REPUBLIC OF TURKEY
OSTİM TECHNICAL UNIVERSITY
GRADAUTE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
INDUSTRIAL POLICY AND TECHNOLOGY MANAGEMENT
MASTER’S DEGREE PROGRAM

ASSESSING THE DIGITAL TRANSFORMATION READINESS OF FOOD AND BEVERAGE SME’s IN TRIPOLI, LIBYA

MASTER’S THESIS

PREPARED BY
ADEL ALMADGHEEW

THESIS ADVISOR
Assoc. Prof. Dr. Hamide ÖZYÜREK

ANKARA, 2025

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THESIS ACCEPTANCE AND APPROVAL

The study entitled A STUDY OF ASSESSING THE DIGITAL TRANSFORMATION READINESS OF FOOD AND BEVERAGE SMEs IN TRIPOLI, LIBYA.

Prepared by ADEL ALMADGHEEW was accepted as a Master's Thesis by our jury.

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APPROVAL

I hereby approve that this study, accepted by the jury, fulfills the requirements for being a Master's/PhD Thesis.

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Prof. Dr. Ufuk TÜREN

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Director of the Graduate School

OSTİM TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES MASTER'S THESIS
ORIGINALITY REPORT

Thesis Title: Assessing the Digital Transformation Readiness of Food and Beverage SMEs in Tripoli, Libya.

Student Name Surname: Adel Almadgheew

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Program: Industrial Policy and Technology Management

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Student's Signature
Adel Almadgheew
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ABSTRACT

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ASSESSING THE DIGITAL TRANSFORMATION READINESS OF FOOD AND BEVERAGE SMEs IN TRIPOLI, LIBYA

This study assesses the readiness and perceptions towards digital transformation by small and medium enterprises (SMEs) operating in the food and beverage sector in Tripoli, Libya. The effects of organizational, demographic, and positioning variables on four dimensions, namely: Digital Transformation Strategy and Leadership (DTSL), Adoption of Digital Technologies (ADT), Business Processes and Integration (BPI), and Challenges and Readiness for Digital Transformation (CRDT), were tested using a strong quantitative research design.

Descriptive and multivariate analysis results revealed that 78% of reporting companies have begun the process of digital transformation, with 62.3% of these appointing dedicated digital committees. The results of the Principal Component Analysis confirmed four latent constructs: technology adoption, strategic leadership, readiness and digital talent, and business integration. Such findings emphasized the interplay among strategic, technological, and human aspects. Multiple linear regression indicated that DTSL ($\beta = 0.244$), ADT ($\beta = 0.254$), and BPI ($\beta = 0.217$) are all positive predictors for digital readiness (CRDT), explaining 37.7% of variance ($R^2 = 0.377$, $p < 0.001$).

Demographic analysis reported no significant differences between males and females, although results show that females performed slightly better in all dimensions. However, age and education level proved statistically significant. Age bracket 35 to 44 was more engaged and ready for digitalization; postgraduate level was most influential for higher strategic insight, technology competency, and organizational readiness.

In terms of positional attributes, the results highlight that managers regarded strategic leadership and technology adoption significantly higher compared to those below management; thus, reflecting their strategic involvement. Nonetheless, there were no positional differences for business process integration or digital readiness, suggesting that those concepts enjoy relatively uniform understanding within the organization.

These results emphasize that leadership, education, and strategic inclusion are instrumental to the successful execution of digital transformation. Practical implications suggest targeted training, leadership development, and the creation of digital strategies that accommodate the diverse capacities of SME workforces in transitional economies.

Keywords: SMEs, Food and beverages sector, Digital technologies, Business processes, integration, Challenges, Digital transformation readiness

ÖZ

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TRABLUS, LİBYA'DAKİ GIDA VE İÇECEK KOBİ'LERİNİN DİJİTAL DÖNÜŞÜME HAZIRLIK DÜZEYİNİN DEĞERLENDİRİLMESİ

Bu çalışma, Libya'nın Trablus kentinde faaliyet gösteren küçük ve orta ölçekli işletmelerin (KOBİ) dijital dönüşüme olan hazır bulunuşluk düzeylerini ve bu konudaki algılarını incelemektedir. Nicel araştırma desenine dayalı olarak yürütülen çalışmada, örgütsel, demografik ve pozisyonel değişkenlerin Dijital Dönüşüm Stratejisi ve Liderlik (DTSL), Dijital Teknoloji Benimseme (ADT), İş Süreçleri ve Entegrasyon (BPI) ile Dijital Dönüşüme Hazırlık ve Zorluklar (CRDT) olmak üzere dört temel boyut üzerindeki etkisi analiz edilmiştir.

Tanımlayıcı ve çok değişkenli analizler, katılımcı işletmelerin %78'inin dijital dönüşüm girişimlerine başladığını ve %62,3'ünün bu süreç için özel dijital ekipler kurduğunu ortaya koymuştur. Temel Bileşenler Analizi (PCA), teknoloji benimseme, stratejik liderlik, dijital yetenek ve hazırlık ile iş entegrasyonu olmak üzere dört gizil yapıyı doğrulamıştır. Bu yapıların birbirleriyle güçlü biçimde ilişkili olduğu gözlemlenmiştir. Çoklu doğrusal regresyon analizinde DTSL ($\beta = 0.244$), ADT ($\beta = 0.254$) ve BPI ($\beta = 0.217$) değişkenlerinin dijital dönüşüme hazır oluş üzerinde anlamlı ve pozitif etkiler yarattığı bulunmuştur. Model, CRDT değişkenindeki varyansın %37,7'sini açıklamaktadır ($R^2 = 0.377$; $p < 0.001$).

Demografik analizlerde, cinsiyet temelli farklar istatistiksel olarak anlamlı bulunmamakla birlikte, kadınların tüm boyutlarda erkeklere kıyasla marjinal düzeyde daha yüksek puanlar aldığı gözlemlenmiştir. Yaş ve eğitim düzeyleri ise anlamlı farklılıklar göstermektedir. Özellikle 35–44 yaş aralığındaki çalışanlar daha yüksek dijital farkındalık ve hazırlık düzeyi sergilemekte, lisansüstü eğitim seviyesine sahip bireyler ise daha gelişmiş stratejik bakış açısı, teknolojik yetkinlik ve kurumsal hazırlık göstermektedir.

İş pozisyonlarına göre yapılan analizlerde, yöneticilerin stratejik liderlik ve teknoloji benimseme konularında en yüksek algıya sahip olduğu ve bu durumun rollerinin stratejik niteliğinden kaynaklandığı belirlenmiştir. Ancak iş süreçlerinin entegrasyonu ve dijital dönüşüme hazırlık boyutlarında pozisyona göre anlamlı farklar bulunmamıştır.

Elde edilen bulgular, dijital dönüşüm sürecinde liderlik, eğitim düzeyi ve kurumsal katılımın kritik rolünü vurgulamaktadır. Sonuçlar, geçiş sürecindeki ekonomilerde faaliyet gösteren KOBİ'ler için hedefe yönelik eğitim, liderlik geliştirme programları ve kapsayıcı dijital stratejilere duyulan ihtiyacı ortaya koymaktadır.

Anahtar Kelimeler:Küçük ve Orta Ölçekli İşletmeler (KOBİ'ler), Gıda ve İçecek Sektörü, Dijital Teknolojiler, İş Süreçleri, Entegrasyon, Zorluklar, Dijital Dönüşüme Hazır Bulunuşluk

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ICONS AND ABBREVIATIONS

AR	Augmented Reality
CRM	Customer Relationship Management
CT	Information Communication Technologies
CPS	Cyber-Physical Systems
DTSL	Digital Transformation Strategy and Leadership
ADL	Adoption of Digital Technologies
BPI	Business Processes and Integration
CRDT	Challenges and Readiness for Digital Transformation
IoT	Internet of Things
DT	Digital transformation

CHAPTER ONE
INTRODUCTION

The foundations of digitalization trace back to the 18th century, when Gottfried Wilhelm Leibniz introduced the binary number system in 1703—establishing the conceptual basis for today's digital logic through the use of only two digits: 1 and 0 (Leibniz, 1703). Over centuries, this binary principle has evolved significantly, laying the groundwork for transformative technologies. As Mertens (2014) noted, the evolution of digitization has reshaped countless sectors, including manufacturing, logistics, and food production.

In the food and beverage industry, digital transformation offers unprecedented opportunities for innovation, efficiency, and responsiveness. Bowersox, Closs, and Drayer (2005) emphasize that digital technologies redefine business processes by improving supply chain operations and overall performance. In Libya, particularly Tripoli, digital manufacturing tools—ranging from automated systems to Internet of Things (IoT) applications—are increasingly being explored to improve connectivity across supply chains and facilitate real-time communication between systems and machines. These advancements align with the principles of Industry 4.0, a term popularized in Germany to describe the integration of digital and physical production environments (Federal Ministry of Education and Research, 2011; Ashton, 1999).

Although these technologies promise significant gains, they also necessitate substantial structural adaptations, as companies must reconfigure operations to accommodate new digital ecosystems (Hameed, 2018). In Tripoli, where infrastructure and resources may be constrained, applying models like the Dortmund Management Model 4.0 offers a practical roadmap for digital adoption in resource-limited environments (Humpel & Henke, 2017).

Agility in manufacturing is vital for food and beverage firms seeking to respond quickly to fluctuating consumer demands. Agile approaches focus on development with the customer in mind priortizing product quality as well as promising technological upgrades or improvements (Chong & Chen, 2010; Bottani, 2009). In such dynamic market settings, success in engaging and satisfying customers requires anticipation of trends and appropriate shifting in production strategies (Homburg, 2019). In this regard, branches of multi-purpose and adaptive technologies, such as IoT and Cyber-Physical Systems (CPS), endow organizational agility with human-machine real-time interaction (Bretel et al., 2014).

However, there are a number of challenges hindering the path of digital transformation in the food and beverage sector in Tripoli. Other barriers include resistance to change in the organization, lack of digital skills among the employees, and a lack of coherent strategy (Euchner, 2018). Strong leadership spearheads all of these challenges, ensuring that there is a culture of innovation and strategic alignment in Nahrkhalaji et al. (2018). Digitalized supply chains are value-creating tools for transparency and improved supply chain risk management and operational efficiency. These technologies allow the firm to introduce real-time monitoring and resource optimization so that the food and beverage enterprises will be more resilient and adapted to disruption (Barros et al. 2012; Bogner et al. 2016). This study seeks to investigate how such technologies can be adapted and applied to meet the specific needs of food and beverage SMEs in Tripoli while describing opportunities and obstacles.

1.1. Problem Statement

Precarious both for the private sector in general and in the food- and beverage-related activities that play critical roles in food security and employment domestically, is the sub-sector of small and medium enterprises (SMEs). Notwithstanding this crucial position, SMEs in Libya are always facing structural impediments: limited access to financing, methods of operation that have become very outdated, and bureaucratic barriers that insulate them from competitiveness in an omnipresently digital global market (Libya Herald, 2023; Qabas, 2025). Even though investigations into global trends confirm that digital transformation improves business agility, customer engagement, and operational efficiency (p. 10 Costa Melo et al., 2023), most of the empirical examinations documented in the literature on digital transformation are restricted to developed economies and provide little insight on the way digital apps affect the performance of SMEs in fragile or conflict-affected contexts like Libya (Sidabutar & Siswanto, 2024). The absence of established localized models to guide these digital transformations further widens this gap, leaving business owners and policymakers with little-to-no clear strategies for driving such changes. Leadership capacity and organizational agility have emerged in the global arena as critical enablers of successful digital transformation (Kurniawati et al., 2021) but are still least studied in regards to the food and beverage sector in Libya.

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1.2. Importance of Study

Small and Medium-sized Enterprises (SMEs) play a pivotal role in Indonesia's economic development, not only due to their significant contribution to the national GDP but also because of their resilience in the face of past economic crises (Gunadi, Lesmana, & Fachrizah, 2022). However, during the COVID-19 pandemic, stringent social restrictions and the fear of virus transmission severely disrupted SMEs' offline operations, leading to decreased mobility and public engagement (Halimatussadiah et al., 2020).

In the broader context of global economic integration, digital transformation is increasingly viewed as a crucial mechanism to enhance competitiveness and ensure long-term sustainability. Economic globalization continues to be a shared aspiration among nations, and the digital economy is expected to become a cornerstone for international trade and cooperation in the coming years (Wiyono & Kirana, 2021).

Research into sustainable digital transformation within SMEs indicates that this field is still emerging, with growing scholarly and practical interest. Digital transformation is recognized not only for improving internal processes but also for reshaping industry boundaries and organizational competitiveness (Kurniawati, Handayati, & Osman, 2021). This disruption is characterized by a convergence of business models and technologies, often blurring traditional distinctions between sectors and creating new market dynamics (Costa Melo et al., 2023).

Despite increasing interest in this domain, only 42% of the reviewed studies have proposed quantitative frameworks to evaluate digital transformation performance. Interestingly, 88% of these works incorporate empirical methods, underscoring a gap in the theoretical and methodological infrastructure required to measure transformation outcomes rigorously (Costa Melo et al., 2023). This signals a need for the development of more robust and universally applicable quantitative tools to assess the digital readiness and impact of transformation efforts, particularly in SMEs.

Libya is making strides in digital transformation, particularly with regard to the development of SMEs (Libya Herald, 2023). Its transformation onto electronics is opening up its own avenues for efficiencies, innovations, and global competitiveness for not only small but large enterprises; it is providing the SMEs access to coordinated platforms with funds, training, and markets, all helping bring down obstacles that, traditionally, included bureaucracy and restricted capital; opportunities that at the same time are embracing technology for enhanced productivity and digital growth for bigger companies with artificial intelligence, secured data systems, mobile integration, etc.; the environment for acceptance of digital transformation has been supported by government interventions such as the Digital Lab program and national strategies in education and e-governance among others. Inherent challenges notwithstanding, such as the primitive economy and infrastructural disparity, the sweeping push by stakeholders further opens up Libya into a digitally inclusive economy where both SMEs and large enterprises will innovate, resist, and grow together through inclusive digital growth (Qabas, 2025).

1.3. Research Question

Digital transformation has emerged as a strategic process that enhances business efficiency, strengthens competitiveness, and supports sustainability on a global scale. However, existing literature predominantly focuses on the impact of digital transformation on small and medium-sized enterprises (SMEs) in developed countries, while sector- and region-specific analyses in developing economies remain limited. In particular, there is a notable lack of comprehensive studies examining the readiness of SMEs operating in the food and beverage sector in Tripoli, Libya. In this context, this research aims to address the question,

- What is the readiness of digital transformation for small and medium-sized enterprises in the food and beverage sector in Tripoli, Libya?

1.4. Objective of Thesis

In an era where digital technologies are fundamentally reshaping business operations across the globe, understanding the readiness of enterprises to adapt to these changes has become a critical area of research. Small and medium-sized enterprises (SMEs), particularly in developing and fragile economies, often face unique challenges in embracing digital transformation due to structural, financial, and institutional constraints. Libya, as a country undergoing both political transition and economic reform, presents a distinctive case for exploring these dynamics. This section outlines the objectives of the study, which focuses on assessing the digital transformation readiness of SMEs in the food and beverage sector in Tripoli, Libya—a sector essential to the country's food security and economic recovery.

