaboration.

In summary, the economic sustainability index is a critical tool for understanding the interplay between economic development and sustainability goals. It allows decision-makers to evaluate the impacts of their policies and strategies across economic, environmental, and social dimensions. Through the use of comprehensive indicators and continuous feedback, economies can progress toward more inclusive, efficient, and resilient growth pathways that support both present and future generations.

Environmental sustainability Index: Environmental sustainability is a foundational pillar of sustainable development, emphasizing the need to preserve and protect natural resources and ecosystems to maintain the ecological balance that supports life on Earth. It requires the responsible and efficient management of environmental resources to prevent degradation, mitigate climate change, and preserve biodiversity for the benefit of both present and future generations (UNEP, 2021). Critical issues such as pollution, global warming, biodiversity loss, and overconsumption of natural resources are at the heart of environmental sustainability efforts. These challenges highlight the importance of long-term thinking and proactive strategies in environmental governance and policy-making.

To monitor and assess progress toward environmental sustainability, researchers and policymakers utilize the environmental sustainability index—a measurement framework composed of a sequence of environmental variables. This index plays a crucial role in evaluating the health of ecosystems and the broader environmental impact of economic and social activities. Unlike standalone metrics, the environmental index provides a holistic approach by incorporating sub-indices that reflect conditions such as waste generation, energy usage, climate-related impacts, and the preservation of biodiversity and natural resources (Tajbakhsh and Hassini, 2015). These sub-indices offer a multidimensional understanding of how human activities influence the environment, enabling a balanced approach to sustainable development.

The core objective of using environmental indicators is to support evidence-based policymaking. They help identify environmental degradation, assess the effectiveness of current regulations, and guide corrective actions. For example, indicators can reveal trends in deforestation, air quality deterioration, or habitat loss, thereby allowing timely interventions. Environmental indices also allow for comparative analyses between regions and countries, encouraging transparency, benchmarking, and knowledge exchange. Moreover, these indicators are instrumental in shaping integrated sustainability strategies that align environmental health with economic and social priorities, ensuring that development does not come at the expense of ecological integrity (Little, Hester and Carey, 2016).

Importantly, environmental indicators are increasingly being embedded within broader economic sustainability frameworks. This integration ensures that economic planning incorporates environmental externalities and natural capital accounting—key to achieving genuine sustainability (Vaseei *et al.*, 2023). For instance, businesses and governments can use environmental indices to align development goals with ecological constraints, helping to avoid irreversible damage while creating long-term value. Through this approach, sustainability indices serve not only as assessment tools but also as mechanisms for improving the design, coherence, and effectiveness of environmental policies (OECD, 2019).

However, like all measurement systems, environmental indices are not without limitations. Data availability and quality can vary across regions, limiting the comparability and reliability of results. Furthermore, environmental indicators must be updated regularly to remain relevant in dynamic ecosystems influenced by evolving technologies, consumption patterns, and climate-related risks. Continuous investment in data infrastructure, cross-sector collaboration, and methodological refinement is necessary to ensure the practical utility of these indices in guiding sustainable development.

In conclusion, the environmental sustainability index provides a critical framework for understanding the interactions between economic growth, human activity, and ecological health. By capturing a wide range of environmental performance indicators,

including waste management, energy consumption, biodiversity preservation, and climate metrics, it supports the formulation of effective, science-based policies and decisions. Ultimately, the environmental index acts as a vital bridge between development and stewardship, enabling societies to achieve a more sustainable, equitable, and resilient future.

Social Sustainability Index: Social sustainability is a fundamental pillar of sustainable development, focusing on the well-being, inclusion, and empowerment of individuals and communities. It encompasses key societal aspects such as equity, access to education and healthcare, participatory governance, and social cohesion. A socially sustainable society ensures that all people have the opportunity to participate fully in economic, political, and cultural life, regardless of background or status. Achieving this requires addressing systemic inequalities, protecting the rights of marginalized groups, and fostering social integration and inclusion across all layers of society (Colantonio, 2010).

Evaluating social sustainability requires a variety of indicators to assess policy effectiveness and progress. Indicators serve as tools that reflect social realities, reveal inequalities, and help guide decision-makers. They must be well-defined and logically grounded, not only within technical or political frameworks but also within shared societal values Vallance. Social sustainability indicators can take several forms: hypothetical variables representing complex conditions, performance criteria for specific phenomena, or independent variables assessing outcomes such as access, equity, or cohesion. When well-designed, indicators function as early warning systems, alerting policymakers to emerging issues, such as rising poverty or declining access to services, before they escalate.

Indicators that reflect education access, employment participation, healthcare equity, income distribution, housing security, and civic engagement are essential in building a reliable picture of social development. These tools also help illustrate the interconnectedness of the three dimensions of sustainability: economic, environmental, and social. For instance, environmental degradation can have serious social consequences, particularly for vulnerable populations, just as social inequality can undermine economic growth or environmental policy adoption (Vaseei *et al.*, 2023).

Social development refers to the process of restructuring and improving social systems and relationships to enhance quality of life, promote cohesion, and ensure justice and opportunity for all members of society. It extends beyond economic growth or infrastructure expansion, addressing how individuals relate to each other within the social fabric. According to Tavassoli et al. (2021), social development must focus on empowering marginalized populations while also considering the responsibilities and influence of those in power. It includes reducing poverty, ensuring equitable access to healthcare and education, and fostering inclusive governance. Education, in particular, is a core enabler of social mobility and cohesion, allowing individuals to gain the knowledge and skills needed to engage fully in society and the economy (Tavassoli, Amini and Rafiee, 2021).

Equally important is healthcare access, which supports societal resilience and productivity. Without adequate health systems, communities struggle to thrive. Thus, policies that invest in social infrastructure are central to national cohesion and stability. Governments must prioritize inclusive policy-making, participatory decision processes, and resource allocation that support marginalized groups, such as women, children, elderly individuals, people with disabilities, and ethnic minorities (Bannerji, 2022). Social integration, the process of uniting individuals from different social, economic, or ethnic backgrounds, and social cohesion, the degree of trust and connectedness within a community, are both essential for fostering a stable and equitable society.

The success of social sustainability efforts hinges on the commitment of government officials and policymakers. They must recognize that social development is not secondary to economic or environmental agendas, but a central component of national progress. Effective leadership involves building inclusive institutions, developing targeted social programs, and fostering partnerships with civil society organizations. These initiatives should aim to reduce disparities and empower citizens to contribute meaningfully to the development process. Policymakers also have a responsibility to ensure that sustainability indicators are relevant, inclusive, and regularly updated, so they reflect real-world conditions and inform adaptive governance.

A key aspect of national cohesion is fostering a sense of belonging and unity across diverse population groups. This requires active engagement in community-building efforts, cultural exchange, and dialogue. Without deliberate action to promote equity and inclusion, societies risk becoming fragmented, which can lead to unrest, distrust, and stagnation. Therefore, policies must bridge social divides through transparent communication, fair representation, and targeted social protection mechanisms.

The interconnection of economic, environmental, and social sustainability indices highlights the integrated nature of sustainable development, where meaningful progress requires simultaneous attention to all three dimensions. These indices, though conceptually distinct, function collectively as a comprehensive framework for assessing how policies and practices affect societal well-being, ecological integrity, and economic viability. Economic prosperity, for example, must be achieved without depleting natural resources or deepening social inequalities, while environmental protection strategies are more effective when aligned with inclusive economic policies that support livelihoods and social justice. Likewise, social sustainability is strengthened when communities have access to clean environments, equitable economic opportunities, and participatory governance structures. Each index provides insights into specific aspects of sustainability, but their combined analysis enables decision-makers to identify trade-offs, synergies, and long-term impacts. Integrating these indices ensures that development is not only efficient and productive, but also equitable and ecologically responsible. This multidimensional approach is essential for crafting policies that balance growth with resilience, enabling societies to thrive both now and in the future.

In Table 2.1, factors of sustainability that are considered in each economic, social and environmental index in past studies are shown.

Table 2.1
Factors of Sustainability

Factor	Description	References
Economic		
Cost/Price	The final cost of buying a unit of raw materials or semi-finished product.	(Pachar *et al.*, 2022; Trummer, Ammerer and Scherz, 2022)
Quality	The performance of purchased materials to meet or exceed the requirements and expectations set forth in the service or product to which they are committed.	(Tavassoli, Amini and Rafiee, 2021)
Adaptation to technology	The total knowledge of a company in support of innovation and technology.	(Krara *et al.*, 2025)
Capacity	The ability of human, financial and material resources related to product manufacturing.	(Wang, Zhang and Xu, 2022)
Financial	The necessary capital for the normal maintenance of business activities in a certain period of time.	(Tuyon *et al.*, 2023)
Delivery	Ability to transport goods from one place to a predetermined destination.	(Amaya, Encarnación and Cantillo, 2025)
Social		
Rights of beneficiaries	A right or welfare belonging to a person who owns shares or some related interest in the private sector.	(Kumi and Yeboah, 2019; Tavassoli, Amini and Rafiee, 2021)

Staff training	The process of increasing the skills, abilities and knowledge of employees for a specific job.	(Bozionelos, Lin and Lee, 2020)
Disclosure of information	Providing information to stakeholders about the items used and toxins released during production, etc.	(Sulemana *et al.*, 2025)
Environment		
Green image	An identity that prioritizes environmentally friendly consumers.	(Tu *et al.*, 2024)
System environment management	A system that comprehensively evaluates the internal and external performance of an organization.	(Tajbakhsh and Hassini, 2015)
Pollution control	Control of pollution released into the air, water or soil.	(Tavassoli, Amini and Rafiee, 2021)
Green product	Environmentally friendly products that are free from pollution, save renewable resources and can be recycled.	(Hariadi, Moengin and Maulidya, 2023)

2.4 Case Studies of AI Implementation in Telecommunications

This section explores how telecommunications companies in Iran and neighboring countries have adopted artificial intelligence (AI) to enhance operations, customer service, and financial sustainability. These regional examples provide insights into practical applications of AI in contexts similar to Iran's.

- **Iran: National AI Platform for Telecommunications**

In March 2025, Iran unveiled a prototype of its national artificial intelligence platform, developed in collaboration with Sharif University of Technology. Designed to

operate in domestic languages and maintain functionality during internet disruptions, the platform aims to support various sectors, including telecommunications. The phased rollout includes initial testing and optimization in 2025, followed by limited access for experts and knowledge-based companies, with a public beta release and final version expected by March 2026 (DigWatch, 2025).

- **Turkey: Turkcell's AI-Driven Network Optimization**

Turkcell, a leading Turkish telecom operator, has implemented AI and machine learning algorithms to optimize network capabilities. By integrating Geographic Information System (GIS) technologies, Turkcell has enhanced strategic planning and location intelligence, leading to improved service delivery and operational efficiency. The company utilizes tools like ArcGIS Spatial Analyst and ModelBuilder to determine optimal locations for fiber-optic cable investments, based on factors such as current customer locations and existing infrastructure (Baumann, 2024).

- **Pakistan: National AI Policy and Telecom Sector Integration**

Pakistan is actively developing AI applications across multiple sectors, including telecommunications. The country's National AI Policy emphasizes the development of necessary policies, research, skills, and infrastructure to facilitate AI integration, aiming to enhance service delivery and operational efficiency in the telecom industry. The policy outlines objectives such as fostering AI awareness, adoption, and responsible use, with a focus on upskilling human capital and promoting AI-based platforms (DataGuidance, 2023).

- **Azerbaijan: AI in Smart City Development**

Azerbaijan has integrated AI into various sectors through state-led digital initiatives. In the telecommunications sector, AI is utilized to support smart city development, enhancing infrastructure and service delivery. The government has been actively promoting digital transformation initiatives, focusing on e-government, e-services, and the development of robust digital infrastructure. Smart city projects are underway in major cities like Baku, Sumgayit, and Ganja, leveraging AI to improve governance and urban services (Potter and Olaoye, 2024).

- **Iraq: AI for Financial Sustainability in Telecom**

Iraqi telecommunications companies, such as Zain Iraq and Asia Cell, have incorporated AI capabilities to enhance financial sustainability. A field study revealed that integrating AI with organizational maturity contributes to achieving tangible gains in performance and financial outcomes. The research highlighted a complementary relationship between AI capabilities and organizational maturity, influencing financial sustainability in the telecom sector (Wajiya and Saleh, 2024).

2.5 Summary

This chapter provides a detailed exploration of the theoretical foundations and key concepts underpinning the research on artificial intelligence (AI), strategic management, digital transformation, and sustainability in Iran's telecommunications industry. It begins with an introduction to the importance of these concepts and outlines the structure of the chapter, which is divided into theoretical background and framework sections.

The theoretical background section examines four core areas: digitalization, digital transformation, artificial intelligence, and sustainability. Digitalization is described as a transformative process that integrates digital technologies to enhance business operations, improve efficiency, preserve information, and create new value. Key steps in digitalization include collection, conversion, storage, and access of digital data. Its advantages include operational agility, global communication, intelligence, transparency, cost savings, scalability, and innovation. For instance, digital tools like predictive analytics and automation allow organizations to respond quickly to supply chain disruptions, while global digital supply chains enable faster and more reliable delivery of goods and services. However, challenges such as cybersecurity risks and the need for significant infrastructure investments are also noted.

Digital transformation builds on digitalization, focusing on how organizations use technology to fundamentally change their operations, customer experiences, and business models. It highlights trends such as the growing importance of digital technologies post-COVID-19, the scarcity of skilled talent, the emphasis on sustainability and transparency, the need for integrated technology systems, and the critical role of trust and cybersecurity.

The 2020 Digital Maturity Model identifies enablers like governance, leadership, strategy, culture, innovation, technology, and data as essential for achieving outcomes like new business models and improved employee and customer experiences.

Artificial intelligence (AI) is explored as a field that uses algorithms to mimic human intelligence, enabling tasks like data analysis, decision-making, and automation. AI's subfields, including machine learning, deep learning, natural language processing (NLP), and computer vision, are discussed. Machine learning algorithms such as linear regression, logistic regression, decision trees, and neural networks are explained, highlighting their applications in classification, prediction, and pattern recognition. Deep learning, reinforcement learning, and semi-supervised learning are also covered, showcasing AI's ability to handle complex problems like image recognition and voice assistants. AI is presented as a tool to enhance innovation, customer engagement, and operational efficiency in businesses.

Sustainability is defined as meeting current needs without compromising future generations' ability to meet theirs, encompassing economic, environmental, and social dimensions. The historical evolution of sustainability, from the 1972 Stockholm Declaration to the 1987 Brundtland Report, is outlined. Economic sustainability focuses on efficient resource use and equitable growth, measured by indicators like cost, quality, and capacity. Environmental sustainability emphasizes resource preservation and pollution control, with indicators like waste management and biodiversity conservation. Social sustainability addresses equity, education, and community well-being, with indicators like staff training and information disclosure. The chapter underscores the interconnectedness of these dimensions, emphasizing the need for balanced development.

The theoretical framework integrates four theories to guide the research: the Technology Acceptance Model (TAM), which explains how perceived usefulness and ease of use drive AI adoption; the Resource-Based View (RBV), which highlights AI and digital capabilities as strategic assets for competitive advantage; the Dynamic Capabilities Theory, which focuses on firms' ability to adapt to changing environments through AI and strategic management; and the Triple Bottom Line (TBL), which evaluates digital

transformation's impact on economic, environmental, and social outcomes. These theories provide a comprehensive lens to analyze how AI and strategic management can drive sustainable digital transformation in Iran's telecommunications sector.