- This study aims to assess the readiness of small and medium-sized enterprises (SMEs) in the food and beverage sector in Tripoli, Libya, for digital transformation. The research seeks to assess the internal and external factors that influence SMEs' readiness to accept and implement digital technologies, including infrastructure, workforce skills, leadership mindset, innovation culture, access to finance, and, finally, the policy environment.

- Given the global urgency of entering the digital economy amid the COVID-19 pandemic, it is increasingly clear that digital transformation is no longer a strategic necessity for gaining a competitive advantage; survival also depends on it. Several studies have examined the phenomenon of digital transformation of SMEs in advanced economies (OECD, 2021; European Commission, 2020), while a few have focused on the phenomenon related to SMEs in emerging economies (World Bank, 2022). However, there remains a "missing gap" in the literature on SMEs in fragile and transition economies, particularly Libya.

- Current digital frameworks cannot accommodate all the specific circumstances, such as political instability, lack of infrastructure, or a weak digital ecosystem in Libya. The existing literature lacks regional studies that address the socioeconomic and institutional realities of Libyan businesses, particularly in high-potential but vulnerable subsectors, such as the food and beverage sector. Furthermore, previous studies have focused primarily on large firms or aggregated national indicators, without truly examining the barriers or enablers of SME transformation at the sector or city level.

- This study will therefore contribute to bridging the knowledge gap by generating local experiences. Focusing on Tripoli, a commercial hub that has become home to an increasingly vibrant entrepreneurial scene, the research is expected to identify the digital maturity and constraints faced by SMEs in the food and beverage sector, which is vital for food security, employment, and economic diversification in Libya. It is envisioned that the findings will help policymakers, business support organizations, and SME owners understand what they need to do in terms of strategic interventions and capacity building to create a more inclusive digital economy..

1.5. Research Hypothesis

Hypotheses were formulated after reviewing the literature (Westernman et al., 2014; Kane et al., 2015; Matt et al., 2015; Zhang et al., 2018; Vial, 2019)This study is built on a hypothesis as below:

H1: Digital transformation strategy and leadership positively influence digital transformation challenges and readiness.

H2: Digital technology adoption positively influences digital transformation challenges and readiness.

H3: Business processes and integration positively influence digital transformation challenges and readiness.

1.6. Scope and Limitations of the Study

This research focuses on evaluating the digital transformation readiness of small and medium-sized enterprises (SMEs) in the food and beverage industry in Tripoli, Libya. As an assessment of Tripoli's importance to Libya, being its economic and administrative capital, it provides a good context within which to investigate how SMEs are adjusting to the rapidly changing digital environment. For the urban context, the research aims to capture a coloration of technological, organizational, and human factors that influence digital readiness, while accepting diversity between the infrastructure and market environment in Tripoli, within other Libyan regions.

The study is limited to SMEs in the food and beverage industry, including food producers, restaurants, catering facilities, and beverage manufacturers. This sector has been selected because of its vital importance and grew need for digital solutions to be adopted in supply chain management, customer engagement, and operation within Libya. Focusing on this area, the research will provide insights into the specific strategies and policies regarding digital transformation that will be of immense benefit in a sectoral approach.

In conceptualizing digital transformation readiness, research analyzes readiness on several dimensions: the availability and adoption of digital technologies; organizational capabilities such as leadership and culture; employee digital skills; and external environment factors like regulatory support and market dynamism. That multi-faceted dimension ensures that there is a wholesome understanding of the readiness levels and the identification of barriers or enablers particular to food and beverage SMEs based in Tripoli.

Data collection and analysis would only be current, extending to the years 2024-2025, representing the current " paradigm " of digital adoption and preparedness among these enterprises. This study will gain insights from SME owners and managers into their perceptions relatives challenges and strategic orientations toward digital transformation. The application of research is above all with the SMEs of other sectors, but focused above all on large corporations and informal enterprises. Such delimitation facilitates research depth and its usefulness to stakeholders interested in speeding up the processes of digital innovation in Libyan food and beverage SMEs.

1.7. Organization of the Study

This research is divided into six chapters, each meeting a specific goal as it investigates the preparedness of SMEs in the food and beverage industry in Tripoli, Libya for digital transformation. Introduction figure in establishing the background of the study, specifying the significance of the study, and specifying the general research questions. Chapter 2 deals with extensive literature on issues regarding digital mobility concerning large SMEs. Chapter 3 articulates the study methodology, which includes study design, sample, and data collection methods. Chapter 4 consists of a very extensive analysis of the data collected, indicating the results and their implications. Finally, Chapter 5 discusses the findings, and Chapter 6 offers recommendations for further investigation based on those findings and the conclusion of the study, saying why knowledge present in this work is of contribution to scholarship and possible applications in the field of augmented reality.

CHAPTER TWO
LITERATURE REVIEW

2.1. Digital transformation (DT)

Digital transformation (DT) refers to the process by which organizations adopt and implement digital technologies to create new or improve existing products, services, and operations by converting traditional business processes into digital formats (Mirzagayeva & Aslanov, 2022; Vial, 2019; Warner & Wäger, 2019). The primary objective of DT is to enhance value creation through innovation, invention, and the improvement of customer experience and operational efficiency (Schmarzo, 2017; Wren, 2020).

This is an efficient and cost-effective digital transformation defined on the premise of a deliberate and strategic redefinition of the business model, functions, and processes within an enterprise through technological advances, to achieve optimum efficiency and effectiveness in a digital environment for both operational and financial gains, minimized costs, and risks (Chartered Institute of Procurement & Supply, 2020).

There is indeed a large number of digital transformation cases, but data are scarce on macro-level measurements because data related to this development can help affirm its overall impact in 2020 (Kretschmer & Khashabi, 2020). There are proponents of the rapid digital transformation who believe that the more mature an organization is in its journey to digital, the more risks it would face because of delay (KPMG, 2016); however, an incremental method called discovery-driven planning (DDP) is said to be most fitting for traditional organizations. DDP, which emphasizes a gradual development of transformations, enables such organizations to best curb possible risks while assuring quick responses to market alterations to enhance success chances in digital adoption (McGrath & McManus, 2020).

2.2. Benefits, Barriers, and Enablers of Digital Transformation

2.2.1. Benefits

Digital technologies offer the opportunity to energize the operational and transactional facets of business with the promise of increasing efficiency, innovation, and responsiveness. According to Heinze, Griffiths, Fenton, and Fletcher, 2018, "value and innovation are created faster by digital knowledge exchange partnerships." Furthermore, according to Westerman et al. (2014), organizations that invest in digital technologies get more accurate and timely information concerning their performance, which results in strategic benefits that derive from enhanced decision-making and customer engagement. In 2020, the Chartered Institute of Procurement & Supply said that digital competence increasingly enhances visibility in the supply chain and aids flexible, remote-working models.

2.2.2. Barriers

And the opportunities notwithstanding, digital transformation undertakings can face multiple challenges. Key among these is change management, together with resistance by employees unaccustomed to new processes or systems (Wamba & Queiroz, 2022). Lack of good communication during transition phases can cause delays or, worse, total failure of the project. Often planning is carried out with too high expectations, resulting in unrealistic budgeting and timelines. Integration poses yet another difficulty, as older legacy systems often resist integration with new solutions. In the case of companies, internally they simply don't have the resources, support from executives, skilled personnel, or a common vision to drive changes (Heinze et al., 2018). Furthermore, in some cases corporate cultures tend to resist the flexibility and innovation that are quintessential to digital transformation (Westerman et al., 2014).

2.3. Enablers

However, several enablers call for successful digital transformation despite the persistence of challenges. Key drivers include organizational capabilities, skilled personnel, emerging technologies, and a supportive culture. According to Wamba and Queiroz (2022), data capabilities and adaptive capacity are core to managing technology changes. In terms of human capital, the employees should be endowed with a good analytical mind, high emotional intelligence, and innovation-driven, responsive mindsets in order to participate meaningfully in the transformation processes. Artificial intelligence, analytics platforms, social media, and other enabling technological tools must come as part of the enablers. Finally, cultural alignment, including a data-driven approach and executive-level engagement, is essential in fostering sustainable transformation (Westerman et al., 2014).

2.4. Industry 4.0

The evolution of manufacturing over the past two centuries reflects a dynamic interplay between technological innovation, economic necessity, and societal transformation. Since the First Industrial Revolution, which introduced water and steam-powered mechanization, successive industrial eras have progressively reshaped production systems—moving through electrification, assembly line automation, and the adoption of digital technologies (Mourtzis, 2018). This historical trajectory has culminated in what is now referred to as *Industry 4.0*, the Fourth Industrial Revolution, which represents a paradigm shift in how products are conceived, manufactured, and delivered (Kagermann, Wahlster, & Helbig, 2013). Far from being a passing trend, Industry 4.0 is the cumulative result of global pressures and disruptive challenges, including persistent labor shortages in Western economies, the globalization of supply chains, and the transformative rise of e-commerce and digital consumer behavior (Imran, 2018). These conditions necessitated a reimagining of industrial production—one that is more intelligent, decentralized, and responsive to market dynamics.

At its core, Industry 4.0 seeks to establish a new level of integration and control across the product life cycle, from design and development to recycling and repurposing (Brettel et al., 2014). Unlike earlier models such as Computer-Integrated Manufacturing (CIM), which aimed to eliminate human intervention altogether, Industry 4.0 places the human operator in a more strategic role—interacting with cyber-physical systems (CPS) and intelligent machines, rather than being replaced by them (Spath et al., 2013). It leverages advanced connectivity, combining physical devices—sensors, robots, machines—with digital networks such as the Internet of Things (IoT) and cloud platforms to create smart, adaptive manufacturing environments (Lu, 2017; Xu, Xu, & Li, 2018).

Furthermore, Industry 4.0 involves a reevaluation of design and engineering frameworks across disciplines to accommodate integrated, real-time data flows and decision-making (Schuh et al., 2014). By structuring production into flexible, value-driven modules that share only necessary information with subsequent processes, manufacturers can reduce coordination complexity while increasing responsiveness (Lasi et al., 2014). This approach also supports the development of self-aware, learning-capable machines that optimize performance and proactively manage maintenance needs (Zuehlke, 2010).

The German Federal Government has emphasized the strategic importance of Industry 4.0 by defining it as a structural transformation involving Cyber-Physical Production Systems (CPPS), where production and logistics systems utilize global information networks for real-time, automated coordination (Kagermann et al., 2013). Central to this transformation are the enabling technologies of IoT, IIoT, cloud manufacturing, and intelligent systems—each forming part of the nine foundational pillars of Industry 4.0 that promote full production integration and seamless human-machine collaboration (Wan et al., 2015; Hermann, Pentek, & Otto, 2016). Together, these innovations not only enhance production efficiency but also redefine traditional relationships between suppliers, producers, customers, and the workforce.

2.5. Theoretical Framework: Digital Transformation in the Context of Industry 4.0

From a theoretical standpoint, digital transformation may be referred to as integrated leveraging of the coordinated digital technologies, such as IoT, cloud computing, big data, artificial intelligence (AI), and cyber-physical systems (CPS), to innovate, improve operational efficiency, and create real-time decision-making (Lu, 2017; Hermann, Pentek, & Otto, 2016). These, therefore, shift companies from traditional, linear value chains to more networked, agile, and responsive systems, like those indicative of the Industry 4.0 environments (Xu, Xu, & Li, 2018).

The theoretical bases of digital transformation are closely linked to socio-technical systems theorization that sees this interplay of the human actors, the organizational structure, and the technical system. Unlike other automation paradigms of the previous Automation Times, such as Computer-Integrated Manufacturing (CIM), which often neglect the role of human input, Industry 4.0 actualizes the human worker within smart production systems as a strategic decision-maker (Spath et al., 2013).

According to Mourtzis (2018), the contemporary transformation toward digital and automated manufacture is the final point-the culmination of a long historical trend that dates all the way back to the mechanization of labor during the First Industrial Revolution. In this historical trajectory, the most potent arguments are visible today in small and medium-sized enterprises (SMEs), where the main driver of digital transformation has become adapting to globalized competition, emerging labor shortages, and the demands from e-commerce (Imran, 2018). Yet with SMEs, the technological component of digital transformation is not the only important one; it is greatly embedded in organizational culture, leadership orientation, and the external policy environment (Kagermann, Wahlster, & Helbig, 2013).

From a theoretical point of view, the framework of Industry 4.0 devised by Kagermann et al. (2013) proves to be fundamental in understanding the process of transforming the digitally operated industries. It indicates Cyber-Physical Production Systems-as core enablers of smart manufacturing-supplemented by connectivity, real-time information transfer, and systems integration as foundational elements. These concepts are developed further in the nine pillars of Industry 4.0, which comprise technologies like autonomous robots, simulation, horizontal and vertical integration, the Industrial Internet of Things (IIoT), augmented reality (Hermann et al., 2016).

Schuh et al. (2014) maintain that production design and engineering appear to warrant reassessing current design methodologies while adapting them to fit modern interdisciplinary models. Thus understood, digital transformation is not some stand-alone technical upgrade; it is a systemic change that entails rethinking cross-functional collaboration across the organization, rethinking how information flows between departments across the value chain, and rethinking how IT solutions underpin end-to-end processes.

Additionally, this breaks down traditional production into discrete units for value-oriented manufacturing that communicate selectively with each other. It brings about process flexibility and scalability in a manner that minimizes the complexity generally accompanying coordination and decision making in large, hierarchically structured systems. At the policy and national strategy level, further enrichment of the theoretical setting is brought about from the conceptualization of the Industry 4.0 by the German Federal Government, emphasizing on one hand the systemic nature of digital transformation as a structural innovation and the other on the global interconnectedness of networks and information systems as the basis of intelligent and autonomous production that creates an ecosystem of logistics, manufacturing, and data (Kagermann et al., 2013).

2.6. Competitive Environment

Global market developments have greatly impacted the manufacturing sector. While globalization and innovations in e-commerce have opened up growth opportunities, they have also introduced challenges such as supply chain visibility and uncertainty.

Looking ahead, it is crucial to predict how e-commerce will influence manufacturing, retail, and logistics. This involves merging the online and offline worlds, progressively shifting towards home delivery alternatives. Consumers increasingly demand fast delivery after making a purchase, and businesses must address these expectations promptly (Ghasemi, 2012). The widespread use of the internet, constant influx of new information, and the growing competition in product features and pricing have significantly shaped consumer purchasing behavior and consumption patterns (Farahani et al., 2015).

The rise of internet penetration has transformed customer purchasing habits and demand, intensifying competition for supply chain managers. Projections for the future highlight trends such as globalization and expanded exports, enhanced supply chain visibility, standardization, automation, and the need for adaptability in a competitive economic landscape (Farahani et al., 2015; Nicolas et al., 2020).

Adapting to market changes and automating operations using new digital technologies is essential to maintaining a competitive edge. The impact of these advancements on supply chain management must be closely monitored (Glas, 2016). Supply chain managers face the challenge of keeping their businesses at the forefront of innovation by crafting strategies that focus on technological advancements and opportunities within modern supply chains (Glas, 2016).

Digitalization not only alters business operations but also increases the disruption companies face. New technologies such as 3D printing, the Internet of Things (IoT), and social media have significantly impacted supply chain management. These innovations are expected to address key challenges in supply chains, reducing costs and complexities, improving product efficiency, and enhancing service control (He et al., 2017).

2.7. Competitive Advantage and Strategy Models

Michael Porter’s (1979) Five Forces model analyzes a firm’s competitive position based on five strategic factors:

- Competition
- Threat of new entrants

- Bargaining power of suppliers
- Bargaining power of customers
- Threat of substitute products

Porter's model emphasizes that a company must understand these factors to mitigate threats and establish a competitive advantage. Competitive advantage is defined as the cost of producing a product or offering a service, coupled with the value derived from differentiation. A company can build competitive advantage by lowering production costs or increasing differentiation, or both. Differentiation refers to the unique attributes—both tangible and intangible—that make a product or service stand out, thus enhancing the perceived value by customers. The perceived value translates to the price customers are willing to pay.

With the advent of digital technologies in manufacturing, consumers are more informed, suppliers have access to a broader customer base, and many products are being replaced by digital or mobile alternatives (e.g., CDs, movies, apps). Porter's model specifically highlights how the external business environment influences the development of competitive advantage.

Barney (1991), in contrast, developed the Resource-Based View (RBV), focusing on the internal resources of a company to create competitive advantage. According to Barney, companies possess a unique combination of resources that, if managed effectively, can offer distinct advantages over competitors. The RBV theory outlines four key criteria for valuable resources:

- Resources must be valuable
- Resources must be rare
- Resources must be hard to imitate
- Resources should not be easily substituted

Barney suggests that by evaluating and strategically utilizing these resources, companies can differentiate themselves from competitors (Barney, 1991). In the context of a highly digital environment, differentiation becomes even more critical and can be achieved by focusing on products and services, business processes, and the relationship between digital transformation and the manufacturing sector (Avasant, 2016; Weinman, 2015). The technologies inherent in Industry 4.0 now enable companies to gather and analyze data, reassess business models, improve products and services, and strengthen relationships with customers.

2.8. The Potential of Industry 4.0

Industry 4.0 holds significant potential as companies invest in channel coordination systems, automation through cyber-physical systems, and robotics. This technological evolution aims to address shifts in consumer behavior, particularly the demand for personalized products. As a result, industries are compelled to adopt new paradigms, transitioning towards mass personalization or "mass customization." Key principles of Industry 4.0 include interoperability, virtualization, decentralization, real-time capability, service orientation, and modularity (Hermann, Pentek, & Otto, 2016).

Interoperability refers to the ability of humans and machines to perform various operations seamlessly. It involves creating a universal computer language that enhances communication between different systems, such as machines and software (Helu, 2017).

Virtualization involves generating a virtual representation of the production floor and processes, achieved through simulation or sensors embedded in the production system (Bughrin, 2019).

Decentralization emphasizes a distributed control system that allows both employees and machines to make swift, informed decisions, often facilitated by Information and Communication Technologies (ICT) (Bughrin, 2019).

Service orientation focuses on transforming business models using available data. Instead of merely offering products, businesses now provide comprehensive, integrated solutions combining services and functionalities. This shift is enabled by sensors embedded in objects, which enhance service delivery and customer engagement (Mubarik, 2016).

Modularity refers to breaking down processes or products into smaller, manageable units. This principle underpins agile production systems, enabling better management of complexity by isolating components of the production process (Helu, 2017).

Intelligent, connected digital technologies are vital to the achievement of Industry 4.0 (Porter & Heppelmann, 2014). Smart products collect and analyze data, while connectivity enables the automatic transfer of information from one object to another, which is used for data sharing, decision-making, and analysis (Porter & Heppelmann, 2014).

- Smart, connected, digital technology advances Industry 4.0 at its best (Porter & Heppelmann, 2014). In a nutshell, smart products can collect and analyze data, and with connectivity, all information transfer from one object to another occurs in a way that makes it possible to share, decide, and analyze (Porter & Heppelmann, 2014).

Translation made with the realities of this world-It is connected, intelligent, and digital technology that is going to propel Industry 4.0 (Porter & Heppelmann, 2014). In a nutshell, smart products can collect and analyze data, and with connectivity, all information transfers from one object to another so naturally, it is able to share, decide, and analyze (Porter & Heppelmann, 2014).

Smart, Connect, and Digital Technologies are at the forefront of Industry 4.0 Transformation (Porter & Heppelmann, 2014). In simple terms, smart products make sense by collecting and analyzing their data, while connectivity allows this information to be exchanged between objects and used for data sharing, decision-making, and analysis.

Smart, connected, digital technologies advance Industry 4.0 at best. In a nutshell, smart products can collect and analyze data, whereas connectivity ensures that all information transfers from one object to another occur in such a way that it makes it possible to share, decide, and analyze (Porter and Heppelmann, 2014).

2.9. Levels of Integration in Industry 4.0

The pathway to a fully integrated Industry 4.0 environment can be classified into four levels of advancement: monitoring, control, optimization, and autonomy (Porter & Heppelmann, 2014).

- Monitoring refers to the systematic collection, analysis, and use of data that allow an organization to assess its performance against objectives and make management decisions. It employs external sensors and data sources to monitor production conditions, external environments, and product operations. This also allows for the scheduling of alerts and notifications in cases of abnormal situations.
- Control refers to the process of ensuring that everything is being done according to the strategic plan laid down by the highest management. Control involves integrating software applications in the smart products or cloud platform to control product functions and tailor user experience.
- Optimization leverages monitoring and control tools, employing algorithms to analyze data and refine operations for improved performance. This level facilitates predictive diagnostics, services, and repairs.
- Autonomy combines monitoring, control, and optimization to enable self-directed operations. Products and systems autonomously coordinate operations, improve functionality, personalize experiences, and conduct self-diagnoses.
- Industry 4.0 technologies enhance surveillance capabilities, allowing complete oversight of production conditions and product usage. They also foster autonomous operations, self-improvement, and self-coordination among products and systems, marking a transformative step in industrial practices.

2.9.1. Technologies Supporting Industry 4.0

Implementing a business strategy requires a coordinated allocation of resources, including human resources, finances, technology, and materials. Resources encompass all assets, capabilities, organizational processes, attributes, information, and knowledge a firm controls, enabling it to design and execute strategies that enhance efficiency and effectiveness (Barney, 1991).

With the widespread adoption of the internet and rapid technological advancements, companies must carefully identify and select the technologies most relevant to their specific needs. A review of the literature highlights several critical digital technologies associated with Industry 4.0. These include advanced manufacturing, additive manufacturing, augmented reality, simulation, cloud computing, the industrial Internet of Things (IoT), cybersecurity, and big data analytics with customer profiling (Ardito, Petruzzelli, Panniello, & Garavelli, 2019).

2.9.2. Key Technologies Enabling Industry 4.0

2.9.2.1.Advanced Manufacturing

Advanced manufacturing refers to technological innovations that improve product and process development. Tools such as simulation software, Computer-Aided Design (CAD), and Computer-Aided Manufacturing (CAM) streamline design and manufacturing processes. For mass customization, these tools enable the creation of products with standardized and personalized features. CAD and CAM systems, along with parametric modeling, facilitate precise product designs and automated machine programming (e.g., CNC, laser cutting, and bending), reducing design time and increasing efficiency.

2.9.2.2.Additive Manufacturing

Additive manufacturing, or 3D printing, creates three-dimensional objects by layering materials as defined by computer-aided models. This method is particularly useful for producing prototypes or parts with unique shapes. It supports various materials, including metals, plastics, textiles, and biological substances, making it versatile for industries requiring customized components.

2.9.2.3.Augmented Reality (AR)

AR integrates virtual elements into the real world, enhancing tasks like maintenance, equipment operation, and product design. Virtual reality (VR), a related technology, creates simulated environments for training employees, testing new machinery, or visualizing plant layouts. Both AR and VR improve workforce preparedness and facilitate design processes by simulating real-world applications.

2.9.2.4.Simulation

Simulation involves using IT tools and specialized software to model and predict system performance. By realistically simulating product structures, performance, and functions, companies can optimize designs, reduce machine setup time, and improve system availability (Zhou, 2013).

2.9.2.5.Cloud Computing

Cloud computing enables seamless communication between software and hardware over the internet. It provides scalable, reliable, and cost-effective solutions for data storage and access. Cloud computing improves resource utilization, reduces IT infrastructure costs, and supports enhanced data integration across business systems (Wenhong & Yong, 2014).

2.9.2.6.Internet of Things (IoT)

IoT involves interconnected devices with unique identities operating in intelligent environments. Data collected through embedded systems are analyzed to optimize operations and improve decision-making. IoT enhances interaction between users, devices, and services, enabling smarter, more efficient processes (Tan & Wang, 2010; Mattern & Floerkemeier, 2010).

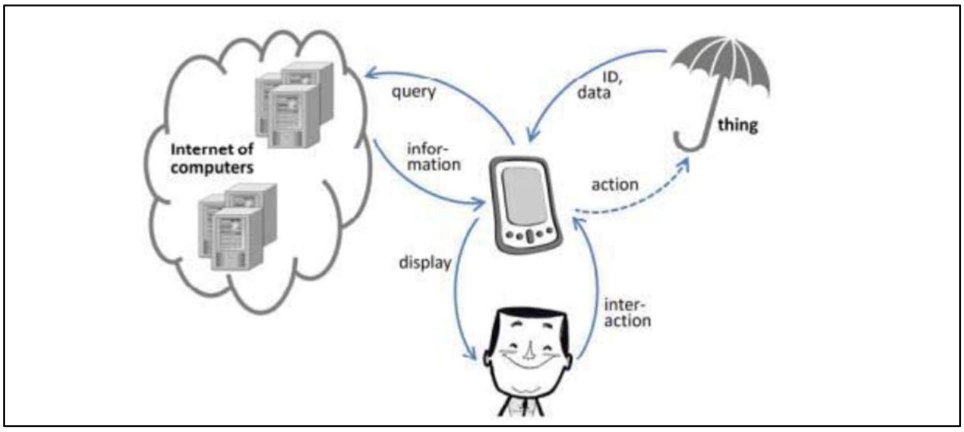


Figure 2.1 The smartphone as a mediator between people, things and the internet (Mattern & Floerkemeier, 2010)

2.9.2.7. Cybersecurity

Industry 4.0's reliance on data sharing and interconnected systems increases the importance of cybersecurity. Businesses must protect their operations and information to ensure safe and reliable functionality in the digital manufacturing environment (Ernst, Frische, & Hamill, 2015).

2.9.2.8. Big Data Analytics and Customer Profiling

Big data refers to the vast amounts of structured and unstructured information generated by various sources. Analyzing this data enables businesses to optimize operations, strengthen customer relationships, and enhance supply chain productivity. Tools like Customer Relationship Management (CRM) systems and remote maintenance solutions provide actionable insights, improve customer satisfaction, and streamline interactions.

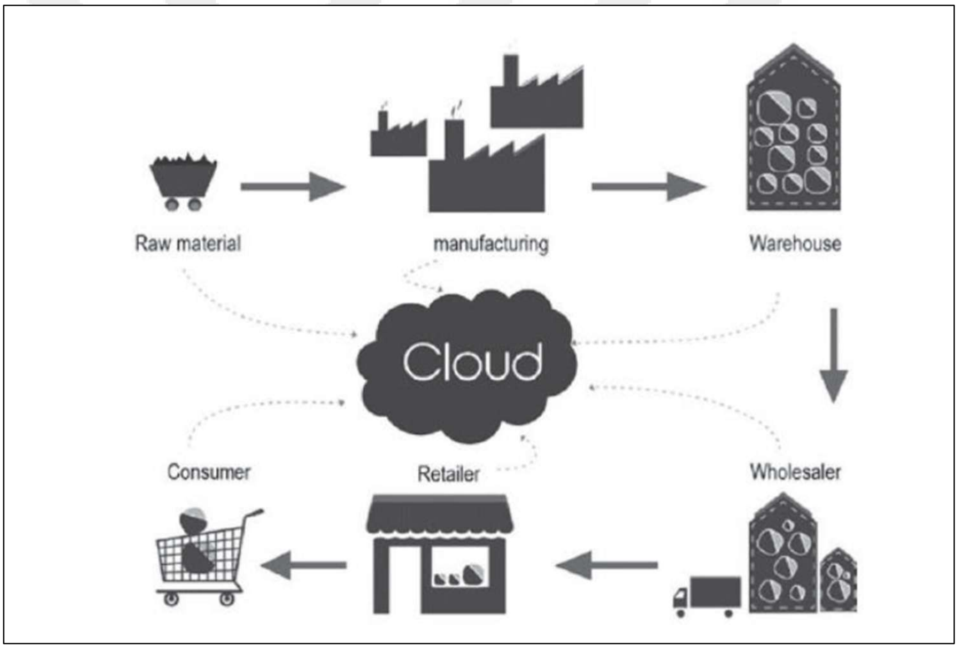


Figure 2.2 Data of entire supply chain is accessible in the cloud (Kühnle & Bitsch, 2015)

2.10. Additional Industry 4.0 Tools

3D Printing (Direct Digital Manufacturing): This technology uses CAD and additive techniques to produce products layer by layer, reducing costs for limited production volumes. It can revolutionize supply chains by enabling on-demand manufacturing and reducing warehousing needs.

Drones: Autonomous drones are used in logistics and supply chain operations for tasks like inventory management and package delivery. They can rapidly collect data, read barcodes or RFID tags, and transmit information to centralized systems.

Mobile Applications: Mobile apps optimize supply chain processes through features like payment systems, RFID integration, barcode scanning, and route mapping. They enhance flexibility and efficiency in operations by leveraging handheld devices.

These technologies collectively form the backbone of Industry 4.0, enabling businesses to achieve enhanced productivity, adaptability, and competitiveness in a rapidly evolving industrial landscape.

2.10.1. Interrelationships between Industry 4.0 Technologies

The integration of various digital technologies provides significant benefits, particularly when interconnected. This interconnectedness is depicted in Figure 3, illustrating the core concepts of Industry 4.0.

Figure 2.3 Industry 4.0 technologies Source (Waller, 2014)

At the heart of Industry 4.0 technologies are Cyber-Physical Systems (CPS), Cloud Computing, the Internet of Things (IoT), and the Internet of Services (Hermann et al., 2016). These elements work in synergy to create an autonomous, customer-centric system that enhances productivity and efficiency. Industry 4.0 emphasizes tailoring products and services to the customer experience. Through customer participation and input from online communities, companies can refine their product development and design processes. Tools like virtualization, simulation, and additive manufacturing enable quick prototyping and testing of products and services.

Simultaneously, large volumes of data are collected through various everyday interactions and stored in Big Data systems. By linking this data to the cloud, businesses identify patterns, habits, and trends in customer behavior. These insights allow companies to capitalize on new opportunities, enhance their products and services, and streamline processes.

When production begins, Cyber-Physical Systems collect data and transmit it in real time to the cloud via the Internet of Things. Cloud-based applications and software analyze this data, and the results are communicated back through the IoT network to the CPS. The analysis outcomes can then guide machines in executing tasks autonomously or provide humans with actionable insights for further decision-making (Hofmann, 2017).