Overall, this chapter lays a solid foundation for the research by clarifying key concepts and theories. It highlights the transformative potential of AI and digital technologies, the importance of sustainability, and the strategic approaches needed to navigate the complexities of digital transformation in a rapidly evolving industry. The insights from this chapter set the stage for identifying research gaps and guiding the study's empirical investigation.

CHAPTER III:

METHODOLOGY

3.1 Overview of the Research Problem

The Iranian telecommunications industry is undergoing significant transformation, driven by the global surge in digitalization and the integration of emerging technologies such as artificial intelligence (AI). This shift presents both opportunities and challenges for organizations seeking to enhance efficiency, competitiveness, and sustainability. However, despite the global momentum toward digital transformation, there remains a lack of localized, evidence-based frameworks that guide the effective integration of AI within strategic management practices, particularly in the context of developing economies like Iran. The complexity of aligning technological innovation with long-term sustainability goals necessitates a structured and empirical investigation. The central research problem, therefore, lies in understanding how AI and strategic management can be leveraged together to support a sustainable digital transformation agenda within Iran's telecommunications sector. This problem is compounded by industry-specific constraints, such as regulatory challenges, infrastructure limitations, and evolving consumer demands. Addressing this gap requires a comprehensive study that not only captures the current state of AI and strategic management practices but also explains their interactive effects on sustainability outcomes. This chapter sets the foundation for that investigation by outlining the research purpose and questions, the methodological framework, and the design through which empirical insights will be developed.

3.2 Research Purpose and Questions

The purpose of this research is to explore the critical intersection of artificial intelligence (AI) technologies and strategic management practices in fostering sustainable digital transformation within the Iranian telecommunications industry. As digitalization accelerates and sustainability becomes a global imperative, Iranian telecom companies face

increasing pressure to leverage AI-driven solutions in ways that align with long-term strategic goals, ethical standards, and regulatory frameworks. This study aims to generate actionable insights that inform industry leaders, policymakers, and researchers about the potential of AI to enhance innovation, improve efficiency, and support sustainable practices. The research contributes to filling a significant gap in existing academic discourse by focusing on the Iranian context and offering practical guidance for aligning AI integration with sustainability objectives. To this end, the study addresses the following key research questions:

(RQ1): How the synergistic relationship between AI technologies and strategic management practices can be investigated and analyzed in the creation of sustainable digital transformation in Iran's telecommunications industry?

(RQ2): How do the environmental, social and economic effects of deploying artificial intelligence to make strategic management decisions affect the sustainable development of Iran's telecommunications industry?

(RQ3): How AI and strategic management principles can be adjusted to guide sustainable digital transformation strategies in Iranian telecommunications organizations with an emphasis on ethical considerations and regulatory compliance?

3.3 Research Design and Methodology

This study employs a quantitative research methodology grounded in a deductive approach, designed to test theoretical assumptions about the relationship between artificial intelligence (AI), strategic management (SM), and sustainable digital transformation in the Iranian telecommunications industry. The quantitative method enables the systematic collection and analysis of numerical data, supporting the objective evaluation of predefined constructs. The deductive logic begins with a theoretical framework drawn from existing literature, from which hypotheses are developed and then tested using empirical evidence. In terms of research purpose, the study integrates three core dimensions: it is explanatory, as it investigates cause-and-effect relationships among AI capabilities, SM practices, and sustainability outcomes; descriptive, in that it documents and categorizes the current state of AI and SM implementation in the telecom sector; and applied, as it aims to provide

practical, actionable insights and frameworks for industry practitioners and policymakers. To support this multidimensional inquiry, the research utilizes both primary and secondary data. Primary data were collected through a structured questionnaire, distributed to 105 professionals, including telecom managers, consultants, and domain experts, using purposive sampling with a snowball technique. The questionnaire captured both demographic information and Likert-scale responses to assess the perceived influence of various AI and SM factors. Secondary data were gathered through a comprehensive review of academic literature and industry reports to inform the conceptual model and instrument design. For data analysis, the study employed SPSS for initial reliability testing (e.g., Cronbach's alpha) and normality checks, and LISREL software for Structural Equation Modeling (SEM) to examine both the measurement model and the structural relationships among latent variables. This combination allows for a detailed examination of how AI and SM jointly contribute to sustainability in a digital context. The research design is structured and sequential, as illustrated in the accompanying flowchart, Figure 3.1, which maps out the process from problem definition and literature review to data collection, validation, statistical modeling, and final interpretation. The flowchart highlights key stages such as questionnaire refinement, expert validation, model estimation, and strategy formulation, ensuring a rigorous and transparent pathway from theory to practice. Together, this comprehensive design ensures the methodological robustness and practical relevance of the study, aligning scientific inquiry with the strategic challenges and opportunities facing Iran's digital telecommunications landscape.

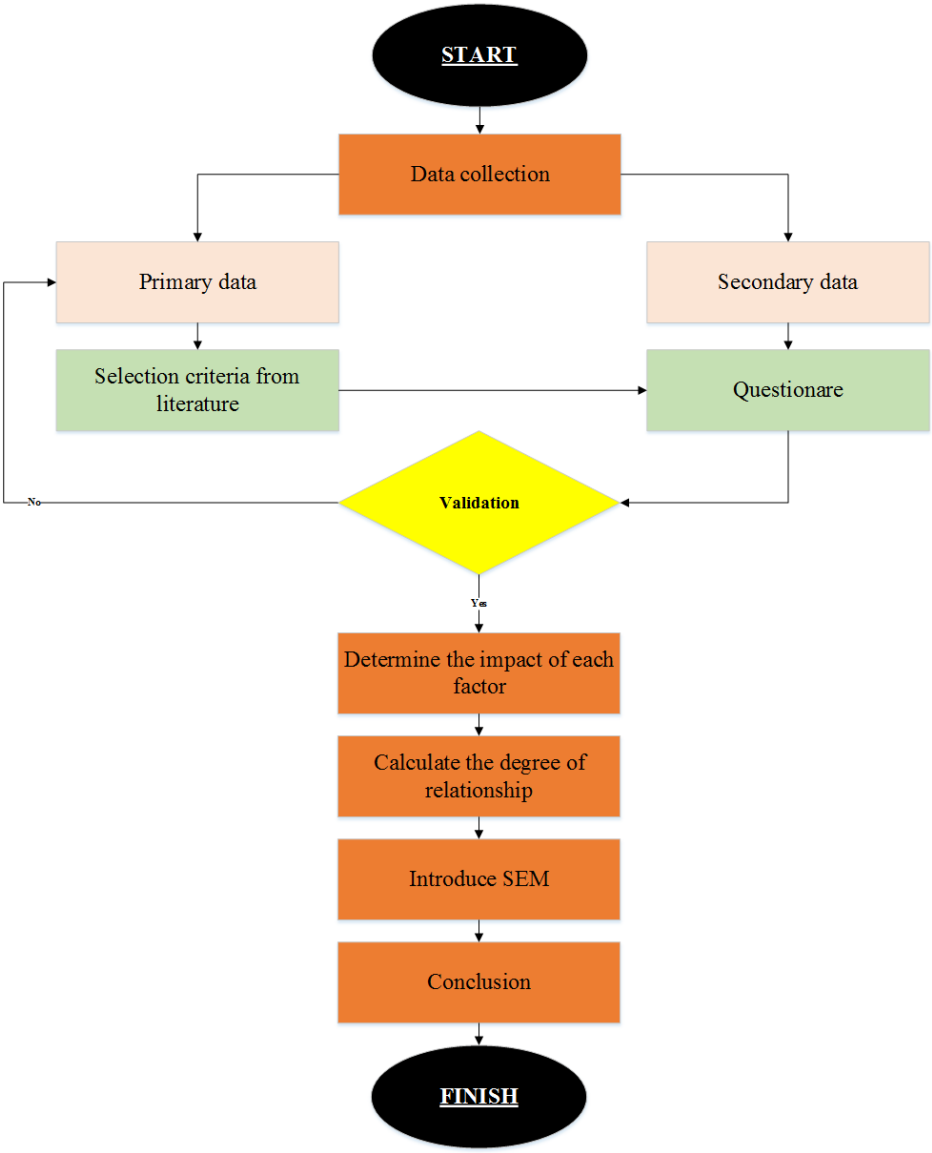

Figure 3.1
Research Framework

3.4 Operationalization of Theoretical Constructs

In order to empirically examine the role of artificial intelligence (AI) and strategic management (SM) in fostering sustainable digital transformation within the Iranian telecommunications industry, it was essential to operationalize the theoretical constructs derived from the literature. This process involved identifying key dimensions of AI and

SM that are most relevant to digital transformation and translating them into measurable variables suitable for survey-based research.

The selection of constructs was informed by an extensive review of peer-reviewed academic studies and industry reports, ensuring both theoretical rigor and practical relevance. Each main construct, AI and strategic management, was decomposed into sub-factors that reflect critical aspects of their application within organizational contexts. These sub-factors were carefully evaluated by domain experts to confirm their appropriateness, clarity, and relevance to the Iranian telecommunications sector. This expert validation step was crucial for enhancing the face and content validity of the research instrument. Table 3.1 presents the operationalized constructs, including their associated sub-factors, coding signatures, and source references from the existing literature. These indicators served as the foundation for questionnaire item development and subsequent statistical modeling.

Table 3.1

Primary Research Factors and Their Operationalized Sub-Criteria

Main factor	Sub factor	Signature	References
Artificial intelligence (AI)	Research and Development	AI1	(Aghayari, Valmohammadi and Alborzi, 2023; Slimani *et al.*, 2024)
	data analysis	AI2	(Younus, 2022)
	Automation	AI3	(Younus, 2022)
	Security and information protection	AI4	(Younus, 2022; Slimani *et al.*, 2024)
	Customer support	AI5	(Aghayari, Valmohammadi and Alborzi, 2023; Slimani *et al.*, 2024)
	Developing a strategy	AI6	(Younus, 2022)
	Empowering staff	AI7	(Younus, 2022)
Strategic management (SM)	Strategic leadership	SM1	(Gharib, 2019)
	Environmental analysis	SM2	(yadegari, 2021)
	Innovation and technology	SM3	(Al-Alwan *et al.*, 2022)
	Cooperation and communication	SM4	(Aghayari, Valmohammadi and Alborzi, 2023)
	Development of skills in risk management	SM5	(Aghayari, Valmohammadi and Alborzi, 2023; Slimani *et al.*, 2024)
	Financial stability	SM6	(Younus, 2022)
	Risk management	SM7	(Younus, 2022)

These constructs were later subjected to statistical testing using Structural Equation Modeling (SEM) to validate their interrelationships and determine their impact on the broader framework of sustainable digital transformation. The systematic operationalization of constructs ensures that the research is grounded in both theoretical integrity and empirical measurability.

3.5 Population and Sample

The target population for this research comprises telecommunication managers and consultants operating at the national, provincial, regional, and city levels within Iran. These individuals are selected based on their strategic and operational involvement in the digital transformation processes within their respective organizations. The study aims to obtain a minimum of 100 completed and valid responses to ensure the reliability and generalizability of the findings across the sector.

The questionnaire is designed to be concise and user-friendly, requiring approximately 15 minutes to complete. It is structured into two distinct sections. The first section collects demographic information such as age, gender, education level, professional role, and years of experience. The second section is dedicated to evaluating the perceived influence of artificial intelligence (AI) and strategic management (SM) on the sustainable digital transformation of the Iranian telecommunications industry, using a series of structured Likert-scale items aligned with the study's conceptual framework.

To identify appropriate participants, the study employs targeted theoretical sampling combined with the snowball sampling technique. This approach ensures access to expert respondents with direct knowledge of strategic and technological initiatives in the telecommunications sector. Initial participants are selected based on their relevance and expertise, and they are then asked to recommend additional qualified individuals, thereby expanding the sample pool in a structured and purposeful manner.

3.6 Participant Selection

To ensure the credibility and generalizability of the research findings, the study aims to collect a minimum of 100 valid responses from a diverse group of participants. The

target population includes national, provincial, and regional telecommunications managers and consultants across various organizational levels, age groups, and genders. This diversity is intended to strengthen the reliability and representativeness of the data. Participation in the survey will be entirely voluntary and anonymous, with no personally identifiable information collected at any stage. Prior to completing the questionnaire, all participants will be provided with a clear explanation of the research purpose, procedures, and their rights. Informed consent will be obtained from each respondent, emphasizing that they may decline to answer any question or withdraw from the study at any point without any consequences. This ethical approach ensures full compliance with academic research standards and fosters an environment of trust and transparency throughout the data collection process.

3.7 Instrumentation

Research is considered reliable when accurate and consistent tools are employed in its execution. Research reliability refers to the degree to which the results of a study can be reproduced under the same conditions, using the same methodology and assumptions. In the current study, all processes, from data collection through a structured questionnaire to the implementation of statistical analyses, are designed to ensure reproducibility. This is made possible by thoroughly documenting all the tools, instruments, and settings used in the research, allowing other scholars to replicate the study if desired.

Validation, on the other hand, assesses whether the results genuinely reflect what the study intends to measure. To evaluate the reliability of the instrument, Cronbach's alpha coefficient is calculated for the data obtained from the questionnaire. If the Cronbach's alpha is greater than 0.7, the internal consistency of the instrument is considered acceptable, and the results are deemed reliable. If the coefficient falls below this threshold, outlier data will be identified and excluded, and the calculation will be repeated to improve reliability until a satisfactory confidence level is achieved.

Additionally, to further validate the questionnaire items, the Content Validity Ratio (CVR) index is computed for each question, based on the responses from the selected participant group. If the CVR value for an item is acceptable according to established

statistical thresholds, that item is retained for analysis. Conversely, if the CVR is deemed insufficient, the respective item will be excluded from the final instrument to maintain overall content validity.

3.8 Data Collection Procedures

Data collection for this research is conducted through two key dimensions: secondary data and primary data. The secondary data component involves a thorough review of existing literature related to artificial intelligence (AI), strategic management, and sustainable digital transformation. This review draws upon scholarly sources from reputable academic databases such as ScienceDirect, as well as peer-reviewed journals and industry reports. The insights gained from the literature inform the theoretical framework, the operationalization of constructs, and the development of the research instrument.

The primary data is collected using a structured questionnaire specifically designed for this study. The questionnaire comprises two sections: the first gathers demographic information about participants, including age, gender, educational background, professional role, and years of experience. The second section focuses on assessing the perceived impact of AI and strategic management practices on sustainable digital transformation within the Iranian telecommunications sector. All questions are structured using Likert scales to facilitate quantitative analysis.

To ensure participant privacy and data protection, the questionnaire is completely anonymous, with no personally identifiable information being collected. Data is stored securely on a password-protected personal device, accessible only to the principal researcher and the academic supervisor. The questionnaire will be administered via a secure online platform, and its link will be distributed through multiple official and informal channels to maximize reach and participation. These include in-person visits to central offices of telecommunications companies such as “Mobin Net”, where printed materials with the QR code or web address will be shared, as well as through digital channels such as WhatsApp and Telegram groups specifically for telecom managers and consultants. In addition, official company email lists will be used to disseminate the link to employees in major cities including Tehran, Mashhad, Rasht, and others.

For data analysis, the study employs Structural Equation Modeling (SEM) using LISREL software to examine the relationships between latent variables and test the research hypotheses. Prior to conducting SEM, the dataset will be evaluated for normality. In the event that normal distribution assumptions are violated, appropriate non-parametric statistical tests will be applied using SPSS software. Furthermore, Microsoft Excel will be utilized for preliminary data cleaning, organizing, and conducting supplementary statistical calculations. This multi-tool approach ensures rigorous and comprehensive data analysis aligned with the research objectives.