2.11. Small and Medium-Sized Enterprises (SMEs)

Small and medium-sized enterprises (SMEs), also referred to as small and medium-sized businesses (SMBs), are defined by their limited size in terms of personnel and revenue. This classification is widely recognized and applied by global institutions such as the World Bank, OECD, WTO, United Nations, and the European Union (Antoldi, Cerrato, & Depperu, 2012; Gómez & Titi, 2023; Olorunshola & Odeyemi, 2022).

Across national economies, SMEs significantly outnumber large corporations and collectively contribute more to employment. Globally, SMEs represent 90% of all enterprises and generate over 50% of total employment (Aga et al., 2015; Fischer & Reuber, 2000). In the European Union, SMEs account for 99% of all business establishments. Similarly, in Australia, SMEs make up 98% of businesses, contribute one-third of GDP, and employ approximately 4.7 million individuals (Cueto et al., 2022). Chile reported that 98.5% of firms were SMEs in 2014 (OECD, 2016), while in Tunisia, enterprises with fewer than 100 employees accounted for 62% of employment, with self-employed individuals representing about 28% of non-agricultural jobs (Rijkers et al., 2014). In the United States, SMEs are responsible for half of the country's jobs, though they contribute only 40% to GDP (U.S. Department of State, 2004).

The significance of SMEs is particularly pronounced in developing economies, where they often constitute a larger proportion of total businesses (Aga et al., 2015; Antoldi et al., 2012). These enterprises are key drivers of innovation and foster healthy competition across sectors (Gómez & Titi, 2023). While SMEs play a vital role in job creation, they are also more vulnerable to job losses during economic downturns, reflecting their structural fragility (Rijkers et al., 2014).

2.12. Digital Transformation Readiness in SMEs

Digital transformation readiness is defined as the organization's overall preparedness to adopt and integrate digital technologies into the organization successfully (Bharadwaj et al., 2013). The readiness of SMEs is influenced by various factors, including organizational culture, leadership commitment, technology infrastructure, and employee skills (Müller et al., 2018). Studies suggest that SMEs face challenges that are radically different from those of larger firms, including inadequate financial resources, a lack of digital expertise, and resistance to change that may act as impediments to their digital adoption (Jonathan & Kuika Watat, 2020).

Within the food and beverage industry, the need for digital transformation is heightened by the overall complexity of supply chain management, quality control, customer interaction, and regulatory compliance (Bogue, 2019). The use of technologies such as the Internet of Things (IoT), big data analytics, and cloud computing in these firms can create an extra measure of transparency, efficiency, and agility (Kamble, Gunasekaran, & Sharma, 2020). However, the readiness of SMEs to adopt digital technologies is quite different for SMEs in developing economies which face infrastructural and socio-economic constraints (Jonathan & Kuika Watat, 2020).

2.13. Digital Transformation in SMEs

Despite well-crafted digital transformation plans, many businesses face significant challenges in execution. Poor implementation is often a major reason why digital transformation initiatives fail (Correani et al., 2020). Digital transformation is more than incremental improvements; it is an ongoing process requiring a well-thought-out plan aligned with specific organizational objectives. A key element of a successful digital transformation strategy is the alignment of business and IT strategies (Bharadwaj, Sawy, &

Venkatraman, 2013). Even with a sound strategy, a lack of robust implementation planning can derail efforts. Correani et al. (2020) identify four key factors for successful digital transformation: engaging customers through data analysis to enhance experiences, equipping employees with digital skills, automating business processes, and innovating services, products, or business models.

To achieve successful digital transformation, organizations must strengthen both their digital and leadership capabilities (Schiuma et al., 2022). Digital mastery, as explained by Weerasinghe and Nirere (2022), involves four levels: novices, conservatives, fashionistas, and digital masters. For instance, organizations that prioritize digital skills over leadership development should invest in leadership training to empower managers. Managers play a crucial role in inspiring and guiding employees through organizational changes brought about by digital transformation (Westerman et al., 2014).

Westerman et al. (2014) state that three principles can help mitigate the challenges posed by digital transformation: new behaviors should be encouraged, the right to partake should be earned, and the importance for change has to be communicated. The vision for digital transformation should be made paramount by the leaders, exactly why is it important, and what resources are needed to make it happen. The employees should get acquainted with what transformation means for themselves and the organization as a whole. Leaders should lead by example, identify, and assist within the organization, "digital champions" demonstrating the benefits of transformation to both internal and external stakeholder.

Digital transformation brings with itself opportunities and obstacles. The leaders should be equipped with how to deal with obstacles which include lack of cooperation in change, lack of resources available, and lack of technical know-how. Studies describe various barriers in the way of digital transformation across industries. Alhubaishy and Aljuhani (2021) identify resource constraints, resistance to change, and difficulty in adapting to new technologies as common troubles in education. Similarly, in the field of logistics, resistance to change, lack of skills, and data security issues restrain digital acceptance (Cichosz, Wallenburg, & Knemeyer, 2020). Other issues across industries are related to such things as unclear objectives, limited technologies, and lack of funding or human capital (Gao et al., 2019; Chen et al., 2021).

The culture of the organization is key in facilitating or blocking digital transformation. Resistance within the organizational culture to that change cannot help in achieving transformation (Senior & Swailes, 2016). The leaders should be ready to face the cultural problems posed during the process of transformations. It has been noted that digital systems are often easier to change than cultures and mindset, which can become a great resistance as employees reject the new digital environment (Sambamurthy & Zmud, 2017). Another impediment is that a lack of organizational knowledge management can be detrimental to various aspects of digital transformation if its vital information exists solely within an individual rather than digitally. Resource limitations, whether financial, technical, or human capital, are common barriers that can be faced on the path to any digital transformation. To upgrade to digital systems requires some investment in new technologies, new software, and training of the employees (Hai et al., 2021). Shortage of skills can make these challenges worse, as the skilled project managers are crucial to implementation success (Sambamurthy & Zmud, 2017). Skill gaps among employees, used to the application of digital tools by some and not by others, can create friction (Westerman et al., 2014).

To be able to reap the benefits of digital transformation, organizations must deal with these challenges on a proactive basis. Digital prowess and leadership acumen are critical for resolving the myriad challenges posed by the digital world to achieve desired results (Westerman et al., 2014).

Digital transformation gives new meanings to business, individuals, and groups in terms of how they work, communicate, and create value by information technology. This transformation does not only involve this technological facet but also touches upon the paradigm shift in perception and understanding. People construct mental models with which to make sense of these changes, and are shaped by shared narratives within a community certainly not developed in isolation (González-Varona & Torres, 2021). This serves to highlight yet another view of the social dimension in the digital transformation and calls forth the very collective way of maneuvering through the process (Weick, 1995). It becomes important in joining the complementary driving factors for supporting entrepreneurship and small and medium enterprises (SMEs) in their adaptation to the challenges of the digital age (Roundy & Fayard, 2019).

SMEs face several forms of inertia that digital transformation seeks to address. These include psychological inertia at the individual level (entrepreneurs), sociotechnical inertia at the group level (IT professionals), and economic and political inertia at the systemic level (socioeconomic support professionals). Moreover, the evolving IT needs of SMEs result in a growing interdependence among diverse and frequently new relationships among collaborating actors. Additionally, critical technological resources or assets necessary for business operations and innovation are often located outside the firm's boundaries, especially in service and innovation-related sectors. Each actor involved must also define their scope of action, including the context in which exchanges and activities occur (Bin & Hui, 2021; Pelletier & Cloutier, 2019).

The topic of digital transformation in SMEs continues to capture significant interest from academics and practitioners alike. Advanced digital transformation technologies are driving innovation and reshaping production processes. Despite its technological focus, successful implementation requires the ability to lead technological innovation in a sociotechnical environment while adapting business models to integrate new technologies (Frank et al., 2019; Muller et al., 2018).

INDICATOR OF STAGES IN E-READINESS. Experts mention that SMEs are supposed to undergo research and innovation for them to be able to stay economically relevant in an environment where things have quickly changed technologically and now all forms of disruption are digital. Digital Transformation to SMEs is all about digitizing the organization as a whole and its business processes (Tarutė et al., 2018). All this brings about a creative cultural environment best suited to facilitate transformational phases towards digital configurations today but will also create significant new transformations in the imaginations of organizational settings for the future (Garzoni et al., 2020).

Yet, many small and medium enterprises (SMEs) are often not conversant with the new digital sales channels through which markets can be reached. In fact, those channels have replaced many of the traditional sales methods as they market products through an online marketplace, while some others advertise products through a digitalized platform. That is why SMEs should establish or utilize online stores, large platforms for both private and public entities to reach the global market (Stich et al., 2020).

Indeed, MAJOR IT transformations can be understanding in that it is more than just using digitized technologies. Certainly, the organization and its cultural dimension have often been underestimated. SMEs now contend at the global level with businesses that are swiftly assimilating themselves into the digital era (Zhang, Xu and Ma, 2022). Such a market niche works on high competitiveness for SMEs but may not be effective for long as entrepreneurs adapt to changes in digital business models and platforms over time (Tarutė et al., 2018).

To effectively embrace digital transformation, SMEs must adopt a holistic approach. This includes addressing factors beyond technical implementation. However, medium-sized businesses often face significant resource constraints, including limited time, financial capital, expertise, and experience needed to plan and execute digitization projects (Bin & Hui, 2021).

2.14. Industry 4.0 and its Role in SME Digital Transformation

The discourse on Industry 4.0 among scholars, policymakers, and business practitioners in the world has become one of the key phrases envisioning the change of industrial systems using interconnected digital technologies (Roblek et al., 2016). Obviously, improving the running of industrial processes is also creating new value for businesses and for societal needs.

The number of publications indexed in Scopus under the keyword "Industry 4.0" is on the rise with respect to the increasing interests being generated by academia. This term is certainly very narrow and does not cover the entire range of underlying technologies that make it up, but the upward trend shows how fast the field is moving. Projections on the new rates of publication indicate that more than 575 papers on Industry 4.0 will probably be published in 2017-200 of them had already appeared by mid-2017 (Apreda et al., 2016).

Such a quick swell of publication output reflects the emergence of specialized field-focused and general-purpose technologies. Some of these technologies serve particular sectors while others, such as IoT, AI, and CPS (cyber-physical systems), are broadly applicable across industries (Trappey et al., 2016).

Starting in Germany back in 2011, Industry 4.0 has evolved to be adopted in various settings around the world as governments and international agencies design national and regional strategies (Smit et al., 2016). Table 2 in the original study thus records such engagements, pointing to the global resonance of the framework.

However, there is no consistent definition of Industry 4.0. Although general agreement exists about the high-level architecture of the concept, there is still considerable debate surrounding the core technological components and scope (Riel et al., 2017; Lasi et al., 2014).

Industry 4.0 represents the convergence of digital, physical, and biological systems, introducing smart factories where cyber-physical systems monitor and automate processes (Lasi et al., 2014). For SMEs in the food and beverage sector, Industry 4.0 can enable real-time monitoring of production lines, predictive maintenance, and enhanced product customization (Lu, 2017). However, studies show that many SMEs struggle with the initial stages of Industry 4.0 integration due to a lack of digital skills and strategic planning (Mittal, Khan, Romero, & Wuest, 2018).

2.15. Digital Transformation in Libya: Challenges and Opportunities

Libya, as a developing country with ongoing socio-political challenges, presents a unique context for digital transformation. The digital infrastructure is uneven, with urban centers like Tripoli exhibiting higher connectivity levels than rural areas (Qabas, 2025). Moreover, SMEs face barriers such as limited access to finance, regulatory hurdles, and a shortage of trained IT professionals (Senusi, 2023). Despite these challenges, initiatives by the government and private sector, including the recent SME digital platforms, reflect a growing commitment to digitalizing the economy (Libya Herald, 2023).

Empirical studies suggest that enhancing digital readiness among Libyan SMEs requires a coordinated approach focusing on improving digital literacy, infrastructure investment, and fostering partnerships between government, academia, and industry (Qabas, 2025). According to empirical studies, the amelioration of digital readiness for Libyan SMEs necessitates collaboration about three key areas: digital literacy development, infrastructural investment, and building partnerships between government, academia, and industry. Several recent studies since then have upheld this empirical claim, primarily founded on observable data to understand real-world phenomena (Aspin, 1995). For example, Alhaj (2022) used quantitative surveys of 150 SMEs across Tripoli to highlight significant gaps in ICT skills among employees as well as a lack of structured digital training programs. This empirical evidence calls for the urgent initiation of targeted digital literacy programs. In the same vein, a field survey by Elfitouri and Mohamed (2021) was conducted using semi-structured interviews with SME owners within the food and beverage sector and discovered that unreliable internet infrastructure and power outages are major flush inhibitors to digital uptake—these being observable and measurable environmental constraints. In addition, the World Bank's recent research on digital development in fragile states underlined the very essence of multistakeholder collaboration, showing through comparative case analysis that sustainable digital transformation often depends on capacity-building and innovation-diffusion partnership by private sector, government policy actors, and academic institutions. The empirical inquiry above illustrates that without addressing these foundational issues-skills, infrastructure, and ecosystem collaboration-digital readiness in Libyan SMEs, as a result, will remain constrained.

This was substantiated by the application of confirmatory factor analysis in validating its latent constructs against observed variables via theoretical abstraction against survey items. For example, the application of confirmatory factory analysis to validate a model on knowledge integration by Cegarra-Navarro et al. (2022) was conducted in a review of small and medium enterprises (SMEs) that were Spanish SMEs going through digital disruption. The application of confirmatory factor analysis showed how confirmatory factor analysis identified construct reliability and convergent validity through different fit indices such as CFI and RMSEA.

In addition to validating measurement, they present a comprehensive way in which to test the relationships between constructs using one model: Structural Equation Modeling (SEM). SEM can check both the direct and indirect effects, which include the mediation and moderation variables of a relationship better. For instance, in the MENA region, SMEs under the research by Al-Emran et al. (2021) used SEM to find out the extent to which organizational culture was affected by digital capability towards ICT and DT readiness. Their findings brought forward significant mediating effects and emphasized that leadership plays a significant role in bridging technology adoption and process integration.Further, SEM permits model estimation based on goodness-of-fit indices such as the Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR), which as an additional feature enrich empirical observations with transparency and objectivity, thus supporting Hair et al. (2019); Kline (2015).

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Purpose of the Study

In order to assess the readiness of food and beverage SMEs in Tripoli, Libya, for digital transformation, a sector-based descriptive research was conducted.

3.2. Data Collection

Data were collected using Google Forms and face-to-face in a separate room using both measurement and interview methods. Participants read and answered the survey questions themselves. The average data collection time ranged between 30 and 35 minutes.

3.3. Study Variables

The study variables consist of dependent variables and independent variables as follows below:

- Dependent Variable: Challenges and Readiness for Digital Transformation (CRDT)

- Independent Variable: Digital Transformation Strategy and Leadership (DTSL), Adoption of Digital Technologies (ADT) and Business Processes and Integration (BPI)

3.4.Sample

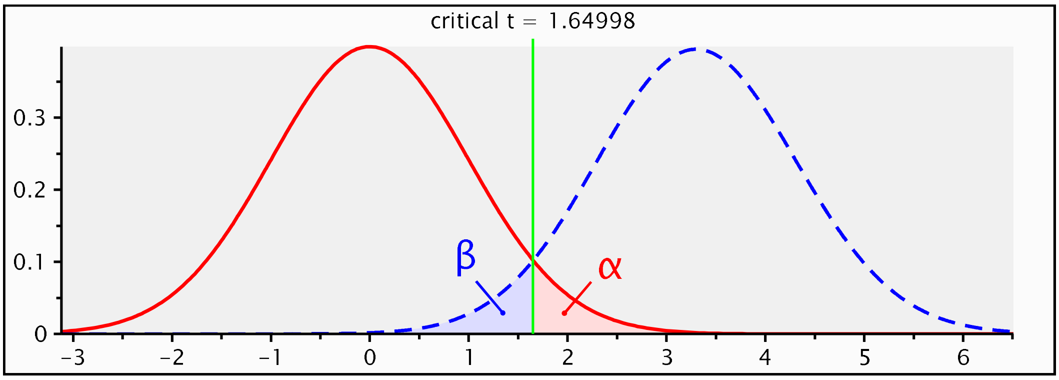
The best estimate for the sample of this research was determined through power analysis using G-Power software. Accordingly, the number of subjects to be recruited was expected to be 300 Figure 3.1. Participants were selected by a nonprobability convenience sampling technique.

Convenience sampling is used extensively for empirical research since it is easy to do, especially when conditions are characterized by the unavailability of resources, time pressure, or limited access to the study population. Under this type of sampling, individuals are chosen not through some random selection procedure, but rather based on their easy availability and their willingness to cooperate (Etikan, Musa, & Alkassim, 2016). This framework is appropriate if external impediments, such as political turbulence or prohibitions, limit the application of advanced sampling techniques (Salkind, 2011).

Despite widely acknowledged limitations with convenience sampling regarding generalizability, it can provide valuable initial insights, especially in applied field research. Such a situation indeed existed in this study regarding food and beverage companies in Libya, namely Shams Food Company for Bakery, Mozart Sweets Company, Al-Sahl Holding Company for Food Industries, and Belleza Investment and Tourism Services Company. The individuals working for these companies who agreed to take part in the study and completed the survey questionnaire were included in the final sample (see Appendix 1).

Table 3.1 G-power analysis for determining sample size

analysis Input	A prior :	Compute required sample size
	Tail(s)	= One
	Effect size d	= 0.3818351
	α err prob	= 0.05
	Power (1-β err prob)	= 0.95
	Allocation ration N2/N1	= 1
Output	Noncertrality parameter δ	= 3.3067890
	Critical t	= 1.6499830
	Df	= 298
	Sample size group 1	= 150
	Sample size group 2	= 150
	Total sample size	= 300



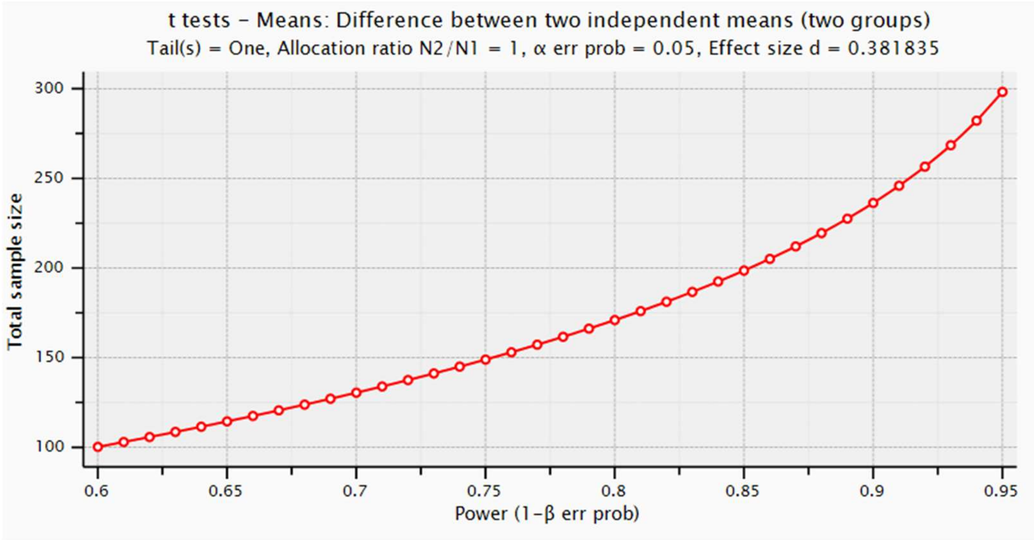


Figure 3.1. G-power Analysis

3.5. Data Collection Tools

Data were collected using "socio-demographic characteristics" an administrative reform scale to assess administrative reforms, and the Employee Job Descriptive Index (JDI) Job Satisfaction scale to assess employee satisfaction.

3.5.1. Socio-demographic Characteristics

There are 11 questions in the socio-demographic scale (gender, age, education, position, and company characteristics. These categories enable the analysis of how demographic variables relate to digital transformation readiness and barriers). (See Appendix-2)

3.5.2. Barriers to Digital Transformation

Scale in english (Limani et al. 2019), Scale in Arabic language (Salameh, 2021). Consists of four sub-dimensions on a five-point Likert scale from 1 to 5

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1. Data analysis

The collected data were analysed using IBM SPSS Statistics 26.0 (SPSS Corporation, Chicago, Illinois, USA). Frequency analysis, mean comparison tests, and correlation analysis were used during statistical analysis. In addition to that, the kurtosis-Smirnov and Kolmogorov-Smirnova tests were used to determine the statistical tests used and to ensure that the data were in conformity with a normal distribution. For mean comparisons, ANOVA and t-test were used, depending on the number of groups in parametric tests.

R analysis was used to express the correlation between sub-dimensions, while the Kolmogorov-Smirnova test was used to determine the normal distribution between variables. Simple linear regression analysis was also involved. The first analyses were descriptive with respect to demographic characteristics of the participants. In descriptive analysis, qualitative types of descriptive percentages (%) and frequencies (n) were presented together.

Thus, those two values could be exposed and put together. Summary statistics were calculated for each of the scores obtained by the research subject on the subdimensions of the scale. A 5% margin of error was taken into account when scrutinizing the results of statistical analysis. The applications were put into practice using SPSS 26 (IBM, 2016).

4.2. Descriptive analysis

Table 4.1: Distribution of study participants according to demographic data

Variables		n	%
Gender	Female	116	38,7
	Male	184	61,3
	Total	300	100,0
Age	18-24	90	30,0
	25-34	119	39,7
	35-44	70	23,3
	45 and above	21	7,0
Educational level	Grade 12 / Terminal	52	17,3
	National and Technical Education (BT, TS)	40	13,3
	Bachelor's Degree	145	48,3
	Master's Degree	58	19,3
	PhD Degree	5	1,7
Current position in the company	Technician	47	15,7
	Supervisor	62	20,7
	Quality Officer	29	9,7
	Manager (Top, General, Operations, Production, Quality, Regional)	47	15,7
	Other	115	38,3
Work experience	Less than 1 year	58	19,3
	1-5 years	101	33,7
	6-9 years	69	23,0
	10-15 years	51	17,0
	More than 15 years	21	7,0
Company established	Before 1980	17	5,7
	1980-1990	22	7,3
	1991-2000	30	10,0
	2001-2010	118	39,3
	2011-Present	113	37.6
Number of employees in the company	Less than 10	121	40,3
	41-100	84	28,0
	101-200	66	22,0
	More than 200	29	9,7
Company's yearly turnover	100,000 LD	63	21,0
	100,001-500,000 LD	39	13,0
	500,001-1 million LD	122	40,7
	1000001-5 million LD	65	21,7
	Above 5 million LD	11	3,7
Countries company operate	Libya only	273	91,0
	Multinational (operating in multiple countries)	27	9,0
Digital transformation implemented	No	66	22,0
	Yes	234	78,0
Have dedicated team	No	113	37,7
	Yes	187	62,3

Table 4.1 provides a breakdown of the demographic distribution of the study sample. The gender distribution indicates a male-dominated workforce, with 61.3% of the respondents identifying as male and 38.7% as female. This shows an existing gender gap that may be a consequence of cultural or sectoral hiring propensities. Those aged under 35 years account for the majority of the respondents (69.7%), with the highest concentration of respondents belonging to the age group of 25-34 years at 39.7%. This implies a comparatively younger workforce that is usually flexible and willing to accommodate digital changes.

In regard to educational background, almost half of the respondents (48.3%) have attained a bachelor's degree while 19.3% have a master's degree. Such high academic qualifications suggest that the sector is geared more to appreciate and utilize new technologies. A very small group (1.7%) has obtained PhDs, with 30.6% having technical or secondary education. This creates equilibrium between theoretical knowledge and hand-on practice.

Job positions in these SMEs vary greatly amongst themselves. Supervisors (20.7%) and technicians (15.7%) constitute a sizeable part of the workforce while 15.7% are in senior management or operational positions. Considerable diversity exists in job categories and types; 38.3% of the respondents fit into the thus-called "Others" category, which probably includes non-managerial jobs such as kitchen, delivery, and administrative work. Variety within job types is common for small firms within food and beverages, where multitasking and multi-tasking roles are in abundance.

On work-experience, quite a host of respondents (33.7) showcase between 1-5 years after which are followed by 23% with 6-9 years. Only 7% carry a whole 15 years and over. This thus indicates a salary of perhaps moderate experience, and early or mid-way career development, therefore making it more amenable to new approaches and technologies. Firm characteristics indicate that most of the firms in the sample were birthed between 2001 and 2010 (39.3%), indicating the sector harbors a lot of relatively young firms. Most of them come in small, with 40.3% having under ten employees, 28% having 41-100 employees, while only 9.7% boast anything above 200 heads. Financially, 40.7% of firms report annual revenues of 500,001-1 million Libyan dinars, whereas reports of revenues below 100,000 Libyan dinars were given by 21%. This affirms that mostly small firms are being represented in the sample.

A very great majority (91%) of the firms work solely within Libya, indicating domestic market exploitation involving very small amounts of international practice or engagement. While this continues to help the firms in adjusting their own strategies to local needs, it might also end up limiting local exposure to global best practices and innovations.

On digital transformation, the prospects are deemed bright. About 78% of companies have engaged in some form of digital transformation, declaring an impressive momentum for technology adoption. Additionally, 62.3% have their own digital teams, which are indicative of a structured and concerted approach to technology transformation. However, 37.7% of them are yet to form such teams, and this could hinder their potential to fully formulate digital solutions and maintain the transformation in the long run.

4.3. Factor Analysis

Before assessing the reliability of the data set, a principal components analysis (PCA) was conducted to determine whether the questionnaire items specifically aligned with the following concepts: authoritarianism, democracy, transformational leadership, and teacher performance. This was necessary for this preliminary stage because the results were needed to ensure that each item reflected an intended dimension. Varimax rotation with Kaiser normalization was used to enhance the clarity of the factor structure and reduce any overlap between them in the resulting analysis. The analysis showed that the extracted factors explained more than 50% of the total variance, indicating that the scale has a sound structure and can be subjected to further study. The identified factor loadings are enumerated as follows in Table 4.1 below.

The multivariate statistical method of factor analysis captures the reduction of a large number of variables into a varying number of coherent, unrelated composite factors. This method is commonly used to verify the structural validity of a measurement scale. A valid analysis is characterized by its predicted factors being uncorrelated and easy to interpret. This entire approach is likely to group relevant variables into broad, theoretically meaningful domains (Tuttledale, 1992). Structural validity concerns the extent to which a measure is assumed to correctly and accurately define concepts, while construct validity addresses the question of whether items actually measure the traits they were designed to measure.

Table 4.2: Results of an analysis of the rotating principal components

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
ADT5	0.774			
ADT6	0.751			
BPI2	0.748			
Total ADT	0.706	0.569		
ADT4	0.695	0.729		
CRDT2	0.642			-0.71
DTSL5	0.624			
Total BPI	0.569		0.548	0.527
CRDT3	0.534		0.506	
DTSL4	0.507	0.648		
BPI1				0.627
Total DTSL	0.528	0.734		
DTSL2		0.731		
ADT1		0.725		
DTSL1		0.677		
ADT2		0.640		
DTSL3		0.563		
ADT3				0.85
Total CRDT			0.737	
CRDT5			0.713	-0.69
CRDT4			0.645	
BPI4			0.626	
BPI3				0.728
CRDT1				-0.573
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 6 iterations.				
DTSL: Digital Transformation Strategy and Leadership, ADT: Adoption of Digital Technologies, BPI: Business Processes and Integration				

Table 4.2 shows the results of a PCA (principal components analysis) using Varimax rotation with Kaiser normalization to identify some underlying patterns of data relative to digital transformation in small and medium enterprises operating in the food and beverage sector in Tripoli, Libya. PCA is a data reduction technique used to gather variates (questions or items) into components or factors that represent the underlying components. Here, it helps understand how different aspects of digital transformation, namely technology adoption, business process integration, leadership, and strategy, might be grouped together.

The rotated component matrix lists the components (i.e., ADT5, BPI2, CRDT2) along with their factor loadings on four extracted items. The loadings describe the strength and direction of the relationship between the component and the item. Loadings higher than 0.5 are generally taken as statistically significant, and bolded loadings denote the factor that the variable principally loads on.

Component 1: Adoption of Digital Technologies (ADT) This component is precisely defined by items such as ADT5 (0.774), ADT6 (0.751), and BPI2 (0.748), all of which exhibit high loading levels. These items clearly reflect the behaviors and decisions related to adopting digital tools within SMEs. The overall score for ADT and ADT4 also exhibit high loading levels here, confirming that this component captures the essence of technology adoption. This indicates a unified perception among respondents about how digital tools are integrated into operations.

Component 2: Digital Transformation Strategy and Leadership (DTSL) This component is defined by items DTSL2 (0.731), ADT1 (0.725), DTSL1 (0.677), and DTSL3 (0.563). The DTSL Total score is also very high (0.734), validating the construct. Interestingly, ADT1 and ADT2, originally categorized under Technology Adoption, also score high on this indicator, highlighting the relationship between leadership vision and readiness to adopt digital tools. This component captures the strategic and leadership aspects of digital transformation, such as planning, vision, and commitment from senior management.

Component 3: Change Readiness and Digital Talent (CRDT) This factor includes high loadings from CRDT Total (0.737), CRDT5 (0.713), CRDT4 (0.645), and BPI4 (0.626), indicating a component focused on organizational readiness and digital competencies. It also includes BPI3 (0.728), suggesting that business process integration may be closely related to digital skills and adaptability. This component appears to reflect the readiness of employees and the organization's culture for digital change.

Component 4: Business Processes and Integration (BPI) This last component relies on loadings such as BPI3 (0.728) and BPI1 (0.627), and to some extent Total BPI (0.527). It demonstrates how digital transformation impacts internal processes, system integration, and workflow optimization. Interestingly, some CRDT components, such as CRDT1, show a negative loading (-0.573), which may indicate an inverse relationship, which may suggest that resistance to change or a lack of readiness may be hindering effective process integration.