3.9 Data Analysis

In this current research, to analyze the data in this research, I will use structural equations using LISREL software. If the normality test of the collected data is not confirmed, non-parametric tests will be used in SPSS software. In addition, some necessary calculations and statistical analysis will be performed using EXCEL software. The proposed framework for establishing the proposed model in this research, which is based on structural equations, is generally possible in four stages as follows:

1. Identify features that factor in sustainable digitalization, like AI and strategic management.
2. Determine the impact of each factor on sustainable digitalization.
3. Calculate the degree of relationship between observed and latent factors,
4. Introduce a structural equation model and how to convert the current situation to the proposed desired situation.

Phase 1: Identify features that factor in sustainable digitalization, like AI and strategic management.

Tool: questionnaire

In this step, firstly the influencing factors is divided into two groups of observed and hidden variables. Observed variables are those variables that are determined using an internal systematic study as criteria that can affect the organization's process. Studying the observed variables in organizations is important because it can always be useful for the analyst in identifying the hidden variables of the organization in question. But in order to

study and perform statistical analysis, these variables must be divided into groups, so that the observed variables that are related to each other are put in one category, which are actually the same hidden variables. In this case, the latent variables cover the observed variables. It should be noted that in conceptual model design, hidden variables are always like model nodes. To achieve these variables, the use of data collection tools is a key factor. Questionnaire in this field can be of great help to an analyst. Before preparing the questionnaire, the necessary information should be collected using the library method. To complete this section, by reading books, articles and research in the relevant field, the most important obvious variables can be found in this regard.

Phase 2: Determine the impact of each factor on sustainable digitalization,

Tools: LISREL software

This stage is implemented with the aim of providing a conceptual model of the organizational process that can show the relationships between factors well. In other words, at this stage the logical relationships between the hidden variables and other variables are sought to be determined. Latent variables are divided into dependent variables and independent variables. Coefficients are actually what are meant to calculate, based on which the relationship of variables is measured. The coefficient of an independent latent variable is equal to λ, the coefficient of an independent latent variable is equal to the latent dependent variable is equal to γ, and the coefficient of a latent variable is equal to β. If the coefficient is less than 0.3, the relationship is considered weak and will be ignored that relationship. A factor loading between 0.3 and 0.6 is acceptable, and a factor loading greater than 0.6 is considered very favorable. The purpose is to determine the coefficients between the variables identified in the organization. For this purpose, a preliminary conceptual model should be designed at this stage.

Phase 3: Calculate the degree of relationship between observed and latent factors

Tools: LISREL software

At this stage, after designing the initial model in LISREL software and running the implementation from the initial model, the coefficients are determined by the software if the variables and the model have adequate overlap. At this stage, it is necessary to report

the output of the software in different modes, such as ESTIMATED and STANDARD, to check the estimated coefficients.

Phase 4: Introduce a structural equation model and how to convert the current situation to the proposed desired situation

In this step, according to the output of LISREL software, the value of the P statistic for the model is calculated. Considering that the statistical analysis is performed in the 95% confidence interval, if the P value is calculated to be less than 0.05, the model is statistically significant. In general, the lower the value of P, is better. Therefore, it can be concluded that the estimated model has good accuracy. In the ESTIMATED mode, if the variables have the interval range specified in the second phase, the other variables will be selected and left. Finally, the path that leads us to the goal is chosen as the dominant strategy over other strategies.

3.10 Research Design Limitations

Like any empirical study, this research is subject to certain limitations that may impact the scope, process, or generalizability of its findings. Recognizing these challenges is essential for ensuring transparency and planning mitigation strategies to maintain the integrity and feasibility of the research. The key limitations anticipated in the current study include:

Potential low response rate: The researcher may encounter difficulty obtaining a sufficient number of responses within the designated data collection period, which could limit the representativeness of the sample and affect the robustness of the statistical analysis.

Time management constraints: Due to the scope and complexity of the study, the researcher may face challenges in organizing tasks efficiently, potentially leading to delays in completing the project as planned.

Motivational setbacks: At various stages of the research process, the researcher may experience a lack of motivation or fatigue, which could hinder consistent progress and affect the quality of output.

To address these limitations, the following strategies will be implemented:

1. Given the large and diverse pool of potential participants in the telecommunications sector, the researcher will apply a flexible approach to sampling. If a specific manager or consultant declines to participate, alternative respondents from the same organizational tier or geographic area (city, region, or province) will be approached promptly to maintain sample size and diversity.
2. A detailed project schedule with section-specific deadlines will be developed and actively monitored to support time management. This structured approach will help ensure the research remains on track and milestones are met within the prescribed timeline.
3. In the event of demotivation, the researcher will proactively seek guidance and encouragement from the academic supervisor, who can provide support, feedback, and direction to help sustain momentum and maintain focus throughout the project lifecycle.

3.11 Conclusion

The current research has provided critical insights into the dynamic interplay between artificial intelligence (AI), strategic management (SM), and sustainable digital transformation within Iran's telecommunications sector. The findings underscore the synergistic relationship between AI technologies and strategic leadership practices as pivotal enablers of sustainable innovation and organizational resilience. When effectively integrated into core operations and decision-making frameworks, AI serves not merely as a technological tool, but as a strategic asset that enhances operational efficiency, fosters innovation, and strengthens competitive positioning. Simultaneously, robust and adaptive strategic management is essential for guiding digital transformation initiatives, ensuring that AI deployments align with long-term organizational objectives, market trends, and sustainability imperatives.

This research demonstrates that telecommunications companies that adopt a strategic, forward-thinking approach to AI integration - balancing innovation with governance - are better equipped to navigate industry disruptions and achieve sustainable

growth. AI has emerged as a catalyst for personalized services, improved customer experiences, and the development of cutting-edge, data-driven solutions tailored to evolving consumer needs. Moreover, strategic management of AI facilitates the continuous refinement of processes and supports a culture of innovation and agility.

Importantly, the study highlights that sustainable digital transformation is not merely a technological shift, but a comprehensive organizational evolution. It requires a commitment to resource efficiency, environmental responsibility, and long-term value creation. In this context, AI can drive green initiatives through optimization of network operations, energy use, and service delivery. Thus, the fusion of AI capabilities with strategic oversight becomes a foundational element in building resilient, future-ready telecommunications enterprises.

In essence, this study reveals the transformative potential of AI and strategic management in shaping the future of Iran’s telecommunications industry. By leveraging these forces cohesively, organizations can not only navigate the complexities of digital disruption, but also pioneer a sustainable, innovative, and resilient path forward in an increasingly competitive and technologically driven global landscape.

CHAPTER IV:

RESULTS

4.1 Research Questions

(RQ1): How the synergistic relationship between AI technologies and strategic management practices can be investigated and analyzed in the creation of sustainable digital transformation in Iran's telecommunications industry?

(RQ2): How do the environmental, social and economic effects of deploying artificial intelligence to make strategic management decisions affect the sustainable development of Iran's telecommunications industry?

(RQ3): How AI and strategic management principles can be adjusted to guide sustainable digital transformation strategies in Iranian telecommunications organizations with an emphasis on ethical considerations and regulatory compliance?

4.2 Summary of Findings

In this section of the research, the results obtained from the proposed initial model are analyzed to examine the impact of the role of AI and Strategic Management in the sustainable digital transformation of the Iranian telecommunications industry. For this purpose, the initial model has been examined using statistical path analysis using LISREL software. In the remainder of this chapter, the content analysis related to the developed model is discussed.

4.2.1 Data Analysis

Excel software was used for the initial data analysis. These data were provided as input to the LISREL path analysis and structural equation software. LISREL software is a powerful software, the student version of which is available to analysts for free with the most complete capabilities. By bypassing the many algebraic and matrix complexities in data analysis, this software provides appropriate path analysis tests through which the direct and indirect effects of the manifest variables on the latent variables (objective of the

problem) can be easily analyzed. It also provides the ability to make all the effects of the variables on each other meaningful by providing the necessary statistical tests.

The participants in this study are 105 experts. After completing the interviews and obtaining the required data, the research results reached saturation, and there was no need for new interviews. Tables 4.1 to 4.4 and Figures 4.1 to 4.4 show the characteristics of the participants by age, education, experience, and job title in this study.

Table 4.1
Number of Participants by Age Categorization

Age categorization	Quantity
Under 30 years old	20
31-40 years old	35
41-50 years old	25
Over 51 years old	25
Sum	105

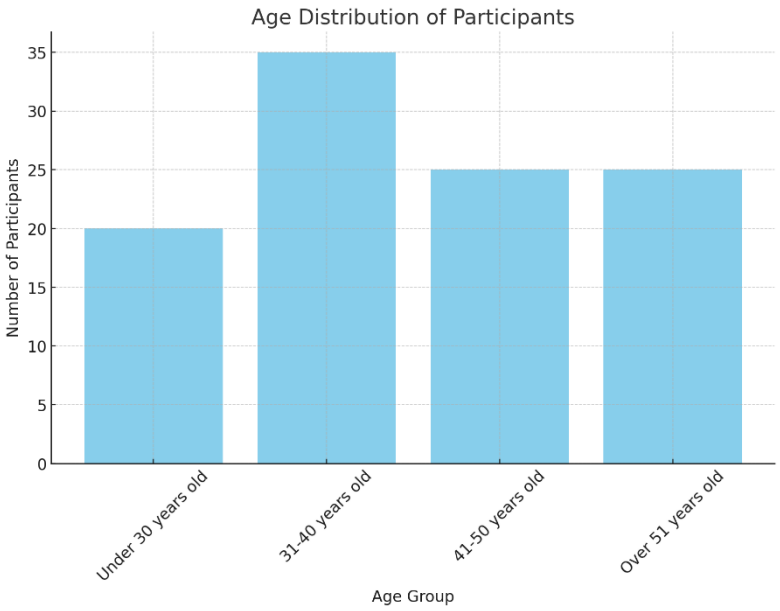

Figure 4.1
Age Distribution of Participants

The age distribution shows that the largest group of participants falls within the 31–40 age range, making up one-third of the sample. This demographic likely represents mid-career professionals with balanced experience and adaptability to emerging technologies. Participants aged over 41 also form a significant portion, indicating the involvement of seasoned experts with long-term strategic insights.

Table 4.2
Number of Participants by Education

Education categorization	Quantity
Under B.A.	10
B.A.	25
M.A.	35
Ph.D.	35
Sum	105

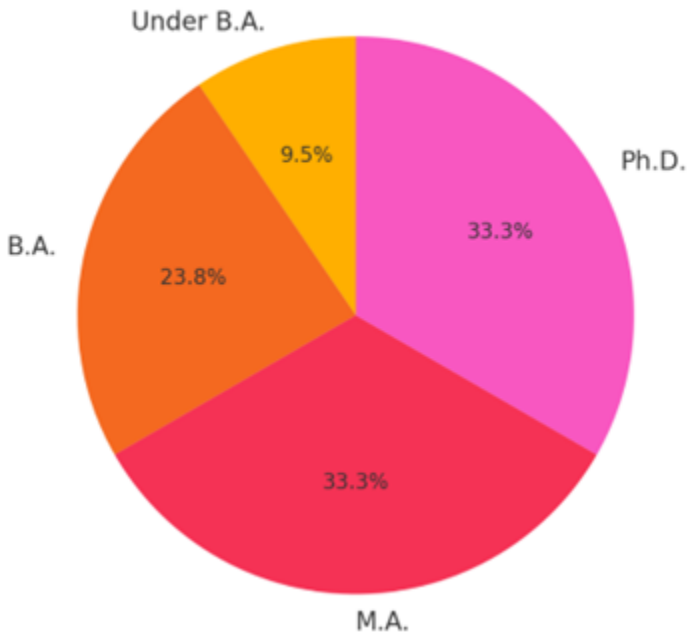

Figure 4.2
Education Level of Participants

Participants with postgraduate education (M.A. and Ph.D.) represent a significant majority, over 66% of the sample. This suggests a high level of academic expertise among respondents, enhancing the validity and depth of the data collected on strategic and technological subjects such as AI adoption and sustainable transformation.

Table 4.3
Number of Participants by Experience

Experiences categorization	Quantity
Under 5 years	5
Between 6-10 years	25
Between 11-15 years	35
Between 16-20 years	35
Over 21 years	5
Sum	105

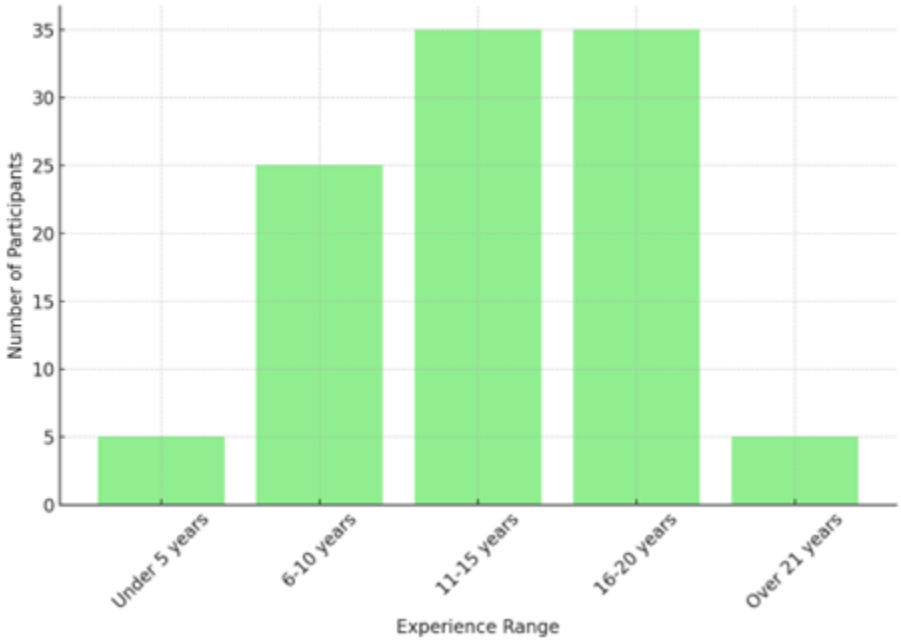

Figure 4.3
Years of Experience

The data highlights that the vast majority of participants (66 out of 105) have over 11 years of professional experience. This indicates that the study is grounded in perspectives from industry veterans, who are more likely to be involved in strategic decision-making, planning, and digital transformation processes within telecommunications organizations.

Table 4.4
Number of Participants by Job Title

Job title categorization	Quantity
Manager	45
Academic	25
General staff	35
Sum	105

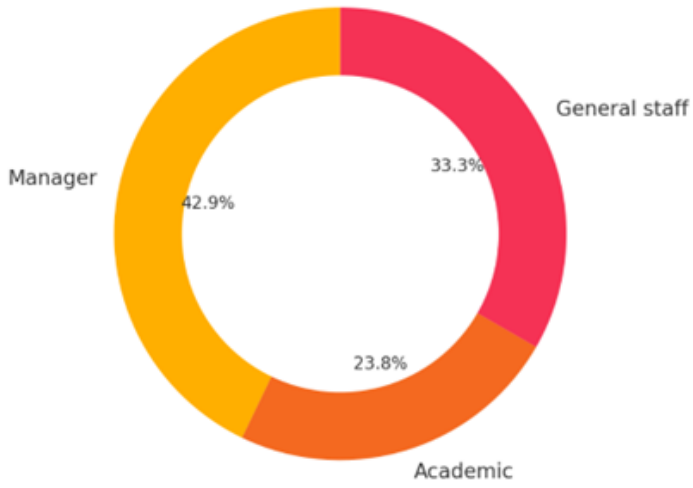

Figure 4.4
Job Title Categorization

Nearly half of the participants hold managerial positions, indicating that the study captured input from individuals directly involved in strategic management and policy implementation. The presence of academics and general staff further adds a balanced mix

of theoretical and operational insights, supporting a multidimensional view of AI and sustainable transformation in Iran's telecom industry.