In addition, some cross-loadings (such as ADT4 and CRDT2) appear, which load moderately on more than one component. This is not uncommon and reflects the interconnected nature of the dimensions of digital transformation—technology adoption, strategic leadership, process improvement, and organizational readiness are often interconnected.

4.4. Reliability Analysis

To check for reliability of the instruments that were used in the study, an evaluation was performed to check the consistency of each scale in representing its intended construct. Cronbach's alpha was used to measure the internal consistency of the variables extracted by the rotated principal components analysis of the digital transformation scale, that is technology adoption, business process integration, leadership, and strategy. A Cronbach's alpha value above 0.7 is generally regarded as acceptable, which means that the scale produces fairly constant and reliable results. The reliability coefficients for each construct are shown in Table 4.3.

Table 4.3: Reliability values of the scales

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
Digital Transformation Strategy and Leadership	40.41	49.84	0.757	0.734
Adoption of Digital Technologies	36.45	47.58	0.744	0.747
Business Processes and Integration	44.27	73.83	0.598	0.820
Challenges and Readiness for Digital Transformation	42.74	67.16	0.612	0.804

Employing four key constructs, Table 4.2 delineates the analysis of reliability regarding the measures of digital transformation among SMEs in the food and beverage sector, Tripoli. In social science research, reliability testing is customarily accomplished specifically using Cronbach's alpha method to test the internal consistency of items from a particular scale. It attempts to quantify how well the set of items truly measures the same underlying concept. Both DTSL and ADT scales have very high intercorrelations (0.757 and 0.744, respectively), which indicates that the scale items exhibit strong internal relationships between themselves. BPI and CRDT scales possess valid correlations (0.598 and 0.612, respectively), and these are, however, slightly weaker, suggesting interpretations of certain items are perhaps different or not consistent with the construct.

4.5. Assumptions of Regression

4.5.1. Normality Testing

As a first step in understanding the dataset, descriptive statistics were analyzed. Mean values, standard deviations, and frequency distributions were some of the measures calculated to provide a general impression of the study variables. Also, variable normality was checked using the measures of Skewness and Kurtosis, along with the Kolmogorov-Smirnov test to see whether the variables followed a normal distribution. This assessment was an important step for the determination of the appropriateness of further statistical methods. The detailed results are shown in Table 4.3.

Table 4.4 Test of normality between variables according to Kolmogorov-Smirnov.

Tests of Normality			
	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Digital Transformation Strategy and Leadership	0.148	300	0.429
Adoption of Digital Technologies	0.138	300	0.174
Business Processes and Integration	0.123	300	0.221
Challenges and Readiness for Digital Transformation	0.083	300	0.287
a. Lilliefors Significance Correction			

In Table 4.4, the values of Kolmogorov-Smirnov. This indicates that the data followed a normal distribution. According to the criteria established by (George and Mallery, 2010).

Table 4.5: Descriptive statistics for the main dimensions of the variables

Variables	Digital Transformation Strategy and Leadership	Adoption of Digital Technologies	Business Processes and Integration	Challenges and Readiness for Digital Transformation
Mean	14.21	18.17	10.35	11.88
Median	13.00	18.00	10.00	12.00
Std.	3.54	3.75	2.126	2.614
Skewness	0.442	0.705	0.083	0.158
Kurtosis	-0.252	0.250	0.168	-0.191
Minimum	5.00	11.00	4.00	5.00
Maximum	25.00	30.00	17.00	20.00

Table 4.5. Descriptive statistics include the four dimensions of digital transformation developed for SMEs: digital transformation strategy and leadership (DTSL), digital technology adoption (ADT), business processes and integration (BPI), and challenges and readiness for digital transformation (CRDT). These dimensions illustrate how different SMEs view digital transformation by examining other ways in which SMEs view it. Digital transformation strategy and leadership: The mean value for this dimension is 14.22, with a median of 13 and a standard deviation of 3.54. This indicates a generally positive, albeit

moderate, perception of strategic leadership in digital transformation-related activities. A slight rightward bias can be observed in the skewness value of 0.442, indicating that more participants rated this dimension low, though not significantly. Additionally, a kurtosis value of less than 0 (-0.252) represents very low dispersion, indicating that the mean and median are not completely separated. Approximately 5 to 25 responses showed wide variation, indicating that some companies have very strong, leadership-driven digital strategies, while others are still significantly behind.

Adoption of Digital Technologies (ADT): The mean is 18.17 and the median is 18, confirming, on average, the most advanced dimension of digital transformation development for SMEs in Tripoli. The standard deviation shows a moderate variance of 3.75; the skewness strongly indicates scores below the mean, with a value of 0.705, indicating that some companies are heavily reliant on technology, but again, many are just scratching the surface of technology adoption. The kurtosis coefficient of 0.250 indicates a slightly peaked distribution, meaning there is a cluster of higher responses surrounding the mean. The range (11-30) indicates that none of the companies scored the worst, indicating some level of core technology use across all companies. The skewness and kurtosis values for all variables fall between +2 and -2, indicating that the data follow a normal distribution (simulation by George and Mallery, 2010). Business Processes and Integration. This value is 10.35, with a mean of 10 and a relatively low standard deviation of 2.13, roughly indicating that the answers are clustered around what the interviewees are actually able to express. Both the skewness (0.083) and kurtosis (0.168) are close to zero, indicating that the answers are clustered around the mean value, forming a type of normal distribution. The range (4-17) shows some variation in how companies integrate digital tools into their core operations. This means that while some companies are working to streamline and digitize their business processes, many still struggle with technology incompatibility with day-to-day operations.

4.5.2. Normality of Residuals

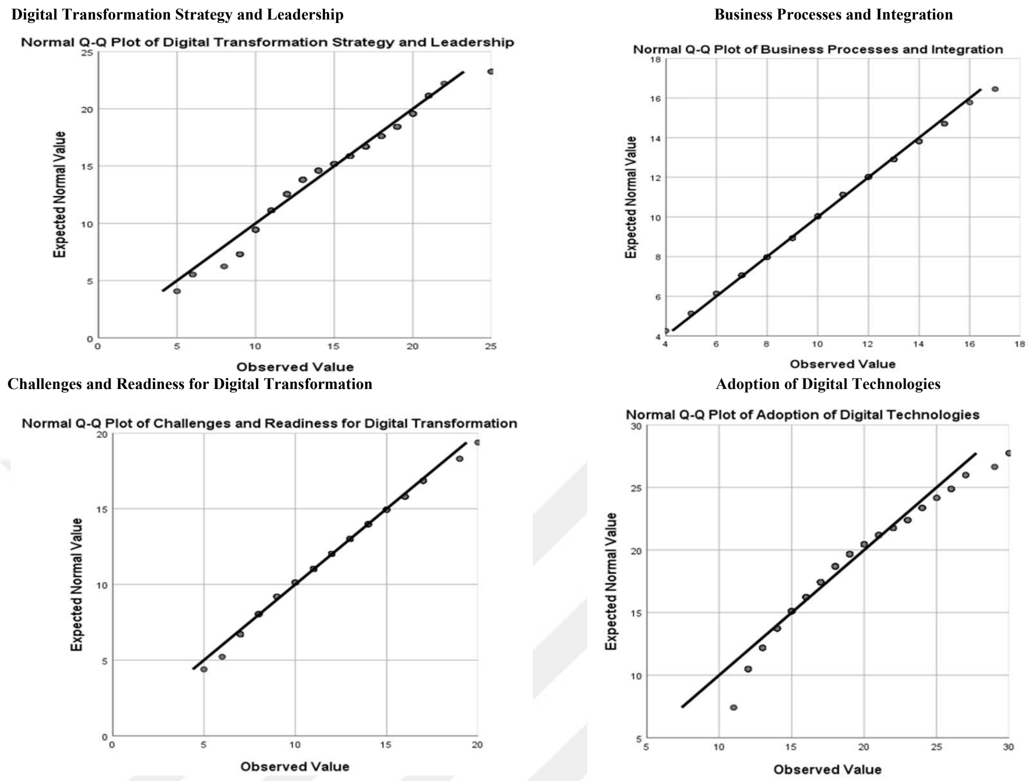


Figure 4.1. Q-Q Plot of standardized residuals versus standardized predicted values for testing regression assumptions

Figure 4.1 illustrates the distribution trend of the variables. The frequency histogram of the variables shows that they follow a normal distribution.

4.5.3. Linearity Assessment

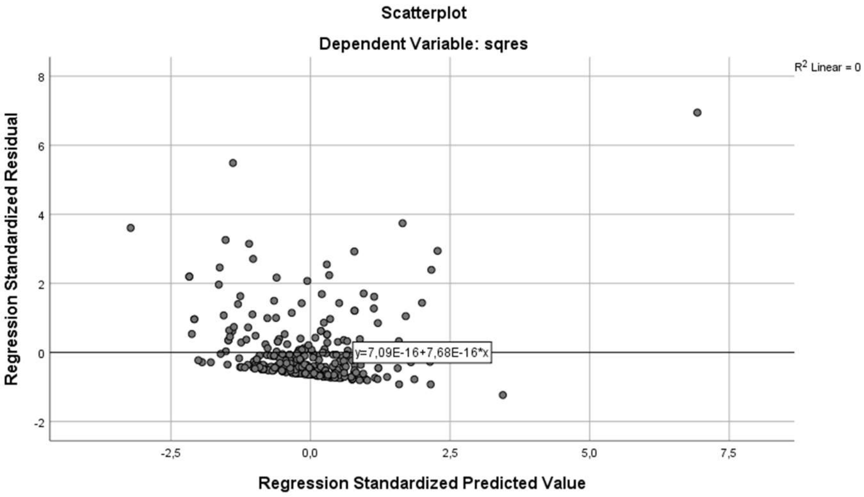


Figure 4.2: Scatterplot of predicted versus standardized predicted values - checking regression assumptions for the study

Figure 4.2 is a typical residual scatter plot that serve as a pertinent diagnostic for those key assumptions of the linear regression models used to assess the digital transformation and restructuring of SMEs in Tripoli, Libya, within the food and beverage industry. In the graph, standard residuals are plotted against standard predicted values, allowing the analyst to visually assess linearity, homogeneity (constant variance), and normality of the residuals. Overall, the scatterplot favors the assumption of linearity because there seems to be no visible curvature or pattern in the residuals, and the regression line is showing no obvious pattern at all through the range of predicted values. This means that the independent variable (for example, digital adoption, infrastructure development, and managerial readiness) maintains a steady linear relationship with the dependent variable (the possibility of either SME performance or success of transformation). Hence, a linear model is suitable for reflecting the relationships in the dataset.

4.5.4. Independence of Errors

Table 4.6: Model Summary – Linear Regression Analysis

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.614[a]	0.377	0.370	2.07490	1.756
a. Predictors: (Constant), Business Processes and Integration, Adoption of Digital Technologies, Digital Transformation Strategy and Leadership					
b. Dependent Variable: Challenges and Readiness for Digital Transformation					

In Table 4.6, the Durbin-Watson value of 1.756 indicates that there is no significant first-order autocorrelation between the residuals for the Challenges and Readiness for Digital Transformation (CRDT) regression model based on four predictors: Digital Transformation Strategy and Leadership (DTSL), Digital Technology Adoption (ADT), and Business Processes and Integration (BPI), plus a constant. Since the CRDT falls within the generally accepted ranges (1.5-2.5) and approaches the ideal value of 2.0, we can conclude that the residuals behave independently. Therefore, we can safely rely on the standard errors and p-values for the four predictors..

4.5.5. Multicollinearity

Table 4.7. Factors, challenges, and positive evaluations of digital transformation

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	3.353	0.679		4.94	0.000		
Digital Transformation Strategy and Leadership	0.180	0.052	0.244	3.46	0.001	0.426	2.34
Adoption of Digital Technologies	0.177	0.048	0.254	3.67	0.000	0.441	2.27
Business Processes and Integration	0.267	0.069	0.217	3.88	0.000	0.672	1.48
a. Dependent Variable: Challenges and Readiness for Digital Transformation							

In Table 4.7, the constant (B = 3.353) represents the baseline predicted value of the dependent variable—challenges and preparedness—when all predictor variables are zero. Although it cannot usually be interpreted in isolation, it contributes to the robustness of the regression equation. Linear regression assumes a linear relationship between the independent and dependent variables, that the variables are normally distributed, that homogeneity of variance is maintained (the error variance is constant), and that there is no multicollinearity among the variables (Weissberg, 2005). To verify these assumptions, additional tests are conducted

4.5.6. Linear regression:

Table 4.8: Evaluating, anticipating challenges, and preparing for digital transformation

Hypotheses	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Evaluation
		B	Std. Error	Beta			Lower Bound	Upper Bound	
	(Constant)	3.35	0.67		4.94	0.000	2.01	4.68	
H1: Digital transformation strategy and leadership positively influence digital transformation challenges and readiness.	Digital Transformation Strategy and Leadership	0.180	0.05	0.24	3.46	0.001	0.078	0.282	Accept
H2: Digital technology adoption positively influences digital transformation challenges and readiness.	Adoption of Digital Technologies	0.177	0.04	0.25	3.67	0.000	0.082	0.272	Accept
H3: Business processes and integration positively influence digital transformation challenges and readiness	Business Processes and Integration	0.267	0.06	0.21	3.88	0.000	0.132	0.402	Accept
R^2= .377 F= 59.603 p=.000									
a. Dependent Variable: Challenges and Readiness for Digital Transformation									

Table 4.8 shows the outputs of a multiple linear regression model on the impact of three selected dimensions on digital transformation challenges and readiness, exploring their impact on the dependent variable among SMEs in the food and beverage sector in Tripoli, Libya. These dimensions are: digital transformation strategy and leadership (DTSL), digital technology adoption (ADT), and business processes and integration (BPI). It is worth noting that the overall model is statistically significant ($F = 59.60$, $p < 0.001$) and moderately predicts CRDT, explaining approximately 37.7% of the variance ($R^2 = 0.37$). Digital transformation strategy and leadership are positive and significant for CRDT ($\beta = 0.24$, $t = 3.46$, $p = 0.001$), indicating that a stronger leadership and vision for digital transformation typically better prepares an organization to address the associated challenges. Adoption of Digital Technologies (ADT): This indicator is also a positive and significant predictor of CRDT ($\beta = 0.25$, $t = 3.67$; $p < 0.001$). Increased adoption leads to better readiness and confidence in managing digital transformation.In addition, the impact of Business Performance Indicators (BPIs) on CRDT is the strongest of all indicators ($\beta = 0.21$, $t = 3.88$, $p < 0.001$). Integrated and digital business processes significantly increase a public organization's readiness for transformation. The constant value (intercept point) is 3.353, which is the baseline for readiness when all these values are set to zero.