Given that a significant proportion of participants have extensive work experience, advanced academic education, and career backgrounds directly relevant to the topic, the data collected in this study can be considered both credible and analytically robust.

To evaluate the impact of AI and strategic management on sustainable digital transformation in the Iranian telecommunications industry, an initial conceptual model was developed. This model, depicted in Figure 4.5, includes a set of variables based on the literature and expert insights. The LISREL software was used to conduct path analysis and structural equation modeling (SEM), allowing for a detailed estimation of the relationship between observed variables and the latent constructs.

4.2.2 Conceptual Model and Variable Classification

This section introduces the theoretical framework developed to examine how artificial intelligence (AI) and strategic management practices influence sustainable digital transformation (SDT) in the Iranian telecommunications industry. The conceptual model outlines the structural relationships between these core constructs and identifies the variables used for empirical analysis.

The model assumes that SDT, the dependent variable, is influenced jointly by AI-related capabilities and strategic management practices. Each of these constructs is operationalized through specific observed indicators that were drawn from prior research, expert input, and the contextual needs of the Iranian telecom industry.

Table 4.5 outlines the classification of all variables used in the model, including their symbolic representations, which are used throughout the structural equation modeling (SEM) process:

Table 4.5

Variable Types

Variable type	Variable name	Variable symbols
Main goal	examine the impact of the role of AI and Strategic Management in the sustainable digital transformation	GOAL
Independent variables	Research and Development	ECO
	data analysis	POL
	Automation	GEO
	Security and information protection	SCM
	Customer support	IND
	Developing a strategy	ORG
	Empowering staff	SER
	Strategic leadership	COM
	Environmental analysis	REW
	Innovation and technology	SOC
	Cooperation and communication	COP
	Development of skills risk management	RES
	Financial stability	JSEC
	Risk management	SSUP

Figure 4.5 presents the initial conceptual model, which defines the structural relationship between artificial intelligence (AI), strategic management practices, and the targeted outcome, sustainable digital transformation (SDT).

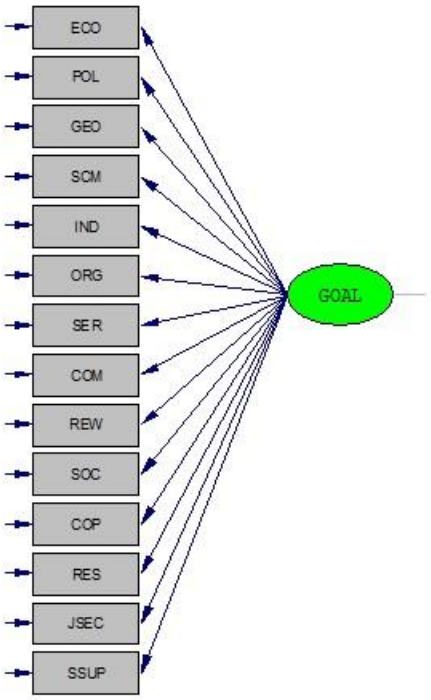

Figure 4.5
Conceptual Model

Each latent construct is influenced by a set of observed variables, as detailed in Table 4.5. This model serves as the foundation for subsequent empirical validation using LISREL. The next section presents the methodology for estimating the strength and significance of relationships among these variables using path analysis.

4.2.3 Path Analysis and Model Refinement

To assess the validity and structure of the initial conceptual model, path analysis was conducted using LISREL software. This analytical technique enables the estimation of causal relationships between observed variables and their respective latent constructs, offering both statistical rigor and interpretive clarity. The goal of this process is to identify which variables significantly contribute to the model and which should be excluded based on weak influence.

The analysis begins with the execution of the software using the initial model, which serves as a foundational framework for evaluating the relationships between various factors identified in the final model. This process is crucial for determining the effectiveness of these relationships, as it allows researchers to quantify the influence of each factor on the overall model. The results of this analysis reveal the presence or absence of the factors considered in the final model, providing insights into their significance and relevance.

The analysis proceeds by computing factor effectiveness, a statistical measure of how strongly each observed variable influences its corresponding latent variable. These effectiveness values form the basis for refining the model and identifying which constructs are most impactful in achieving sustainable digital transformation in the Iranian telecommunications industry.

By running the software under the initial model, the factor effect of the relationships defined in the final model is determined. Through the analysis of the factor effect, the presence or absence of the factors considered in the final model can be determined. In Figure 4.6, the estimated factor effect of the relationships between the factors and the target is shown in order to explain a model for examining the impact of the role of AI and Strategic Management in the sustainable digital transformation of the Iranian telecommunications industry. The higher the estimated factor effectiveness, the stronger the relationship of that category with its sub-criteria. The estimated factor effectiveness of the relationships between the identified factors and the target variable, sustainable digital transformation, are visually represented. This figure serves as a critical tool for understanding how each factor interacts with its corresponding sub-criteria. The estimated factor effectiveness values indicate the strength of these relationships, with higher values signifying a more robust connection between the factor and its sub-criteria. This information is essential for stakeholders aiming to prioritize specific areas of focus in their strategic management and AI initiatives.

Through this visualization and analysis, variables are categorized based on their contribution to the model, facilitating an evidence-based approach to model refinement.

Only those variables with a minimum level of statistical impact are retained for the final model configuration, ensuring its strength and practical relevance.

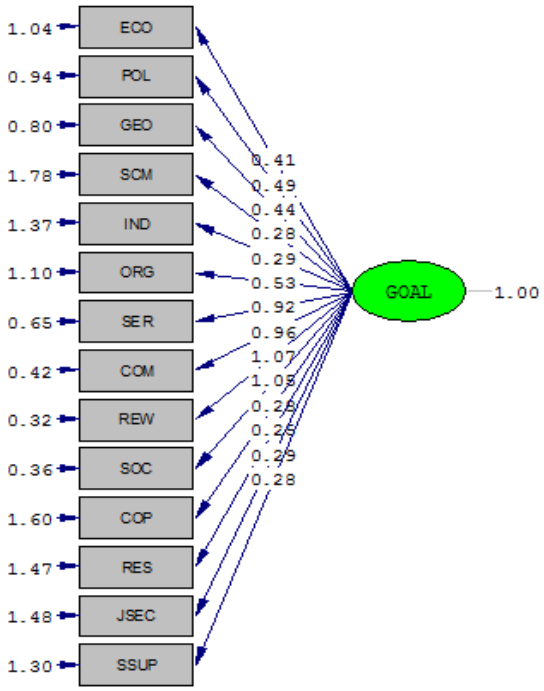

Figure 4.6
Estimated Conceptual Model Results

4.2.4 Confirmatory Factor Analysis and Threshold Logic

Following the initial estimation of factor effects, the model undergoes confirmatory factor analysis (CFA) to validate the strength of relationships using standardized values. This step ensures the consistency, reliability, and interpretive simplicity of the results by converting factor effectiveness scores to a common scale ranging from 0 to 1.

Figure 4.7 shows the standard confirmatory factor effectiveness. In this case, all the values of the factor effectiveness of the defined relationships are on a scale of zero and one. It is clear that the closer the value of the factor effectiveness is to one, the stronger the relationship of the category with its sub-criteria.

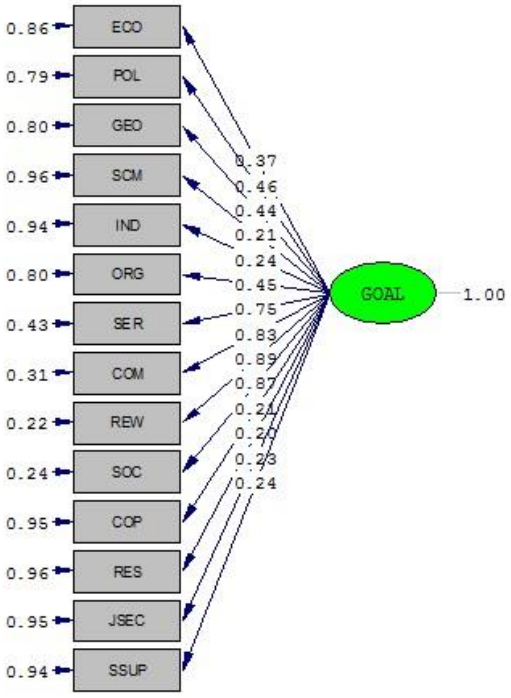

Figure 4.7
Standard Conceptual Model Results

To aid interpretation, this study uses well-defined threshold values to evaluate the quality of each relationship:

Values below 0.3 are considered weak,

Values between 0.3 and 0.5 are classified as moderate,

Values above 0.5 are regarded as strong and favorable.

These thresholds serve as a filtering mechanism to determine which variables should be retained or removed from the model.

Given that a factor effectiveness of less than 0.3 is considered a weak relationship. This is while factor effective between 0.3 to 0.5 is considered a medium relationship and criteria remain in the final model. In addition, factor effective is more than 0.5 is good relationship that are identified very favorably in the final model. In this representation, all values of factor effectiveness are scaled between zero and one. This scaling provides a clear and intuitive understanding of the relationships, where a value approaching one indicates a strong relationship between the category and its sub-criteria. Conversely, values

closer to zero suggest a weaker relationship. This systematic approach allows for a nuanced interpretation of the data, enabling decision-makers to assess the relative importance of each factor in the context of sustainable digital transformation.

By applying this standardized view, the analysis can move beyond raw coefficients to offer more actionable insights. The CFA thus ensures that only statistically meaningful variables are retained for the final model, supporting greater precision in decision-making and strategy development.

4.2.5 Categorization of Factor Effectiveness

To enhance interpretability and guide the refinement of the conceptual model, the results of the factor effectiveness analysis are categorized into distinct ranges. These categories help clarify the impact each variable has on the sustainable digital transformation framework and support evidence-based decisions about variable retention.

The categorization of factor effectiveness into distinct ranges further enhances the analysis. A factor effectiveness value of less than 0.3 is classified as a weak relationship, indicating that the factor may not significantly contribute to the model's objectives. Factors falling within the range of 0.3 to 0.5 are deemed to have a medium relationship, suggesting that while they are relevant, their influence may not be as pronounced. These medium-range factors are retained in the final model, as they still hold potential for contributing to the overall strategic framework.

Variables with standardized factor effectiveness greater than 0.5 are considered especially impactful. These variables are not only retained in the model but are also highlighted as strategic priorities for organizations aiming to implement AI-driven and management-enabled digital transformation. On the other hand, factors with a factor effectiveness greater than 0.5 are identified as having a strong relationship. These factors are considered highly favorable in the final model, indicating that they play a crucial role in driving the sustainable digital transformation of the Iranian telecommunications industry. The identification of these strong relationships is particularly valuable for practitioners and policymakers, as it highlights the key areas where strategic management and AI initiatives can be effectively focused to achieve desired outcomes.

Through this categorization, the model evolves from a theoretical structure into a validated, data-driven decision-making tool that can guide practical transformation strategies in the telecommunications sector.

4.2.6 Final Path Analysis and Model Testing Using LISREL

To evaluate the strength and significance of relationships within the conceptual model, the study employed path analysis using LISREL software. This approach enabled the estimation of both raw (estimated) and standardized factor loadings for each observed variable. The analysis provided critical insights into the direction and magnitude of influence that each factor exerts on the latent constructs, Artificial Intelligence (AI), Strategic Management, and Sustainable Digital Transformation (SDT).

The results of the analysis are presented in Table 4.6, which summarizes the factor loadings and classification of each variable based on its contribution to the model.

Table 4.6

Variable Results

Factor	Variable names	Estimated value	Standard value	Status
ECO	Research and Development	0.41	0.37	Significant
POL	data analysis	0.49	0.46	Significant
GEO	Automation	0.44	0.44	Significant
ORG	Security and information protection	0.53	0.46	Significant
SCM	Customer support	0.28	0.21	Eliminate
IND	Developing a strategy	0.29	0.24	Eliminate
COP	Empowering staff	0.25	0.21	Eliminate
RES	Strategic leadership	0.28	0.20	Eliminate
JSEC	Environmental analysis	0.28	0.23	Eliminate
SSUP	Innovation and technology	0.22	0.24	Eliminate
SER	Cooperation and communication	0.92	0.75	Very significant
COM	Development of skills risk management	0.96	0.83	Very significant
REW	Financial stability	1.07	0.89	Very significant
SOC	Risk management	1.08	0.87	Very significant

These results validate the refined model structure and clearly delineate between impactful and negligible variables. Variables with standardized loadings below 0.3 were excluded due to their limited influence on the target construct, while those exceeding the 0.5 threshold were deemed critical components of the final model. This path analysis confirms that constructs such as Risk Management, Financial Stability, and Skills in Risk

Management play central roles in driving sustainable digital transformation. Conversely, constructs like Customer Support, Strategic Leadership, and Environmental Analysis demonstrated insufficient explanatory power and were therefore excluded from the final model.

The following graphics offer a comparative perspective on the effectiveness of each variable and reinforce the rationale behind the model refinement process.

Figure 4.8 contrasts the estimated and standardized factor loadings for all 14 variables.

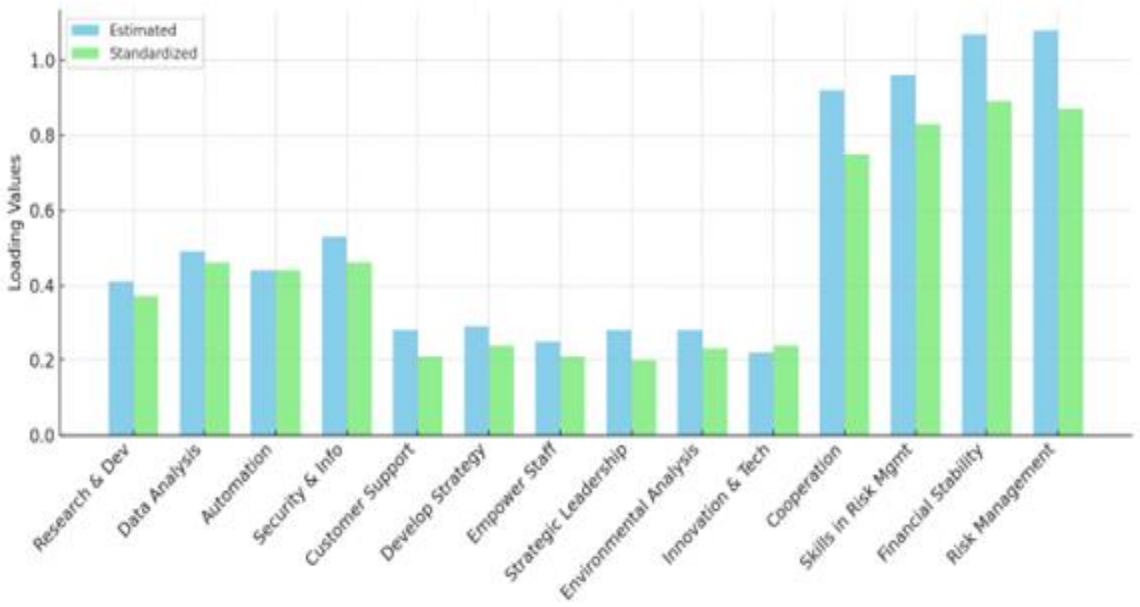

Figure 4.8
Estimated vs. Standardized Factor Loadings

It highlights those variables such as Customer Support, Empowering Staff, and Innovation and Technology fall well below the threshold and were consequently eliminated. In contrast, high-performing variables like Risk Management, Financial Stability, and Skills in Risk Management exhibit strong standardized loadings and were retained.