In our study, we have established that although digital transformation strategy and leadership (DTSL) affected challenges and readiness for digital transformation (CRDT) significantly among SMEs in the food and beverage sectors in Tripoli, Libya, its effects ($\beta = 0.24$) were, however, lesser than that of business processes and integration (BPI), even though both were statistically significant. With regard to theoretical and contextual considerations, many would maintain that DTSL might have had less of an impact in this context for the following reasons:

First, the influence of the maturity and structure of Tripoli's SMEs is significant. Many reside in environments with a lack of exposure to global best practices in formulating and implementing digital strategies. The leadership of these SMEs may understand digital transformation conceptually but has limited institutional capacity, training, or even digital culture to convert the strategic vision into concrete action. This inability to go from merely speaking about the strategy to being capable of its implementation may dim the practical impact of DTSL on digital readiness (Vial, 2019).

Secondly, given the political instability and uncertainty in the economy, most SMEs in Libya are constrained in being able to adopt transformational or innovative leadership approaches because of pressures to merely survive. Strategic leadership for digital transformation usually requires, apart from vision, active investment in digital capabilities, continuous learning, and risk tolerance, all of which are compromised in contexts with weak institutional empathy and economic volatility (Kraus et al., 2021). Where, therefore, DTSLs are there and contributing to readiness but are contextually constrained in their impact. These constraints would, therefore, reduce relative orientation towards more process-driven BPI factors as being prominent.

Moreover, Libyan SMEs' reliance on tacit routines and informal structures may soften the need for strategic planning. Unlike large organizations with formal strategy departments and project management, progress across SMEs is often made through ad hoc decision-making and incremental implementation based more on technological availability and immediate process integration needs than on any sort of top-down strategy (Matt et al., 2015). This could provide an explanation for the stronger or equal traction of BPI and ADT on CRDT compared with DTL.

According to Vial (2019), digital transformation is affected not only by strategic intent or vision of leadership but even more so by the organization's capacity to integrate digital processes and technologies into everyday activities. Thus, when operational readiness is low or leadership is deprived of process-influencing tools, the effect of DTSL would be diluted.

According to Kraus et al. (2021), SMEs in emerging and transition economies often suffer from institutional voids—such as weak legal systems, poor infrastructure, and limited access to knowledge resources—that directly affect how leadership strategies are formulated and implemented. These limitations imply that even well-intentioned leaders for digital transformation may not practically foster it as their counterparts in stable economies.

Compatible with Matt et al. (2015), who underscore that strategic leadership coupled with changes in business processes, customer interactions, and technological capabilities are all essential for digital transformation, our study supports the view that, in the present case, process integration and technology adoption serve as bridges between strategy and transformation readiness. That is possibly what explains the equal-or-greater-than-DTSL influence exerted by BPI ($\beta = 0.267$) and ADT ($\beta = 0.177$) in our context.

4.6.Hypotheses and Results

5. H1: Digital transformation strategy and leadership positively influence digital transformation challenges and readiness.
6. Hypothesis accepted: Digital transformation strategy and leadership positively and significantly influence CRDT ($\beta = 0.244$, $p = 0.001$).
7. H2: Digital technology adoption positively influences digital transformation challenges and readiness.
8. Hypothesis accepted: ADT is a statistically significant positive predictor ($\beta = 0.254$, $p < 0.001$).
9. H3: Business processes and integration positively influence digital transformation challenges and readiness.
10. Hypothesis accepted: BPI is a significant predictor of CRDT ($\beta = 0.217$, $p < 0.001$).

10.1. Group Comparisons

Table 4.9: Distribution of scores on components of the Digital Transformation Scale, specifically technology adoption, business process integration, leadership, and strategy by gender group

Gender		N	Mean	t	P
Digital Transformation Strategy and Leadership	Female	116	14.5259	1.202	0.594
	Male	184	14.0217		
Adoption of Digital Technologies	Female	116	18.6034	1.592	0.185
	Male	184	17.8967		
Business Processes and Integration	Female	116	10.6552	1.961	0.706
	Male	184	10.1630		
Challenges and Readiness for Digital Transformation	Female	116	11.9828	0.505	0.503
	Male	184	11.8261		

Table 4.9 gives the mean scores, t-values, and p-values for each group, with N = 300 (116 females and 184 males). The analysis examined gender differences in the perception of or participation in the digital transformation initiative in order to test for significant status. Across all four components of the Digital Transformation Scale, no important differences were detected between males and females in this regard p-value being above the generally accepted level of significance of 0.05.

For Digital Transformation Strategy and Leadership, females scored somewhat higher (14.53) than males (14.02), but the difference was nonsignificant ($t = 1.202$, $p = 0.594$). In the dimension of Digital Technologies Adoption, females again scored slightly higher (18.60) than males (17.90), but this difference was not statistically significant ($t = 1.592$, $p = 0.185$). The Business Processes and Integration study gave a slightly higher mean for females (10.66) than for males (10.16); however, although the t-value was slightly above the cutoff at 1.961, the corresponding p-value of 0.706 indicates that this difference was not statistically significant.

Lastly, the mean scores were nearly identical for Challenges and Readiness for Digital Transformation (females: 11.98; males: 11.83) and produced a statistically nonsignificant result ($t = 0.505$, $p = 0.503$).

Table 4.10: Distribution of scores for the Digital Transformation, Leadership, and Strategy Scale by age group

Age		N	Mean	F	p	Statistical differences
Digital Transformation Strategy and Leadership	18-24(a)	90	13.5667	3.275	**0.021**	c>d, c>b, c>a, d>b, d>a, b>a
	25-34(b)	119	14.0336			
	35-44(c)	70	15.2571			
	45 and above(d)	21	14.5714			
Adoption of Digital Technologies	18-24(a)	90	17.3333	4.571	**0.004**	c>d, c>b, c>a, d>b, d>a, b>a
	25-34(b)	119	17.9580			
	35-44(c)	70	19.4286			
	45 and above(d)	21	18.7619			
Business Processes and Integration	18-24	90	10.5000	1.860	0.136	------
	25-34	119	10.0672			
	35-44	70	10.4143			
	45 and above	21	11.1429			
Challenges and Readiness for Digital Transformation	18-24(a)	90	11.1778	3.567	**0.015**	c>d, c>b, c>a, d>b, d>a, b>a
	25-34(b)	119	12.0588			
	35-44(c)	70	12.4429			
	45 and above(d)	21	12.0952			

Abbreviation: P *=probability value* F: *distribution using One-way* ANOVA *when there are three or more groups; = Significant if the p <0.05, n: Number, Std: standard deviation*

Table 4.10 shows the results of a one-way analysis of variance concerning the perceptions of digital transformation features among age groups considered variable in the sector of food and beverage (F&B) SMEs in Tripoli, Libya. Per age group for the study entailed 18 to 24, 25 to 34, 35 to 44, and 45+. The following were considered digital transformation dimensions, namely; Digital Transformation Strategy and Leadership (DTSL) There was a significant difference statistically in the perceptions of digital transformation strategy and leadership across age groups (F = 3.275, p = 0.021). That was the highest mean recorded in the older age group of 35 to 44 (15.26) and the lowest mean recorded in the younger age group (18 to 24), pointing to less engagement or awareness of such strategic leadership in digital initiatives. ## Adoption of Digital Technologies (ADT) Big Differences in Technology Adoption among Age Groups (F = 4.571, p = 0.004). Again for the third time, age group 35-44 recorded the highest mean with a score of 19.43, which indicates that it is heavily engaged in adoption of technology. On contrary, the mean from group 18-24 is the least with a value of 17.33. This may reflect lower decision-making authority or exposure to digital tools at the enterprise level.

There were no significant differences attributed to age with respect to business process integration (F = 1.860, p = 0.136). Although there were some differences in mean scores, these were insufficient to indicate that any significant differences based on age exist in the way that participants tend to perceive business process changes resulting from digital transformation. ## Challenges and Readiness for Digital Transformation (CRDT)

There is a statistically significant difference in Challenges and Readiness (F = 3.567, p = 0.015). Older respondents, specifically those aged 35-44 (mean = 12.44), felt more prepared and less challenged by digital transformation, while younger respondents (aged 18-24) indicated lower readiness (mean = 11.18). This probably indicates the inexperience of younger employees or their limited access to strategic and operational insights.

Table 4.11: Distribution of scores on the components of the digital transformation scale, specifically technology adoption, leadership, and strategy, by educational level group.

Educational level		N	Mean	F	p	Statistical differences
Digital Transformation Strategy and Leadership	Grade 12 / Terminal (a)	52	12.76	6.09	0.000	e>d, e>b, e>c, e>a,d>b, d>c,d>a,b>c,b>a,c>a
	National and Technical Education (BT. TS) (b)	40	14.45			
	Bachelor's Degree (c)	145	14.02			
	Master's Degree (d)	58	15.51			
	PhD Degree (e)	5	18.00			
Adoption of Digital Technologies	Grade 12 / Terminal (a)	52	17.19	4.14	0.003	e>d, e>b, e>c, e>a,d>b, d>c,d>a,b>c,b>a,c>a
	National and Technical Education (BT. TS) (b)	40	18.02			
	Bachelor's Degree (c)	145	17.93			
	Master's Degree (d)	58	19.37			
	PhD Degree (e)	5	22.20			
Business Processes and Integration	Grade 12 / Terminal (a)	52	10.38	3.76	0.005	e>d, e>b, e>c, e>a,d>b, d>c,d>a,b>c,b>a,c>a
	National and Technical Education (BT. TS) (b)	40	10.02			
	Bachelor's Degree (c)	145	10.13			
	Master's Degree (d)	58	10.84			
	PhD Degree (e)	5	13.20			
Challenges and Readiness for Digital Transformation	Grade 12 / Terminal (a)	52	10.94	6.47	0.000	e>d, e>b, e>c, e>a,d>b, d>c,d>a,b>c,b>a,c>a
	National and Technical Education (BT. TS) (b)	40	12.02			
	Bachelor's Degree (c)	145	11.62			
	Master's Degree (d)	58	13.10			
	PhD Degree (e)	5	14.00			

In Table 4.11: Comparing perceptions of digital transformation by educational level, significant differences in educational levels were found (F = 6.099, $p < 0.001$). Those with higher education levels appeared to have stronger perceptions and understanding of leadership and strategic roles on digital transformation. PhD holders had the highest mean (18.00), while twelfth-grade students had the lowest mean (12.77). This proves that higher education is positively correlated with a strategic vision towards digital change.

With respect to other ADT, a statistically significant difference emerged in the adoption of digital technologies across educational levels (F = 4.147, p = 0.003). Again, PhD holders had the highest mean (22.20) followed by master's degree holders (19.38), with the lowest mean accorded to twelfth grade graduates (17.19). These results indicate that higher-grade education among individuals is either more familiar with digital tools or somewhat more tend to apply it.

BPI Statistically significant differences (F = 3.760, p = 0.005) were established on how different groups perceived digital integration into business processes. PhD holders had a mean score of 13.20, which is significantly higher than other groups. Although the strategy and adoption differences were more pronounced, these trends continue to rise with increased education.

CRDT Perceptions of readiness and challenges also showed significantly different outcomes (F = 6.479, p < 0.001). Once more, it was those with advanced levels of education who tended to rate either themselves or their organization as more prepared to implement digital transformation while stating that they faced fewer challenges. Mean scores ranged

Table 4.12: Distribution of scores on the components of the digital transformation, leadership, and strategy scale, according to the current position in the company's group

Current position in the company		N	Mean	F	p	Statistical differences
Digital Transformation Strategy and Leadership	Technician(a)	47	13.61	2.95	0.020	d>e,d>a, d>b,d>c,e>a, e>b,e>c,a>b, a>c,b>c
	Supervisor(b)	62	13.53			
	Quality Officer(c)	29	13.27			
	Manager (Top, General, Operations, Production, Quality, Regional)(d)	47	15.27			
	Other(e)	115	14.63			
Adoption of Digital Technologies	Technician(a)	47	17.12	2.83	0.025	d>e,d>a, d>b,d>c,e>a, e>b,e>c,a>b, a>c,b>c
	Supervisor(b)	62	17.48			
	Quality Officer(c)	29	17.72			
	Manager (Top, General, Operations, Production, Quality, Regional)(d)	47	19.02			
	Other(e)	115	18.73			
Business Processes and Integration	Technician(a)	47	10.44	1.30	0.270	----
	Supervisor(b)	62	10.01			
	Quality Officer(c)	29	9.79			
	Manager (Top, General, Operations, Production, Quality, Regional)(d)	47	10.61			
	Other(e)	115	10.53			
Challenges and Readiness for Digital Transformation	Technician(a)	47	11.87	1.69	0.152	-----
	Supervisor(b)	62	11.35			
	Quality Officer(c)	29	11.65			
	Manager (Top, General, Operations, Production, Quality, Regional)(d)	47	12.63			
	Other(e)	115	11.93			

In Table 4.12: Digital Transformation Scale by Current Position in the Company Digital Transformation Strategy and Leadership, there exists a statistically significant group difference (F = 2.957, p = 0.020). Managers reported the highest means in their perception of awareness strategy and leadership in digital transformation (mean = 15.28), given their roles in strategic oversight. Technicians and quality managers have recorded lower means

(13.62 and 13.28, respectively), and this may represent their less frequent involvement in strategic planning.

Digital Technology Adoption. This dimension has also shown significant statistical differences (F = 2.839, p = 0.025). Again, managers reported the highest mean (19.02), closely followed by those occupying "other" positions (18.73). The observations of those in broad representative roles are believed to perceive technology adoption with clarity and confidence. Technicians and supervisors, the latter who scored less, are probably in a system of hierarchy of access and interaction with digital tools.

Business Processes and Integration. Here, no significant differences were found across positions (F = 1.300, p = 0.270). Mean scores were relatively close, ranging from 9.79 (Quality Officer) to 10.62 (Manager). This may indicate a more consistent perception of how digital processes are integrated across departments, regardless of position.

Challenges and Readiness for Digital Transformation Though managers scored highest in readiness (mean = 12.64), the overall difference between groups was not significant (F = 1.693, p = 0.152). This might suggest that perceptions of readiness and challenges may be rather uniform among various roles in the company.

CHAPTER FIVE
DISCUSSION

This study analyzes the digital transformation readiness of Tripoli's food and beverage SMEs in Libya based specifically on three dimensions-strategy and leadership for digital transformation, adoption of digital technologies, and business-process integration. Regression results in Table 4.7 showed that the three identified variables exert a statistically significant positive influence on the dependent variable, digital transformation challenges and readiness. These findings corroborate and differ from the research in other international contexts thereby providing a deeper understanding of how different regions view SMEs' digital transformation.

Hypothesis one (H1) states that digital transformation strategies and leadership influence transformation readiness significantly. Our analysis has supported this ($\beta = 0.244$, $p < 0.01$). This indicates that strategic direction and strong leadership are among the foundational enablers in driving digital change. This aligns well with the results in Thailand by Jewapatarakul and Ueasangkomsate (2024), where they found that leadership capability and a clear strategic vision were significant predictors of successful digital transformation in food manufacturing SMEs. Their research team continues to highlight that in the absence of leadership engagement, digital initiatives often remain fragmented and short-lived. Parallelly, Al-Emran et al. (2021) in their study of several countries across the Middle East concluded that internal resistance to digital change must be countered by aligning the strategic objectives of the business with instituting digital tools that will help with building digital readiness.