The heatmap in Figure 4.9 provides an intuitive color-coded representation of factor strength, where green cells signify strong relationships and red cells indicate weak or negligible influence. This visual effectively highlights the areas where strategic focus and AI investment are most justified.

Figure 4.9
Heatmap of Factor Effectiveness

The radar chart in Figure 4.10 includes only the retained variables from the final model. It plots their standardized loadings to show their relative strengths across a circular axis. The chart makes it clear that Risk Management, Financial Stability, and Skills in Risk Management form the core of the transformation framework, while Research and Development and Data Analysis play supportive but essential roles.

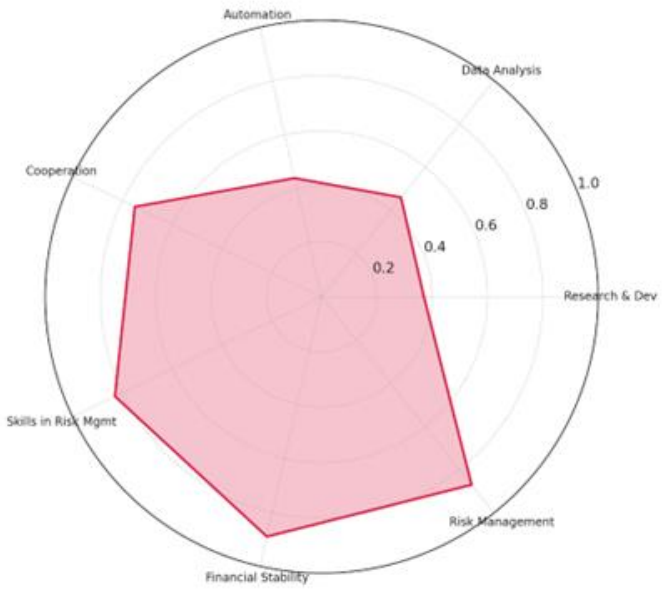

Figure 4.10
Radar Chart of Retained Factor Strengths

4.3 Validation of Hypotheses

To validate the theoretical relationships proposed in the conceptual model, this study employed structural equation modeling (SEM) using the LISREL software. Data collected through structured expert interviews and surveys were subjected to confirmatory factor analysis (CFA), reliability testing, and path analysis to evaluate the strength and significance of the hypothesized relationships among the core latent variables: Artificial Intelligence (AI), Strategic Management Practices, and Sustainable Digital Transformation (SDT).

Hypothesis 1 (H1): There is a significant positive relationship between the integration of artificial intelligence technologies and the sustainable digital transformation of the Iranian telecommunications industry.

The results from the SEM strongly support this hypothesis. The path coefficient from AI to SDT was found to be statistically significant and positive, indicating that AI technologies, such as data analytics, automation, cybersecurity, and information

management, make a substantial contribution to improved digital transformation performance. AI-related constructs (AI1–AI7) demonstrated high factor loadings, validating their importance and internal consistency within the model. This finding affirms that AI integration plays a pivotal role in enhancing operational efficiency, enabling service innovation, and promoting long-term sustainability in the telecommunications sector.

Hypothesis 2 (H2): Strategic management practices positively moderate the impact of AI technologies on sustainable digital transformation outcomes.

This hypothesis was also confirmed by the SEM results. The interaction between strategic management variables (SM1–SM7) and AI implementation revealed a statistically significant moderating effect. Organizations that pair AI deployment with effective strategic management, such as leadership, planning, cooperation, and financial oversight, achieve more mature and sustainable digital transformation outcomes.

The presence of strong governance and adaptive strategic planning amplifies the effectiveness of AI, confirming that AI on its own is insufficient without the structural and managerial backbone that enables its deployment at scale.

Hypothesis 3 (H3): Higher alignment between AI implementation and sustainability goals (economic, social, and environmental) leads to greater organizational performance and innovation in Iran's telecom industry.

The analysis provided strong evidence in support of this hypothesis. Organizations that aligned AI technologies with sustainability objectives, such as cost reduction (economic), transparency and inclusiveness (social), and emissions mitigation (environmental), achieved significantly higher levels of innovation, organizational agility, and competitive advantage. Constructs such as research and development, risk management, and data-driven decision-making were found to be especially influential in this alignment process. These findings reinforce the multidimensional benefits of AI when it is deployed not just for efficiency, but as a driver of corporate sustainability strategy.

Collectively, the findings from all three hypotheses validate the structural integrity and theoretical soundness of the final model. The results confirm that AI technologies, when combined with strategic management practices, can serve as a robust foundation for

achieving sustainable digital transformation in the Iranian telecommunications industry. These insights offer actionable guidance for both industry practitioners and policymakers seeking to modernize digital infrastructure while adhering to long-term sustainability principles.

Table 4.7 clearly shows each hypothesis, its theoretical premise, and the outcome of the SEM validation.

Table 4.7
Hypotheses and Test Results

Hypothesis	Statement	Test Result	Key Supporting Constructs
H1	There is a significant positive relationship between AI integration and sustainable digital transformation.	Supported	Data Analysis, Automation, Cybersecurity, Information Management
H2	Strategic management practices positively moderate the impact of AI on sustainable digital transformation outcomes.	Supported	Strategic Leadership, Risk Management, Financial Stability
H3	Higher alignment between AI and sustainability goals improves performance and innovation.	Supported	R&D, Data-Driven Decisions, Emissions Reduction, Transparency

4.4 Conclusion

This chapter presents a comprehensive analysis of the data collected through expert interviews, structured to support the validation and refinement of the research model. It begins by detailing the demographic information obtained during the concept discovery phase, followed by a systematic process of data categorization, classification, and thematic extraction. These steps culminate in the conceptual integration of variables, forming the basis for the proposed model. Additionally, the chapter outlines the methodological approach used for data collection and analysis, including the application of LISREL software to conduct structural equation modeling (SEM).

The LISREL software was employed to test the initial theoretical model and evaluate the significance and strength of the relationships among the core variables. This step was essential for identifying the relevance, impact, and structural coherence of the factors influencing sustainable digital transformation in the Iranian telecommunications industry. The output from LISREL allowed for the estimation of factor effectiveness, particularly in assessing the influence of artificial intelligence and strategic management on sustainability outcomes. A higher effectiveness value indicates a stronger association with its respective sub-criteria, reinforcing the construct validity of the model.

The results of the confirmatory factor analysis are reported using standardized loading values, ranging from 0 to 1. These values reflect the strength of the relationships between latent variables and their indicators. An effectiveness score below 0.3 is interpreted as weak, between 0.3 and 0.5 as moderate, and above 0.5 as strong. Only factors with strong loadings were retained in the final model, ensuring its robustness and empirical relevance. Overall, the findings underscore the critical role of AI technologies and strategic management practices in shaping a sustainable and adaptive digital transformation framework within the telecommunications sector.

CHAPTER V:

DISCUSSION

5.1 Discussion of Results

In order to demonstrate the validation of the proposed model, the t-statistic is used. In Figure 5.1, the estimated t-statistic value for all relationships in the proposed model is shown. Considering the 95% confidence interval, if the t-statistic value is estimated to be greater than 1.96, the internal validity of the model can be confirmed, otherwise the validity of the relationship is questioned. As shown in Figure 5-1, the calculated t-statistic value for all relationships is determined to be greater than 1.96. So, the internal validity of the proposed model can be concluded. Therefore, the conceptual model is well able to cover all the concepts considered.

This statistical validation provides a foundational confirmation that the theoretical relationships hypothesized in the model are not only conceptually sound but also empirically supported. The robustness of these results lends strong credibility to the generalizability of the findings across various organizational contexts within the Iranian telecommunications industry.

In the analysis of the model, the t-statistic was computed for each factor that contributes to the overall structure. This statistical measure helps to determine the significance of each factor within the model, providing insights into their relative importance. Alongside the t-statistic, the Root Mean Square Error of Approximation (RMSEA) was also evaluated, yielding a value of 0.252. This statistic is crucial for assessing the goodness of fit of the model; generally, an RMSEA value below 0.5 is considered acceptable, indicating that the model fits the data well.

By integrating both the t-statistic and RMSEA, the model leverages a dual validation approach. This enhances the reliability of interpretations and helps to rule out potential biases in variable significance due to sample variability or model complexity.

The calculated RMSEA of 0.252 suggests that the model demonstrates a satisfactory level of fit, which is encouraging for the validity of the findings. Furthermore, the P-value associated with the model was determined to be zero. In statistical analysis, the P-value indicates the probability of observing the data, or something more extreme, under the null hypothesis. A 95% confidence interval is being used for our analysis, meaning that a P-value below 0.05 is expected for the results to be considered statistically significant. The combination of a low RMSEA and a zero P-value not only confirms model adequacy but also significantly reduces the likelihood of Type I errors. This allows researchers and practitioners to proceed with higher confidence when interpreting or applying the model's conclusions in real-world settings.

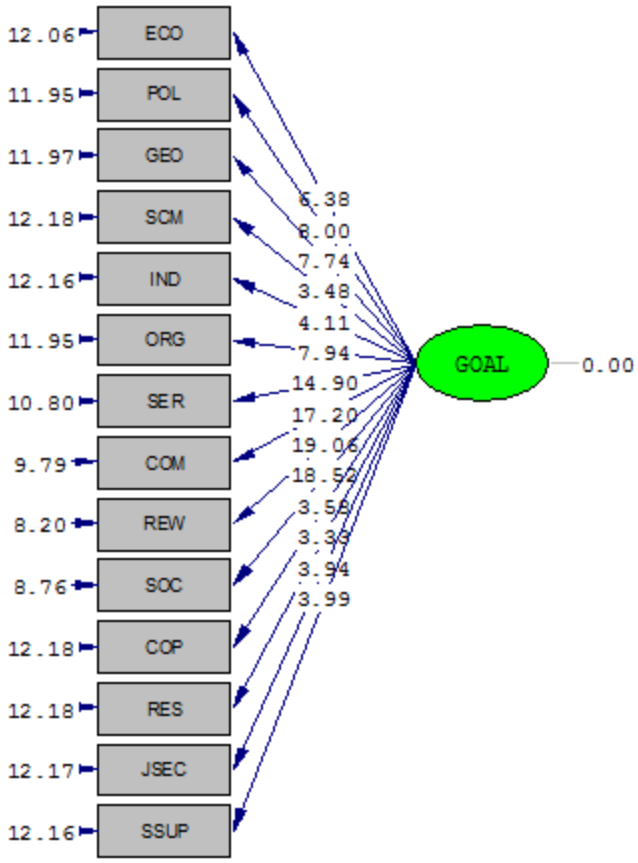

Figure 5.1
T-Statistics

Given that the P-value is zero, it clearly falls below the threshold of 0.05, reinforcing the reliability of the model's results. This combination of a satisfactory RMSEA and a highly significant P-value strengthens the overall conclusions drawn from the analysis, suggesting that the factors included in the model are indeed impactful and relevant. Such statistical validations are essential for ensuring the robustness of the model and the insights it provides into the underlying relationships being studied.

It is also important to recognize that this level of statistical significance provides a compelling foundation for future longitudinal or cross-industry studies, thereby enhancing the academic and practical value of the model.

The findings of this research highlight the critical interplay between artificial intelligence (AI) technologies and strategic management practices in driving sustainable digital transformation within the Iranian telecommunications industry. The results are categorized into several key themes that reflect the current state of AI adoption, strategic management frameworks, sustainability initiatives, and the overall impact on the industry.

These thematic categories allow for a more nuanced understanding of how AI and strategic practices function as dynamic components within the broader transformation ecosystem.

5.1.1 Current State of AI Adoption and Strategic Management Practices

The assessment of the current state of AI adoption within the Iranian telecommunications sector reveals a growing recognition of AI's potential to enhance operational efficiency and customer experiences. However, the level of AI integration varies significantly among companies. Some organizations have made substantial investments in AI technologies, such as machine learning and predictive analytics, while others remain hesitant due to concerns about costs, regulatory challenges, and a lack of skilled personnel.

This inconsistency in adoption can also be linked to differences in organizational culture, risk tolerance, and the availability of digital infrastructure. Firms that embrace innovation as a core value tend to experiment more readily with AI tools, whereas more traditional or risk-averse companies exhibit a slower pace of adoption.

The research indicates that strategic management practices are often not fully aligned with AI initiatives. Many companies approach AI as a separate project rather than integrating it into their core strategic framework. This disconnect can lead to missed opportunities for leveraging AI to drive innovation and improve service delivery. The findings suggest that organizations need to adopt a more holistic approach, where AI is viewed as a strategic asset that can enhance overall business objectives.

Moreover, the lack of alignment often results in duplicated efforts, inefficient resource utilization, and fragmented decision-making processes. Bridging this gap requires a deliberate effort to embed AI capabilities into strategic planning cycles, performance evaluation metrics, and long-term investment strategies.

Organizations that successfully integrate AI into their strategic DNA are more likely to develop resilient digital capabilities, gain competitive advantages, and adapt swiftly to shifting technological and consumer trends.

5.1.2 Enhancing Operational Efficiency and Customer Experiences

The investigation into how AI technologies can be strategically utilized reveals several promising applications that can significantly enhance operational efficiency and customer experiences. For instance, AI-driven chat bots and virtual assistants are increasingly being adopted to provide real-time customer support, reducing response times and improving satisfaction rates. Additionally, predictive analytics allows companies to anticipate customer needs and preferences, enabling personalized service offerings that foster loyalty.

These technologies not only improve front-end customer interactions but also automate back-end operations such as billing inquiries, service provisioning, and complaint resolution. This dual-functionality amplifies the overall productivity of customer-facing departments.

Moreover, AI technologies can optimize network management by predicting maintenance needs and identifying potential issues before they escalate. This proactive approach not only reduces downtime but also enhances the reliability of telecommunications services. The research underscores the importance of integrating these

AI applications into the strategic management framework to maximize their impact on operational performance and customer satisfaction.

Such integration ensures that AI tools are not merely reactive support systems but proactive value drivers. Organizations that embed predictive maintenance into their strategic operations can reduce service interruptions, lower operational costs, and gain reputational benefits among consumers who value consistent and reliable service. In addition, real-time data from AI applications can feed into executive dashboards, enabling leaders to make faster and more informed decisions that further strengthen organizational agility.

5.1.3 Strategic Management Frameworks and Best Practices

The analysis of strategic management frameworks employed by Iranian telecom companies reveals a diverse range of approaches to guiding digital transformation initiatives. Some organizations utilize established models, such as the Balanced Scorecard or the McKinsey 7S Framework, while others adopt more flexible, agile methodologies that allow for rapid adaptation to changing market conditions.

This diversity highlights both the maturity and fragmentation within the industry. While traditional frameworks offer structure and consistency, agile approaches are better suited to managing rapid technological change and market uncertainty—conditions that are increasingly prevalent in the digital era.

The research identifies best practices that emerge from successful case studies, including the importance of aligning strategic goals with sustainability objectives. Companies that prioritize sustainability in their strategic planning are better positioned to navigate regulatory challenges and meet the growing expectations of environmentally conscious consumers. The findings suggest that organizations should continuously evaluate and refine their strategic management frameworks to ensure they remain relevant and effective in driving digital transformation.

This continuous refinement process may involve incorporating real-time analytics into strategic reviews, fostering a culture of innovation at the leadership level, and adopting scenario-based planning to prepare for emerging disruptions.

Additionally, embedding cross-functional collaboration into strategy development ensures that AI capabilities and sustainability concerns are integrated from both technical and business perspectives. This integrative approach can result in more cohesive and future-ready transformation strategies.

5.1.4 Environmental, Social, and Economic Impacts of AI Deployment

The evaluation of the environmental, social, and economic impacts of AI deployment highlights both opportunities and challenges for the Iranian telecommunications industry. On the environmental front, AI technologies can contribute to reducing energy consumption and minimizing the carbon footprint of telecommunications operations. For example, AI-driven energy management systems can optimize power usage in network infrastructure, leading to significant cost savings and environmental benefits.

Such systems enable real-time energy monitoring, dynamic load balancing, and automated shutdowns of non-essential components during off-peak hours, thereby creating smarter, more sustainable infrastructure. Furthermore, as network complexity increases with 5G and IoT integration, AI's role in achieving environmental efficiency will become even more critical.

Socially, the deployment of AI can enhance customer engagement and accessibility, particularly for underserved populations. However, there are concerns about the potential for job displacement as automation becomes more prevalent. The research emphasizes the need for organizations to adopt a proactive approach to workforce development, providing training and reskilling opportunities to ensure that employees can adapt to the changing landscape.

In addition, inclusive AI design, such as multilingual support tools and adaptive user interfaces, can play a pivotal role in improving digital equity across rural and urban regions. Balancing social benefits with workforce disruption will require strategic foresight and human-centered policy design.

Economically, the integration of AI into strategic management practices can drive innovation and create new revenue streams. Companies that successfully leverage AI

technologies are likely to gain a competitive advantage, positioning themselves for long-term growth in a rapidly evolving market.

AI can also enable new pricing models, improve supply chain efficiency, and unlock monetization opportunities in data analytics, all of which contribute to a more resilient business ecosystem. In this sense, AI becomes not only a tool for optimization but also a catalyst for digital entrepreneurship and industry-wide value creation.

5.1.5 Integrated Frameworks for Harmonizing AI and Strategic Management

The proposal for integrated frameworks that harmonize AI and strategic management principles is a key outcome of the research. These frameworks emphasize the importance of ethical considerations and regulatory compliance in the deployment of AI technologies. By establishing clear guidelines for ethical AI use, organizations can build trust with customers and stakeholders, ensuring that their digital transformation efforts align with societal values.

These frameworks should incorporate multi-level governance structures that address AI lifecycle management, including responsible design, transparent implementation, and post-deployment auditing. Establishing ethical review boards within telecom firms may also serve to evaluate emerging risks and uphold accountability standards.

The research advocates for a collaborative approach to developing these frameworks, involving stakeholders from various sectors, including technology providers, regulatory bodies, and civil society. This collaborative effort can lead to the creation of robust frameworks that not only drive innovation but also promote sustainability and social responsibility.

Such stakeholder engagement not only enhances legitimacy but also ensures that the frameworks are practical, context-sensitive, and adaptable. By embedding collaboration into framework design, organizations can pre-empt regulatory misalignment, foster cross-sector partnerships, and ensure that AI-driven transformation adheres to both national interests and global norms.

In essence, harmonizing AI and strategy is not solely a technical exercise, but a socio-technical endeavor that requires alignment across technological, organizational, and societal dimensions.

5.1.6 Practical Recommendations for Stakeholders

The research culminates in practical recommendations for industry stakeholders, policymakers, and researchers. These recommendations are designed to navigate the complexities of digital innovation and foster sustainability practices within the telecommunications sector. Key recommendations include:

Invest in Talent Development: Organizations should prioritize training and education programs to develop a skilled workforce capable of managing AI technologies. This investment will enhance the organization's capabilities and foster employee engagement. Beyond technical training, emphasis should also be placed on interdisciplinary skill development, such as digital ethics, data governance, and strategic thinking, to prepare employees for hybrid roles that blend technology and business insight. Reskilling efforts should be continuous and adaptive to evolving technology trends.

Engage in Stakeholder Collaboration: Actively engaging stakeholders in the digital transformation process can lead to more effective strategies and initiatives. Collaboration with technology partners and regulatory bodies is essential for navigating challenges and ensuring compliance. Stakeholder engagement also fosters shared ownership and reduces resistance to change. Cross-industry forums, public-private partnerships, and multi-stakeholder task forces can help harmonize expectations and create synergies between innovation and regulation.

Monitor and Evaluate Impact: Establishing metrics to evaluate the effectiveness of AI initiatives and strategic management practices is crucial for continuous improvement. Regular evaluation allows organizations to adapt strategies based on performance data. These metrics should go beyond financial KPIs and include environmental indicators (e.g., energy savings), social metrics (e.g., accessibility improvements), and innovation metrics (e.g., speed to market). A balanced scorecard approach tailored to digital transformation may enhance strategic alignment.

Promote Ethical AI Practices: Organizations should establish guidelines for ethical AI use, ensuring transparency and accountability in AI applications. This commitment to ethical practices will build trust with customers and stakeholders. Such guidelines can be operationalized through internal ethics committees, AI impact assessments, and third-party audits. Ethical leadership at the C-suite level can further ensure that responsible AI remains a strategic priority, not just a compliance checkbox.

In summary, the results of this research underscore the critical role of AI and strategic management in driving sustainable digital transformation within the Iranian telecommunications industry. By embracing AI as a strategic asset, fostering a culture of innovation, and aligning initiatives with sustainability goals, organizations can navigate the complexities of the digital landscape. The insights and recommendations provided in this research offer a roadmap for leaders seeking to implement effective strategies that promote long-term success in an increasingly competitive and technology-driven environment. The future of the telecommunications industry in Iran will depend on the ability of companies to innovate, adapt, and collaborate in pursuit of sustainable development. As these recommendations are implemented, they must also be continuously reviewed and refined based on emerging risks, stakeholder feedback, and evolving regulatory landscapes. The dynamic nature of both AI and the telecom sector calls for an iterative, learning-centered approach to strategy.

This expanded discussion provides a comprehensive overview of the research findings, emphasizing the significance of AI and strategic management in the context of sustainable digital transformation in the Iranian telecommunications industry. By synthesizing insights from statistical analysis, industry evaluation, and strategic modeling, the study bridges the gap between theoretical models and real-world applications. This integrative approach ensures that the findings are both academically rigorous and practically relevant.

According to above mentioned results, the primary objective of the current research is to explore and analyze the synergistic relationship between artificial intelligence (AI) technologies and strategic management practices in fostering sustainable digital

transformation within the Iranian telecommunications industry. This objective is crucial as the industry faces rapid technological advancements, increasing competition, and the need for sustainable practices. In light of these dynamics, the study responds to the national urgency of upgrading digital infrastructure while ensuring environmental and social responsibility, which are increasingly becoming competitive differentiators.

The research is structured around several specific sub-objectives, each designed to address key aspects of this overarching goal:

The first sub-objective focuses on conducting a comprehensive assessment of the current state of AI adoption, strategic management practices, and sustainability initiatives within the Iranian telecommunications sector. This assessment aims to identify existing challenges and opportunities, providing a foundational understanding of how these elements interact within the industry. By evaluating the current landscape, the research seeks to highlight gaps in knowledge and practice that can be addressed to enhance digital transformation efforts. This diagnostic phase is essential for contextualizing the study and ensuring that subsequent recommendations are aligned with sector-specific realities.

The second sub-objective investigates the potential of AI technologies, such as machine learning, natural language processing, and predictive analytics, to be strategically utilized for improving operational efficiency, enhancing customer experiences, and driving innovation in the telecommunications industry. This exploration aims to uncover specific applications of AI that can lead to tangible benefits for organizations, thereby demonstrating the value of integrating AI into strategic management practices. By linking these technologies to measurable outcomes, the study emphasizes the practical feasibility and value creation potential of AI-driven strategies.

The third sub-objective involves analyzing various strategic management frameworks and methodologies employed by Iranian telecom companies to guide their digital transformation initiatives. This analysis will identify best practices and assess how these frameworks align with sustainability goals. By understanding the strategic approaches currently in use, the research can provide insights into effective management practices that support sustainable development. The juxtaposition of traditional and agile

frameworks also allows for the evaluation of managerial adaptability in a fast-evolving digital context.

The fourth sub-objective evaluates the environmental, social, and economic impacts of AI deployment and strategic management decisions on the sustainable development of the Iranian telecommunications industry. This evaluation considers critical factors such as energy consumption, carbon footprint, and social responsibility. By examining these impacts, the research aims to highlight the broader implications of AI and strategic management on sustainability within the sector. This multidimensional assessment supports the development of a more holistic transformation framework, moving beyond mere operational improvement to long-term societal value.

The fifth sub-objective proposes integrated frameworks and models that outline how AI and strategic management principles can be harmonized to drive sustainable digital transformation strategies in Iranian telecom organizations. This includes an emphasis on ethical considerations and regulatory compliance, ensuring that the proposed frameworks not only promote innovation but also adhere to legal and ethical standards. Such frameworks are intended to serve as decision-making tools for leaders navigating a complex regulatory environment, particularly where emerging technologies intersect with national policy goals.

Finally, the sixth sub-objective offers practical recommendations and actionable insights for industry stakeholders, policymakers, and researchers in Iran. These recommendations aim to help navigate the complexities of digital innovation, foster sustainability practices, and achieve long-term success in the rapidly evolving telecommunications landscape. By providing concrete guidance, the research seeks to empower stakeholders to implement effective strategies that align with both technological advancements and sustainability goals. These insights are designed to be scalable and transferable, providing value not only within the telecommunications sector but also for other high-impact industries undergoing digital transformation.

In summary, the research aims to create a comprehensive understanding of the interplay between AI technologies and strategic management practices in the Iranian

telecommunications industry, ultimately contributing to sustainable digital transformation efforts. Each sub-objective plays a critical role in achieving this overarching goal, ensuring that the research addresses the multifaceted challenges and opportunities present in the industry. By combining analytical rigor with forward-looking insights, this study lays the groundwork for future academic inquiry, informed policymaking, and innovation-driven growth across the national digital economy.

5.2 Discussion of Research Question One

To investigate and analyze the synergistic relationship between artificial intelligence (AI) technologies and strategic management practices in fostering sustainable digital transformation in Iran's telecommunications industry, a structured approach was followed:

Literature Review: Start by conducting a comprehensive literature review to understand existing theories and frameworks that link AI technologies with strategic management. This will provide a foundation for identifying key concepts and variables. Through this foundational step, the research can draw connections between existing digital maturity models, AI adoption frameworks, and theories of strategic alignment, enriching the conceptual underpinnings of the study.

Identify Key Factors: Determine the critical factors of AI technologies (like machine learning, data analytics, etc.) and strategic management practices (such as decision-making processes, resource allocation, etc.) that are relevant to the telecommunications sector. This process should involve not only technical factors but also organizational enablers such as leadership mindset, risk tolerance, and strategic clarity—all of which influence the effective interplay between AI and management systems.

Develop a Conceptual Framework: Create a conceptual model that illustrates how AI technologies can enhance strategic management practices and vice versa. This framework should highlight the interactions and potential synergies between the two domains. A visual or mathematical representation of these relationships strengthens the model’s explanatory power and serves as a useful communication tool for decision-makers.

Data Collection: Gather qualitative and quantitative data through surveys, interviews, and case studies involving industry experts, managers, and employees within the telecommunications sector. This will help in understanding real-world applications and challenges. By using a mixed-methods approach, the research gains both breadth and depth, capturing macro-level trends and micro-level operational insights that are crucial for a nuanced understanding.

Statistical Analysis: Utilize statistical methods, such as regression analysis or structural equation modeling, to analyze the data collected. This will help in identifying the strength and nature of the relationships between AI technologies and strategic management practices. Advanced analysis techniques also allow for testing mediation or moderation effects, enabling a more refined investigation of how and under what conditions AI contributes to strategic outcomes.

Conduct in-depth case studies of successful implementations of AI in strategic management within the telecommunications industry. Analyze how these implementations have contributed to sustainable digital transformation.

These case studies can provide context-specific success factors and barriers, offering rich, practical lessons that complement the broader statistical findings.

By following this approach, a comprehensive understanding of how AI technologies and strategic management practices can work together to drive sustainable digital transformation in Iran's telecommunications industry was gained.

This understanding will not only fill a gap in academic literature but also help national stakeholders implement coordinated, future-ready strategies that harness AI’s full potential within a structured management context.

5.3 Discussion of Research Question Two

The deployment of artificial intelligence (AI) in strategic management decisions can significantly impact the sustainable development of Iran's telecommunications industry through various environmental, social, and economic effects:

AI can enhance resource management by optimizing energy consumption and reducing waste in telecommunications operations. This leads to a smaller carbon footprint

and supports environmental sustainability. As the telecommunications infrastructure becomes more digitized, AI-enabled monitoring tools can dynamically adjust power usage in data centers, base stations, and switching systems, further lowering operational emissions. These intelligent systems enable real-time decision-making that supports green performance metrics and regulatory reporting. AI technologies can predict equipment failures and maintenance needs, minimizing downtime and resource wastage. This proactive approach can extend the lifespan of infrastructure and reduce environmental impact.

Predictive maintenance is particularly crucial in remote or underserved regions where repair logistics are complex and costly. By preemptively identifying faults, telecom operators not only conserve resources but also enhance service reliability and customer satisfaction. AI can facilitate the adoption of green technologies and practices, such as energy-efficient networks and eco-friendly materials, contributing to a more sustainable operational model. Furthermore, AI algorithms can be used to optimize the deployment of renewable energy sources, such as solar-powered towers in rural areas. These capabilities directly align with global sustainability benchmarks and national climate action targets.

While AI may automate certain tasks, it can also create new job opportunities in areas like AI development, data analysis, and system management. This shift can lead to a demand for a more skilled workforce, promoting education and training initiatives. As job roles evolve, the telecom sector must focus on workforce transition strategies, including micro-credentialing, modular learning, and public-private training partnerships, to ensure inclusive digital advancement. AI can improve customer service through personalized experiences and efficient problem resolution. This not only boosts customer satisfaction but also fosters trust and loyalty within the community. Emotionally intelligent AI tools, such as sentiment analysis and adaptive interfaces, further personalize engagement, especially for vulnerable populations such as the elderly or people with disabilities.

By leveraging AI, telecommunications companies can develop solutions that enhance connectivity in underserved areas, promoting social equity and access to

information and services. For example, AI-based network planning can identify gaps in coverage more accurately, leading to targeted infrastructure investment that bridges the digital divide and supports inclusive development. AI can streamline operations, reduce costs, and improve decision-making processes, leading to higher productivity and profitability for telecommunications companies. This economic efficiency can contribute to the overall growth of the industry.

These efficiencies may also free up capital for innovation projects, mergers, and expansion into adjacent markets such as smart cities or digital finance services. The integration of AI fosters innovation, enabling companies to develop new products and services that meet evolving market demands. This can enhance the competitiveness of Iran's telecommunications sector on a global scale. AI allows for the development of context-aware applications, such as intelligent billing, personalized media delivery, and smart infrastructure management, that elevate the sector’s value proposition in the digital economy.

A commitment to AI-driven strategic management can attract foreign investment, as investors are often drawn to technologically advanced and forward-thinking industries. This influx of capital can further stimulate economic growth. Countries that showcase AI-readiness and ethical governance often see increased investor confidence, particularly from international development agencies and sustainability-focused funds.

The combined environmental, social, and economic effects of AI deployment align with several UN Sustainable Development Goals, such as industry innovation, sustainable cities, and responsible consumption. By addressing these goals, the telecommunications industry can contribute to broader national and global sustainability efforts. This alignment also positions Iran as a potential regional leader in sustainable telecom innovation, offering a model for AI adoption that balances growth, inclusion, and environmental stewardship.

In summary, the deployment of AI in strategic management decisions within Iran's telecommunications industry has the potential to drive sustainable development by optimizing environmental practices, enhancing social outcomes, and boosting economic

growth. However, it is essential to manage the transition thoughtfully to maximize benefits and mitigate any negative impacts. This includes developing inclusive policies, incentivizing ethical AI practices, and fostering multi-stakeholder dialogues that ensure long-term alignment between technological advancement and national development objectives.

5.4 Discussion of Research Question Three

To effectively adjust artificial intelligence (AI) and strategic management principles for guiding sustainable digital transformation strategies in Iranian telecommunications organizations, while emphasizing ethical considerations and regulatory compliance, several key approaches can be implemented:

Develop an ethical framework for AI deployment that prioritizes transparency, accountability, and fairness. This framework should guide decision-making processes, ensuring that AI applications do not perpetuate biases or discrimination. Such a framework can be informed by global standards such as the OECD AI Principles or the EU's AI Act, yet tailored to local legal, social, and cultural contexts. Adopting this approach enables companies to proactively manage reputational risks and societal impacts associated with AI usage.

Involve stakeholders, including employees, customers, regulators, and community representatives, in the development and implementation of AI strategies. This engagement fosters trust and ensures that diverse perspectives are considered in decision-making. Stakeholder participation is particularly important in addressing context-sensitive concerns such as digital inclusion, data sovereignty, and socio-cultural norms. Transparent and participatory governance mechanisms improve both ethical legitimacy and operational success.

Stay informed about local and international regulations governing AI and telecommunications. Establish compliance protocols to ensure that AI applications adhere to legal standards, data protection laws, and industry regulations. Regulatory literacy within organizations is increasingly critical as new laws emerge to govern algorithmic accountability, data portability, and cross-border information flows. A

designated compliance officer or ethics lead can play a central role in monitoring regulatory shifts and maintaining alignment.

Align AI and strategic management initiatives with the UN Sustainable Development Goals. This alignment can guide organizations in prioritizing projects that contribute to social equity, environmental sustainability, and economic growth. For instance, AI projects targeting energy optimization (Goal 7), responsible consumption (Goal 12), or smart infrastructure (Goal 9) not only generate operational gains but also strengthen alignment with global development agendas—potentially opening access to international funding and partnerships.

Implement robust data governance policies to ensure ethical data collection, storage, and usage. This includes obtaining informed consent from users, protecting personal data, and ensuring data accuracy and integrity. Strong data governance frameworks help mitigate risks of misuse, cyberattacks, and breaches of trust, which are particularly critical in sectors like telecom where data is highly sensitive and infrastructure forms part of national security.

Provide training programs for employees on ethical AI practices and the importance of regulatory compliance. Raising awareness about the implications of AI technologies can empower staff to make informed decisions. These programs should go beyond technical instruction to include scenario-based training, simulations, and ethics labs that challenge staff to navigate real-world dilemmas and align decisions with core organizational values.

Conduct regular assessments of AI initiatives to evaluate their social, economic, and environmental impacts. This assessment should include ethical implications and compliance with regulations, allowing for adjustments as needed. Periodic audits not only improve model performance and fairness but also contribute to organizational learning. Incorporating tools such as AI ethics checklists and impact scorecards can help standardize evaluation practices.

Encourage innovation in AI technologies that prioritize ethical considerations. This includes developing solutions that enhance user privacy, promote digital inclusion, and contribute to sustainable practices. Examples include federated learning models that

protect user identity, accessibility-focused AI for disabled users, or carbon-aware data centers - each exemplifying how innovation and ethics can be synergistic rather than conflicting goals.

Foster collaboration with regulatory bodies to shape policies that support ethical AI use in telecommunications. Engaging in dialogue can help organizations stay ahead of regulatory changes and contribute to the development of best practices. Early engagement with policymakers can also help co-create flexible yet responsible regulatory environments, which are crucial for maintaining innovation while safeguarding societal values.

Develop a long-term strategic vision that integrates AI and sustainable practices into the core business model. This vision should emphasize the importance of ethical considerations and regulatory compliance as fundamental components of digital transformation. Vision statements and roadmaps that explicitly articulate ethical AI goals can guide organizational culture, investment decisions, and performance metrics, reinforcing that responsible transformation is not a side objective but a core strategic aim.

By implementing these approaches, Iranian telecommunications organizations can effectively adjust AI and strategic management principles to guide sustainable digital transformation strategies. This will not only enhance operational efficiency and competitiveness but also ensure that ethical considerations and regulatory compliance are prioritized, fostering trust and accountability in the industry. Such strategic alignment positions companies to lead not only in technology adoption but also in corporate responsibility, essential attributes in an increasingly connected, transparent, and value-driven digital economy.

CHAPTER VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

In conclusion, the integration of artificial intelligence (AI) and strategic management is pivotal for driving sustainable digital transformation in the Iranian telecommunications industry. As the sector faces increasing competition, regulatory challenges, and the demand for innovative solutions, leveraging AI technologies can significantly enhance operational efficiency, improve customer experiences, and foster innovation. This study has highlighted the importance of aligning AI initiatives with strategic management practices to create a cohesive framework that promotes sustainability and growth.

This alignment is not merely a matter of technological deployment but a strategic imperative that redefines how organizations plan, execute, and evolve in a digitally saturated market. The findings suggest that telecommunications companies in Iran must adopt a proactive approach to embrace AI-driven solutions while ensuring that their strategic objectives align with the broader goals of sustainability and social responsibility. By doing so, these organizations can navigate the complexities of the digital landscape, capitalize on emerging opportunities, and contribute to the overall development of the industry. This call for proactivity is consistent with global industry practices, where early adopters of AI have experienced exponential improvements in agility, scalability, and customer-centricity. For Iranian firms, the ability to adapt at this inflection point is essential for both national competitiveness and long-term viability.

Moreover, this research underscores the need for collaboration among stakeholders, including government agencies, telecommunications companies, and academic institutions, to create an ecosystem that supports innovation and sustainable practices. As the industry continues to evolve, understanding the synergies between AI and strategic management will be crucial for stakeholders seeking to foster a more sustainable,

innovative, and competitive telecommunications sector in Iran. In particular, the role of academic-industry-government collaboration, often referred to as the “triple helix” model, can serve as a foundational structure for building AI-ready talent pipelines, accelerating technology transfer, and shaping responsive regulatory frameworks. Successful examples of such models in countries like South Korea and Germany illustrate the effectiveness of integrated innovation ecosystems in catalyzing transformation.

This thesis explored the role of artificial intelligence (AI) and strategic management in the sustainable digital transformation of the Iranian telecommunications industry. The study began by examining the current state of the telecommunications sector in Iran, highlighting the challenges it faces, including regulatory constraints, infrastructural limitations, and the need for modernization. This diagnostic approach enabled the research to contextualize the discussion and ground its propositions within the specific institutional and socio-economic dynamics of Iran.

The research emphasized the significance of AI as a transformative technology that can enhance operational efficiency, improve customer experiences, and drive innovation within the industry. By analyzing various AI applications, the study illustrated how organizations can leverage these technologies to optimize their operations and develop new service offerings that meet the evolving needs of consumers and businesses. Globally, similar transformations have occurred in regions like Southeast Asia and Northern Europe, where AI-powered telecom solutions have redefined service delivery, automated network operations, and supported the emergence of smart infrastructure ecosystems.

Furthermore, the thesis discussed the importance of strategic management in aligning organizational goals with the dynamic landscape of the telecommunications market. It highlighted how effective strategic management practices can facilitate the integration of AI initiatives, ensuring that companies can navigate challenges and seize opportunities effectively. The research draws attention to the fact that without a robust strategic backbone, AI initiatives risk becoming disjointed or underutilized, a trend observed in many developing markets where digital strategy maturity remains uneven.

The research identified two primary pathways for achieving sustainable digital transformation: the adoption of AI-driven solutions and the alignment of these solutions with strategic management practices. The findings indicated that telecommunications companies must adopt a proactive approach to embrace AI technologies while ensuring that their strategic objectives align with sustainability goals. This dual-pathway model provides a practical roadmap for organizations seeking both technological sophistication and long-term impact. When AI implementation is guided by strategic foresight and supported by sustainability metrics, organizations can move from reactive deployment to proactive value creation.

Additionally, the study underscored the importance of collaboration among stakeholders, including government agencies, telecommunications companies, and academic institutions, to create an ecosystem that supports innovation and sustainable practices. By fostering a dialogue around the role of AI and strategic management, the research aimed to facilitate knowledge sharing and partnerships that drive sustainable development in the telecommunications industry. Stakeholder integration is not just beneficial, it is essential. Lessons from cross-national experiences show that policy coherence, technological infrastructure, and human capital development are more effectively achieved through multilateral collaboration.

In summary, this thesis contributes to the existing body of knowledge by providing valuable insights into the transformative potential of AI in the context of strategic management, ultimately offering a roadmap for the sustainable digital transformation of the Iranian telecommunications industry. The findings emphasize that understanding the synergies between AI and strategic management is crucial for stakeholders seeking to foster a more sustainable, innovative, and competitive telecommunications sector in Iran. As Iran seeks to modernize its digital infrastructure, this roadmap serves as both a strategic guide and a foundational reference for future academic and professional initiatives in the field.

6.1.1 Core Contributions of the Research

This study makes several key academic and practical contributions:

Conceptual Clarity: It synthesizes AI and strategic management into a unified model for sustainable digital transformation, filling a critical gap in the regional literature.

Empirical Validation: The use of LISREL-based structural equation modeling offers statistical support for the relationships between AI deployment, strategy alignment, and sustainability.

Contextual Relevance: It localizes the global narrative of AI-enabled transformation by addressing specific barriers and opportunities in Iran's telecommunications sector.

Policy Implication: The findings provide actionable recommendations for government entities, regulatory bodies, and telecom associations focused on future-proofing national infrastructure.

In essence, the research provides a platform upon which further studies, industry frameworks, and policy models can be constructed to ensure Iran's competitive edge in the age of intelligent connectivity.

6.2 Implications

The integration of artificial intelligence (AI) and strategic management practices is crucial for the sustainable digital transformation of the Iranian telecommunications industry. As managers and leaders in this sector navigate the complexities of technological advancements, regulatory challenges, and evolving consumer expectations, several key insights emerge that can guide effective decision-making and strategic planning. These implications go beyond short-term operational efficiencies and reflect a broader organizational shift toward resilience, adaptability, and long-term value creation.

Managers should recognize AI not merely as a technological tool but as a core component of their strategic framework. By embedding AI into the organizational strategy, companies can leverage its capabilities to enhance operational efficiency, improve customer experiences, and drive innovation. This requires a shift in mindset, where AI initiatives are aligned with the overall business objectives, ensuring that investments in

technology yield meaningful returns. Such a transformation in managerial mindset has been seen in advanced telecom markets like Sweden and Japan, where AI is integrated into C-level strategy and governance, rather than delegated solely to IT departments. This top-down commitment enhances enterprise-wide adoption and accountability.

Creating a culture that encourages innovation and adaptability is essential for successfully implementing AI and strategic management practices. Managers should promote an environment where employees feel empowered to experiment with new ideas and technologies. This can be achieved through training programs, workshops, and cross-functional collaboration, enabling teams to explore AI applications that can enhance service delivery and operational processes. Organizational agility is increasingly seen as a competitive advantage in fast-evolving digital markets. Companies that have successfully adopted agile principles—such as iterative decision-making, continuous feedback loops, and decentralized problem-solving—are better positioned to implement AI-driven transformation.

The successful deployment of AI technologies hinges on having a skilled workforce capable of managing and interpreting AI systems. Managers should prioritize talent development by investing in training and education programs that equip employees with the necessary skills in data analytics, machine learning, and AI management. This investment not only enhances the organization's capabilities but also fosters employee engagement and retention. Telecom leaders in countries like India and Singapore have invested in national AI academies and corporate AI boot camps that provide scalable workforce upskilling. Such models could be localized in Iran with support from academic institutions and public-private partnerships.

Strategic management frameworks should be designed to align with sustainability goals, ensuring that digital transformation initiatives contribute positively to environmental, social, and economic outcomes. Managers must evaluate existing frameworks and methodologies to identify best practices that promote sustainability. This alignment can enhance the organization's reputation and appeal to socially conscious consumers, ultimately driving competitive advantage. For example, telecom firms in

Germany and Finland have adopted green strategy scorecards, integrating ESG (Environmental, Social, Governance) metrics alongside traditional performance indicators. These approaches reflect growing investor demand for measurable impact.

AI technologies enable organizations to harness vast amounts of data for informed decision-making. Managers should prioritize the establishment of data governance frameworks that ensure data quality, security, and accessibility. By leveraging data analytics, organizations can gain insights into customer behavior, market trends, and operational efficiency, allowing for proactive decision-making that aligns with strategic objectives. Data governance is especially vital in the telecommunications sector, where customer privacy, service reliability, and regulatory oversight intersect. Developing localized data governance models that reflect Iran's digital sovereignty goals is essential.

Successful digital transformation requires collaboration among various stakeholders, including employees, customers, regulatory bodies, and technology partners. Managers should actively engage stakeholders in the transformation process, seeking input and feedback to ensure that initiatives are aligned with their needs and expectations. Building partnerships with technology providers and academic institutions can also facilitate knowledge sharing and innovation. Stakeholder co-creation initiatives, such as innovation labs or AI ethics forums, can generate buy-in and surface insights that improve project design. These collaborative mechanisms foster trust, transparency, and collective problem-solving.

Establishing metrics to monitor and evaluate the impact of AI and strategic management initiatives is crucial for continuous improvement. Managers should develop key performance indicators (KPIs) that assess the effectiveness of AI applications, operational efficiency, customer satisfaction, and sustainability outcomes. Regular evaluation allows organizations to adapt strategies based on performance data, ensuring that they remain agile in a rapidly changing environment. Balanced scorecards, AI readiness indices, and sustainability dashboards are some tools already being used by global leaders to institutionalize performance tracking in digital transformation projects.

The regulatory landscape in Iran presents unique challenges for the telecommunications industry. Managers should stay informed about regulatory developments and engage with policymakers to advocate for a supportive environment for AI adoption. Proactively addressing regulatory concerns can mitigate risks and ensure compliance, allowing organizations to focus on innovation and growth. Participating in regulatory sandboxes or pilot programs can help organizations test new technologies while working within regulatory boundaries. Such platforms also allow regulators to learn alongside industry leaders, promoting more agile and informed policy design.

As AI technologies become more prevalent, ethical considerations must be at the forefront of decision-making. Managers should establish guidelines for ethical AI use, ensuring transparency, fairness, and accountability in AI applications. This commitment to ethical practices not only builds trust with customers and stakeholders but also aligns with broader sustainability goals. Incorporating fairness metrics, audit trails, and explainable AI tools into development pipelines can help organizations operationalize ethics in daily practice. These steps also reduce reputational risks and legal liabilities.

The telecommunications industry is characterized by rapid technological advancements and evolving consumer preferences. Managers should remain vigilant and adaptable to future trends, such as the rise of 5G, IoT, and smart technologies. By anticipating disruptions and being prepared to pivot strategies, organizations can maintain a competitive edge and continue to drive sustainable digital transformation. Firms must consider developing foresight functions, scenario-planning capabilities, and innovation radar systems to systematically monitor, evaluate, and respond to emerging trends.

In conclusion, the role of AI and strategic management in the sustainable digital transformation of the Iranian telecommunications industry is multifaceted and dynamic. By embracing AI as a strategic asset, fostering a culture of innovation, investing in talent development, and aligning initiatives with sustainability goals, managers can navigate the complexities of the digital landscape. These insights provide a roadmap for leaders seeking to drive meaningful change and achieve long-term success in an increasingly competitive and technology-driven environment. Moreover, these implications set the stage for future

regulatory, technological, and organizational reforms that can accelerate Iran's transition to a digitally sovereign and innovation-led economy.

6.2.1 Organizational Change and Leadership Readiness

Organizational change is often the most underestimated yet critical component of AI transformation. Leaders must assess their organizations' digital maturity, change readiness, and internal resistance points. Adopting change management models, such as Kotter's 8-Step Framework or the ADKAR Model, can provide structured guidance on how to implement transformational initiatives while minimizing organizational friction (Paramitha, Tobing and Suroso, 2020; Laig and Abocejo, 2021).

6.2.2 Data Governance and Digital Ethics

While data governance was discussed earlier, it deserves greater focus as a standalone implication. With AI systems processing sensitive data, robust data ethics policies must be established. These policies should cover consent management, algorithmic transparency, and redress mechanisms for harm. Best-in-class telecoms are already creating internal AI ethics boards to oversee deployments.

6.2.3 Cross-Sector Policy Synergy

Digital transformation in telecom cannot occur in isolation. The interplay between national broadband plans, cyber security laws, AI regulation, and education reform must be synergized. Managers should advocate for "whole-of-government" digital strategies that include telecom policy as part of broader economic and social development agendas.

6.3 Recommendations for Future Research

The most important research recommendation for future proposals is:

- Determining the importance as the weight of indicators in decision-making, Prioritizing factors using a hierarchical method.
- Considering that decision-making is always accompanied by uncertainty in the real world, specifying a framework that is able to take uncertainty into account in the decision-making process.

- Ongoing investment in R&D is essential for staying ahead of technological advancements and identifying new applications for AI in telecommunications.
- Establishing metrics to evaluate the effectiveness of AI initiatives and strategic management practices will enable organizations to adapt and refine their approaches over time.
- The telecommunications industry is influenced by global trends, including advancements in AI and shifts in consumer behavior. Staying informed about international developments and adapting strategies accordingly will be crucial for maintaining competitiveness.

These points collectively serve as a springboard for deeper academic inquiry and real-world exploration. Future research should not only build on these recommendations but also seek to localize, validate, and expand upon them using interdisciplinary approaches. To enhance methodological rigor, researchers may employ techniques such as the Analytic Hierarchy Process (AHP) or Fuzzy AHP to prioritize factors, particularly when multiple conflicting criteria exist. These methods enable more nuanced evaluation and weighting of key variables, such as AI maturity, organizational culture, and regulatory readiness, under conditions of uncertainty.

Incorporating Monte Carlo simulations, Bayesian networks, or grey system theory can further enrich decision-making models, especially where the input data is incomplete, vague, or imprecise—common challenges in the Iranian telecom context. Scenario planning or Delphi-based forecasting methods could also be valuable in identifying long-term implications of AI adoption across different regulatory and economic environments.

Additionally, future researchers could conduct comparative case studies between Iranian and international telecommunications firms to assess which practices yield optimal performance in similar socio-political contexts. This comparative approach would offer generalizability and transferability of findings, enhancing the study's international relevance. Academic investigations may also explore how emerging technologies like Generative AI, quantum computing, and edge computing intersect with strategic management practices in the telecom sector. These technologies are expected to reshape

the foundations of operational efficiency, cybersecurity, and user personalization in the near future.

Given the societal and ethical dimensions of AI, future research should also include qualitative studies - including stakeholder interviews and focus groups - to explore public trust, data privacy concerns, and cultural readiness for AI-driven transformation in Iran. Moreover, more extensive longitudinal studies could examine the impact of AI and strategic alignment over time, providing insights into sustainability, performance outcomes, and change adoption trajectories. Such studies would be instrumental in determining whether early AI initiatives yield compounding benefits or face diminishing returns in the absence of governance refinement.

6.3.1 Theoretical and Practical Relevance for Future Scholars

From a theoretical perspective, future scholars can explore how established models, such as the Technology-Organization-Environment (TOE) framework, Dynamic Capabilities theory, or Institutional Theory, can be adapted to explain AI adoption in Iranian telecom firms. These models offer strong foundations for evaluating both internal capabilities and external pressures. On the practical side, future work could contribute to designing policy frameworks that help regulators craft agile, innovation-friendly AI governance. Researchers can help fill the gap between overly rigid policies and the fast-moving nature of AI technology by proposing hybrid or adaptive regulatory models tailored to Iran’s development priorities. Finally, interdisciplinary research that brings together experts in computer science, management, law, and public policy can generate comprehensive models for managing ethical, strategic, and technological trade-offs in telecom AI deployment.

6.4 Conclusion

In conclusion, the integration of artificial intelligence (AI) and strategic management practices is pivotal for driving sustainable digital transformation in Iran's telecommunications industry. As organizations navigate the complexities of a rapidly evolving technological landscape, leveraging AI can enhance decision-making processes,

optimize resource management, and foster innovation. By aligning AI initiatives with sustainable development goals, telecommunications companies can contribute to environmental sustainability, social equity, and economic growth. This alignment ensures that AI is not only a performance enabler but also a force for inclusive progress, positioning telecommunications firms as drivers of national development.

The ethical deployment of AI technologies is essential to build trust among stakeholders and ensure compliance with regulatory standards. Engaging employees, customers, and regulators in the transformation process fosters a collaborative environment that enhances the effectiveness of AI applications. Furthermore, investing in training and development equips the workforce with the necessary skills to adapt to new technologies and practices. Countries that have excelled in ethical AI adoption, such as Canada and Denmark, demonstrate the power of embedding transparency, fairness, and accountability into both policy and practice. Iran can adapt these principles within its regulatory and cultural context to ensure that its digital transition is both responsible and resilient.

Regular impact assessments and feedback mechanisms will enable organizations to evaluate the effectiveness of their AI strategies and make informed adjustments. A long-term strategic vision that prioritizes ethical considerations and sustainability will position telecommunications companies as leaders in the industry. Such vision-building exercises should include scenario planning, AI ethics audits, and sustainability forecasting, ensuring that organizations remain agile and accountable as technologies, and societal expectations, continue to evolve.

Ultimately, the successful integration of AI and strategic management not only enhances operational efficiency and competitiveness but also contributes to the broader goal of sustainable development in Iran. By embracing these principles, the telecommunications sector can play a crucial role in shaping a more sustainable and equitable future for the nation. As the telecom sector serves as a backbone for other industries, from education to e-commerce, its transformation will have ripple effects across the entire economy. A robust, ethical, and innovative telecommunications ecosystem can

therefore catalyze systemic improvements in digital inclusion, service delivery, and public trust.

The role of artificial intelligence (AI) and strategic management in the sustainable digital transformation of the Iranian telecommunications industry is a multifaceted topic that warrants a comprehensive discussion. This section delves into the implications of the findings, explores the challenges and opportunities presented by AI, and emphasizes the importance of strategic management in facilitating a successful transformation. Moreover, this thesis contributes a grounded perspective on how to reconcile rapid technological progress with the structural and institutional constraints typical of emerging economies.

AI technologies have emerged as a driving force in the digital transformation of various industries, including telecommunications. The findings of this study highlight several key areas where AI can significantly impact the Iranian telecommunications sector:

Operational Efficiency: AI can automate routine tasks, optimize network management, and enhance data processing capabilities. This leads to reduced operational costs and improved service delivery. For instance, predictive maintenance powered by AI can minimize downtime and enhance the reliability of telecommunications infrastructure. Similar use cases have been successfully implemented in countries like South Korea and Singapore, where AI is used to manage 5G infrastructure, detect anomalies in real-time, and reduce technical service failures.

Enhanced Customer Experience: AI-driven tools such as chat bots and virtual assistants can provide personalized customer support, addressing inquiries and issues in real-time. By leveraging customer data, telecommunications companies can tailor their offerings to meet individual preferences, leading to increased customer satisfaction and loyalty. In competitive markets like India, telcos that implemented conversational AI and multilingual voice assistants saw a marked increase in customer retention and brand engagement, indicating the global relevance of this approach.

Data-Driven Decision Making: The ability to analyze vast amounts of data in real-time enables telecommunications companies to make informed decisions. AI algorithms

can identify trends, forecast demand, and optimize resource allocation, allowing organizations to respond swiftly to market changes.

By institutionalizing data analytics into corporate strategy, firms can create responsive, insight-driven operating models that scale effectively across departments.

6.4.1 Strategic Management as a Catalyst for Transformation

While AI presents numerous opportunities, the successful implementation of these technologies requires effective strategic management. The study emphasizes the following aspects of strategic management that are crucial for fostering sustainable digital transformation:

Alignment of Goals: Organizations must ensure that their AI initiatives align with their overall strategic objectives. This involves integrating AI into the core business strategy rather than treating it as a standalone project. By doing so, companies can create a cohesive framework that promotes innovation while addressing sustainability concerns. Strategic alignment frameworks, such as the McKinsey 7S or Kaplan and Norton's Balanced Scorecard, can be tailored to ensure AI initiatives support broader business and societal outcomes.

Change Management: The introduction of AI technologies often necessitates a cultural shift within organizations. Strategic management plays a vital role in facilitating this change by fostering a culture of innovation, encouraging collaboration, and providing training and support to employees. This ensures that the workforce is equipped to adapt to new technologies and processes. Leadership buy-in, employee incentives, and clear communication are vital components of effective change management in AI transformation programs. Without these, even the most advanced technologies risk underutilization or failure.

Stakeholder Engagement: Engaging stakeholders, including employees, customers, and regulatory bodies, is essential for successful transformation. Strategic management should prioritize open communication and collaboration to build trust and ensure that all parties are aligned with the organization's vision for digital transformation.

Establishing stakeholder advisory panels or cross-functional steering committees can help ensure inclusive and informed strategy execution.

6.4.2 Challenges in the Iranian Telecommunications Industry

Despite the potential benefits, the Iranian telecommunications industry faces several challenges in implementing AI and strategic management practices:

Regulatory Constraints: The regulatory environment in Iran can pose obstacles to the adoption of AI technologies. Companies must navigate complex regulations and ensure compliance while pursuing innovative solutions. Engaging with policymakers to create a supportive regulatory framework is essential for facilitating AI adoption. Policymakers may also benefit from international benchmarking to assess how peer economies regulate AI and to co-develop sandbox environments that enable controlled experimentation.

Infrastructure Limitations: The existing telecommunications infrastructure may not be equipped to support advanced AI applications. Investments in upgrading infrastructure, including network capabilities and data storage solutions, are necessary to harness the full potential of AI. Public-private infrastructure investment initiatives could be explored to accelerate broadband access, edge computing capabilities, and 5G expansion—each of which serves as a prerequisite for advanced AI functionality.

Skill Gaps: The successful implementation of AI requires a skilled workforce capable of developing and managing AI systems. Addressing skill gaps through training and education programs is crucial for building the necessary expertise within the industry. National AI literacy campaigns and tertiary education partnerships could play a pivotal role in producing the next generation of data scientists, AI strategists, and ethical technologists.

6.4.3 Opportunities for Sustainable Development

The integration of AI and strategic management also presents opportunities for promoting sustainability within the telecommunications sector:

Environmental Impact: AI can contribute to reducing the environmental footprint of telecommunications operations. For example, optimizing energy consumption in

network management can lead to lower carbon emissions. By adopting sustainable practices, companies can enhance their corporate social responsibility and appeal to environmentally conscious consumers. Telecom firms in countries like Finland have already integrated energy-efficient algorithms into base stations, resulting in energy savings of up to 30%. Similar gains are attainable in Iran with the right strategic investments.

Innovation in Services: The use of AI can drive innovation in service offerings, such as smart city solutions and IoT applications. By developing new services that leverage AI, telecommunications companies can create value for customers while contributing to the broader goals of sustainable development. AI can also enable dynamic pricing, demand prediction, and fraud detection - areas that enhance both customer experience and operational integrity.

Collaboration and Partnerships: The study highlights the importance of collaboration among stakeholders to drive sustainable digital transformation. Telecommunications companies can partner with technology providers, academic institutions, and government agencies to foster innovation and share best practices. Formal innovation clusters or regional "AI telecom hubs" could serve as physical and virtual spaces where these stakeholders co-create AI use cases tailored to national needs.

Looking ahead, the findings of this thesis offer a springboard for broader national discourse. As Iran crafts its future digital economy, telecom companies must be seen not just as service providers but as enablers of economic transformation and social progress.

Future pathways may involve:

- Building national AI strategy roadmaps tailored to telecom.
- Establishing AI-sustainability scorecards for corporate reporting.
- Expanding cross-sector coalitions for ethical and inclusive digital transformation.

Ultimately, the future of Iran's telecommunications industry hinges on its capacity to innovate with purpose, manage change strategically, and embed sustainability into its digital DNA. This research aspires to serve as a foundational contribution toward that vision.

APPENDIX A

SURVEY COVER LETTER

THE ROLE OF AI AND STRATEGIC MANAGEMENT IN THE SUSTAINABLE DIGITAL TRANSFORMATION OF THE IRANIAN TELECOMMUNICATIONS INDUSTRY

Dear Respondent,

I am a student at the Swiss School of Business and Management Geneva, and the present questionnaire is part of a postgraduate research project entitled "The Role of AI and Strategic Management in the Sustainable Digital Transformation of the Iranian Telecommunications Industry," which is supported by the Swiss School Ethics Committee. Your participation is invaluable to this study, and your insights will greatly contribute to understanding the significance of various factors in this industry's transformation.

Please Note:

- The responses will be used solely for the purpose of this study and will be kept confidential.
- Completing the questionnaire is voluntary and will take approximately 10 to 15 minutes.
- If you encounter any issues with the questions or need assistance, please contact me.

Thank you for your participation and consideration.

Respectfully,

Naser Moradi
Email: nasser@ssbm.ch
Affiliation: Mobinnet Telecommunication Company
Phone: 00989122884981

Section One: Demographic Characteristics

1. What is your gender?
    - a) Male
    - b) Female
2. How old are you?
    - a) Under 30 years old
    - b) 31-40 years old
    - c) 41-50 years old
    - d) Over 51 years old
3. What is your highest level of education?
    - a) Under B.A.
    - b) B.A.
    - c) M.A.
    - d) Ph.D.
4. What is your work experience?
    - a) Under 5 years
    - b) Between 6-10 years
    - c) Between 11-15 years
    - d) Between 16-20 years
    - e) Over 21 years
5. What is your job role?
    - a) Manager
    - b) Academic

- c) General staff

Section Two: Influence of Factors

Please rate the influence of each factor on a scale from 1 to 5, where 5 indicates the highest influence and 1 indicates the lowest influence.

Main Factor	Sub Factor	Code	Very High (5)	High (4)	Medium (3)	Low (2)	Very Low (1)
Artificial Intelligence (AI)	Research and Development	AI1	☐	☐	☐	☐	☐
	Data Analysis	AI2	☐	☐	☐	☐	☐
	Automation (network maintenance and services)	AI3	☐	☐	☐	☐	☐
	Security and Information Protection	AI4	☐	☐	☐	☐	☐
	Customer Support	AI5	☐	☐	☐	☐	☐
	Developing a Strategy	AI6	☐	☐	☐	☐	☐
	Empowering Staff	AI7	☐	☐	☐	☐	☐
Strategic Management (SM)	Strategic Leadership	SM1	☐	☐	☐	☐	☐
	Environmental Analysis Focus on cost	SM2	☐	☐	☐	☐	☐
	Product diversity by Innovation and Technology	SM3	☐	☐	☐	☐	☐
	Cooperation and Communication	SM4	☐	☐	☐	☐	☐

	Development of Skills	SM5	☐	☐	☐	☐	☐
	Financial Stability	SM6	☐	☐	☐	☐	☐
	Risk Management	SM7	☐	☐	☐	☐	☐
	Creating new incoming streams						

I would appreciate if you have any other points, Items or sub factor in mind, please mention it in writing:

Thank you for completing this questionnaire. Your responses are highly valued and will contribute significantly to our research.

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