In return for Libyan contextual consideration, the leadership discussed in this study could be termed as an exposition on the wider institutional and infrastructural constraints faced by SMEs that underline the importance of internal vision and direction. It may be asserted that, in the absence of due governmental or ecosystem support, leadership fills the void normally occupied by external scaffolding, thus, giving comparatively more weight to internal capabilities than would otherwise be the case in contexts that are more conducive.

The next path tested in the study was H2, which means the adoption of digital technologies would positively affect digital transformation readiness. Results yielded a standardized coefficient of $\beta = 0.254$ ($p < 0.01$), thus confirming the hypothesis. This is further strongly substantiated by previous studies in Indonesia by Ardito et al. (2021), wherein the authors examined manufacturing SMEs and specifically found that the adoption of core technologies, which include ERP systems, IoT, and cloud platforms, greatly affected organizational flexibility and transformation preparedness. In European settings, Müller, Buliga, and Voigt (2018) similarly noted that SMEs in Germany equipped with scalable digital platforms were more capable of aligning to changing customer and market demands. The parallel drawn across these studies speaks volumes to the universality of this relationship independent of economic development level.

However, even though there is consistency in directionality, the relative strength of the technology variable in this Libyan study ($\beta = 0.254$) may be in reflection of a latent technological gap in the region. In contrast, studies from developed economies would showcase a much higher base level of digital infrastructure that rather moderates the effect of initial adoption. Therefore, within Libya, the very act of adopting might tendentially gain a distinctly greater transformative role marked by, than in regions considered to be more technologically mature.

The third hypothesis (H3) related to business process integration, which was also found to have a significant impact on transformation readiness ($\beta = 0.217$, $p < 0.01$). This is consistent with the study by Schuh et al. (2014) and to them stated that process integration is one of the critical parameters to translate technological usage into organizational agility. Likewise, Cimini et al. (2021) demonstrated in research into Italian manufacturing SMEs that there was more likelihood for companies with higher levels of vertical and horizontal integration to realize gains in efficiency, customer satisfaction, and innovation capability. Findings in Italy also indicated that the redesign of business process, rather than application of technology alone, was critical in gaining transformation results.

In comparison to these, the Libyan case stands to provide a sector where integration would perhaps be rendered more difficult owing to legacy systems, informal structures, and a disaggregating supply chain. Notwithstanding this impediment, relevance in the statistical proof of process integration to our study implies, as it were, that process integration may even provoke very little change in internal coherence and, nonetheless, result in transformational readiness for environments with lower levels of digital maturity.

Taken together, these comparisons reveal a broader pattern. In fact, across the various national contexts: Thailand, Indonesia, Germany, and Italy, strategy, technology adoption, and process integration are common predictors of digital readiness. What distinguishes

Libya's SMEs-mostly in the food and beverage sector-is the relatively increased dependency on internal strategic direction and leadership in the absence of systemic institutional support. Furthermore, the scale of effects of technology and process alignment suggests that digital transformation in resource-constrained environments depends not only on the acquisition of the technology, but also on their coherent integration into strategically guided processes.

The regression results of this research resonate and go further in the literature concerning readiness for digital transformation. Although the direction and nature of critical predictors align with findings worldwide, it is a case that adds unique aspects to how transformation takes shape under infrastructural limitations in Libya. Leadership and strategic clarity are, in this framework, not mere enablers but essential catalysts. The reliance on adoption and integration, in this respect, further signifies the need for a systemic approach toward aligning investments in technology with reengineering processes and with organizational culture. These findings could thus provide a strong policy, training, and future research basis in promoting the digitalization of SMEs in fragile or under-supported economies.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

5.1. Research Limitations

One significant limitation of this research lies in its geographic focus. The study exclusively targeted SMEs in the food and beverage sector in Tripoli, which, while economically central to Libya, does not fully represent the broader socio-economic diversity found in other regions of the country. For instance, SMEs in eastern or southern Libya operate under markedly different infrastructural and market conditions, often lacking stable internet connectivity or digital logistics support (A). According to Alshwiah and Elferjani (2022), regional disparities in infrastructure and governance within Libya significantly impact the scalability of digital initiatives, leading to inconsistent readiness across provinces (B). Thus, while the results are highly relevant for Tripoli-based businesses, they cannot be automatically extended to rural areas or cities facing more acute governance and infrastructural breakdowns (A).

Similarly, generalizing the results to other developing economies must be done cautiously. While several countries in North Africa or the MENA region share common barriers—such as unstable power grids, limited digital literacy, or political volatility—each context varies in terms of market regulation, cultural attitudes toward innovation, and access to public-private partnerships (OECD, 2021). Consequently, replication studies in comparable regions would be necessary to validate the external applicability of the findings.

The other recognized limitation pertains to the disconnect between strategic digital awareness and actual business process improvements. While this insight leads to the conclusion that several managers in Tripoli-based SMEs demonstrate a fair degree of understanding of digital transformation strategy, the knowledge does not seem to translate into actual process improvements or integration efforts. Such a paradox raises very important questions around internal organizational dynamics and resistance to change.

Prior research highlights that without a cohesive internal culture that supports innovation and adaptive learning, digital leadership alone is insufficient to drive organizational transformation (Vial, 2019). Companies may have top-level awareness but may not have the internal communication systems, IT staff, or middle management support to execute it (B). This indicates a latent organizational imperfection possibly rooted in hierarchical decision-making structures or in an insufficient delegation of authority that constrains the operationalization of strategic intentions (A).

The third set of barriers to the implementation of digital transformation strategies in Tripoli considers the existing socio-technical environment. While much of the recommendations in this study (e.g., use of cloud systems, digital supply chains, or customer analytics) are very much in line with international trends, actual implementation in practice will face infrastructural and security challenges. Tripoli suffers from erratic power supply, low-speed internet, and fairly porous cybersecurity, which altogether dismiss any serious technological investment (A). The World Bank (2023) puts Libya low in terms of ICT infrastructure and broadband penetration, particularly in rural areas, which limits the establishment of the latest digital platforms (B). Thus, the realism of certain digital initiatives will have to undergo an adjustment in view of the economy and technological bandwidth prevalent in Tripoli (A).

Again, Libya's political and economic instability constitutes a backdrop to digital transformation readiness. Political divisions, devaluation of the currency, and lack of coherent policies have led to a toss-up in regulatory continuity, which deters any long-term investment in digital infrastructure and skills development (A). United Nations Economic Commission for Africa (UNECA, 2022) found that vulnerable countries lack unified digital governance, have weak cybersecurity regulations, and have volatile capital markets, which hampers the growth of digital ecosystems (B). In Libya, political uncertainty makes SMEs reluctant to adopt disruptive technologies out of concern for ROI and sustainability (A).

Lastly, even if the developed model is highly applicable as a framework for urban SMEs in the food and beverage sector, the model's applicability toward other sectors or rural-based SMEs may be highly indirect. The rural enterprises are usually deprived of the infrastructural backbone and market access to take advantage of digital technologies, which makes this readiness even more severely constrained (A). On top of that, sectors like manufacturing, construction, or services face varying digital pressures and pathways to transformation. As Mittal et al. (2018) have indicated, sector-specific digital strategies are essential as readiness factors vary immensely for capital-intensive versus labor-intensive industries (B). Therefore, applications will require sector-specific modifications so that even while the fundamental constructs of strategy, technology adoption, and integration are theoretically applicable, their implementation can be made accurate (A).

5.2. Conclusions

The data scrutinizes the SME landscape in Tripoli's food and beverage sector, pinpointing strengths and weaknesses across the digital transformation journey. Ultimately, having a workforce that is young, educated, and of moderate experience can engender the acceptance of newer technologies. The good news is that the bulk of companies have already embarked on digital transformation initiatives and even set up proper teams for that purpose.

Still a lot of challenges linger in this sector. Many firms are small and target-focused on the local market, somehow limiting their willingness or ability to invest in digital tools or obtain external expertise. In addition, for more than one-third of the companies surveyed to lack digital teams indicates that it still requires many companies to plan and implement technology initiatives more systematically. Thus, for SMEs to ensure that their digital transformation to be on-going, they should give consideration to investing in the training of the workforce, taking advantage of local and international support programs, and outlining clearer digital strategies to become more efficient operations, increase customer engagement and resilience in an ever-digital economy. The findings hint that Tripoli's SMEs are on the right track; nevertheless, a well-targeted support structure and strategic planning will be imperative for the success of their digital journey.

The rotated component matrix produced results with quite a strong indication to validate that in Tripoli, digital transformation for food and beverage SMEs is multidimensional with at least four major components: Adoption of Digital Technologies (ADT), Digital Transformation Strategy and Leadership (DTSL), Change Readiness and Digital Talent (CRDT), and Business Processes and Integration (BPI).

These dimensions call out that digital transformation is not merely about adopting new technology; it requires a strategic direction, support from the top leadership, a workforce prepared to change, and business processes that are restructured. The PCA data supports the construct validity of dimensions and provides valuable advice for managers and policymakers. So, to maximize the success of digital transformation, SMEs must not only acquire technological solutions but also build leadership engagement and internal competencies and reengineer their operations for smoother integration and efficiency.

This also provides a valuable diagnostic tool for decision-makers in Tripoli's food and beverage sector to assess their digital strategy as to well-established versus needing investment and further focus.

Reliability analysis results confirm the validity and reliability of the four scales used in this study. Cronbach's Alpha values of 0.73 to 0.82 suggest that these constructs measure distinct yet interrelated dimensions of SMEs' digital transformation, namely, strategic leadership, technology acceptance, business integration, and organizational readiness.

The response of the F&B SMEs in Tripoli towards digital transformation, as exposed by the findings in Table 4.4, paints somewhat of a refined picture. Digital technology adoption appears to be one of the most progressed aspects, suggesting that a good number of firms started using digital tools in their daily operations. In contrast, strategic leadership and business process integration still present huge variety between firms, with quite a number of firms demonstrating a greater degree of underwhelming structures and misalignment between the technology and the organizational process.

The results also suggest that, on the whole, the organizational readiness to accommodate the challenges of digital transformation is somewhat developed but still varies from company to company. In general, it seems that the pace of technology adoption is encouraging; however, numerous SMEs are lagging behind in developing deeper structural and strategic alignment.

For these companies to fully realize the gains of digital transformation, a more holistic approach must be adopted that couples together technology adoption with leadership, strategic direction, integrated business processes, and a well-developed digital readiness. Interventions such as training programs, strategic planning support, and resource mobilization could narrow/diminish these gaps to ensure that digital transformation is sustainable and impactful across the sector.

This correlation analysis provides sufficiently strong statistical proof of the interconnectedness of leadership, technology adoption, operational processes, and organizational readiness in the digital transformation journey for SMEs in Tripoli's food and beverage sector. Leadership and strategy emerge largely from these areas not as foundations but catalysts for movement in other digital transformation areas.

However, this alone does not lead to successful results without adhering to a more holistic approach-there must be visionary leadership, integrated business processes, and change-ready culture. SME leaders and policymakers must put onboard the significant message: ensure that transformational paths will become sustainable through strategic leadership reinforcement and a giving environment for digital integration.

This would serve as a basis on which to design targeted digital initiatives in which technology coexists closely with human capital, business workflows, and long-term growth strategies, as Libya's SME landscape adapts to change.

Results derived from Table 4.7 would thus suggest that gender has no statistically significant impact on any of the perceptions or experiences relating to the digital transformation associated with food and beverage SMEs in Tripoli. Both a male and female respondent have similar levels approached with leadership strategies, technology adoption, integration in business, and readiness for digital transformation.

These findings are significant, as they demonstrate fair participation by both genders towards the digital journey at least in the perception and engagement aspects. This may probably mean that applying digital initiatives in SMEs has been relatively gender-neutral in effect. Therefore, it underscores for policymakers and organizational leaders the importance of keeping strategies inclusive continuing to provide equal access to training and digital tools, as well as leadership opportunities to all employees regardless of gender.

In broader terms, lack of substantial gender differences may signify progress towards increased gender equity especially in areas of digital readiness and leadership, which are most critical to achieving sustainable, inclusive digital transformation across Libya's SME landscape.

All the data show in Table 4.8 that age greatly influences perception and engagement toward digital transformation in relation to strategy, technology adoption, and organizational readiness. Mid-career persons (35 to 44 years) consistently reported the highest level of engagement, which indicates that they may be in the position to make strategic decisions or actively participate in the implementation.

On the flip side, the younger respondents (18 to 24 years) generally reported low scores across many dimensions due to their lack of exposure toward strategic planning or operational leadership. Interestingly, while the perception of business process integration was found not to significantly differ, i.e., this aspect of transformation may be viewed the same across all age groups.

In a practical sense, this means that organizations may benefit from some form of targeted training and inclusion strategies to ensure that younger staff are involved in digital initiatives. Another area that can considerably reduce the digital gap in Libyan SMEs is the engagement of mid-career professionals in actualizing digital initiatives.

The results of Table 4.9 furnish compelling evidence to support the argument that education level significantly determines perception and participation in the digital transformation process pertaining to SMEs. Higher-educated groups, particularly those with master's and doctoral degrees, consistently expressed greater strength in terms of strategic vision, greater rates of technology adoption, awareness of process integration, and certainty with their organization's preparedness.

This might be attributed to multiple reasons, such as greater awareness and opportunity for training, alongside greater exposure to strategic frameworks. Thus, promoting education and skills development should be seen as a strategic approach to promoting digital transformation in SMEs.

Organizations aspiring to fuel digital transformation must create training programs for their employees with less formal education to minimize the digital divide and cultivate a more uniform transformation across all levels of the workforce. This reiterates the dire need for a wider array of training in digital skills in the Libyan SME sector, where there is a range of educational backgrounds.

Positioning within the organization significantly influences employee perceptions of digital strategy and technology adoption, although it may not be reflected in the overall value associated with preparations or operations. As expected, the highest levels of engagement, awareness, and adoption of the strategy are likely attributed to managers, given their leadership positions and ability to influence decision-making. Conversely, the lowest scores are likely attributed to technicians and quality managers, who appear to operate from an operational rather than strategic perspective.

The lack of significant differences in how business processes are integrated and prepared across sub-levels suggests a fairly common perception across the organizational hierarchy, potentially demonstrating some effectiveness in internal communication or a similar opportunity regarding transformation challenges.

These findings suggest that more comprehensive inclusion and empowerment of technicians and supervisors—in lower roles—is essential for the success of digital transformation efforts in food and beverage SMEs.

5.3. Recommendations

In terms of a comprehensive analysis and strategy recommenders regarding digital transformation readiness in food and beverage SMEs in Tripoli, such recommendations are:

Enhance Strategic Leadership and Vision: SME leaders must formulate a clear-cut and coherent digital transformation strategy aligned with business objectives. Leadership commitment acts as a catalyst for digital adoption and organizational culture change. It is thus necessary that management training programs regarding digital leadership and strategy planning are given priority to bridge existing gaps and ensure that top management is prepared to endorse technology initiatives.

Invest in Workforce Development and Digital Skills Training: Varied educational backgrounds keep the workforces at different experience levels. To ensure that digital literacy and skills training programs are designed for every level of employee-focusing especially on the young ones and on lower-tier employees like technicians and supervisors, such programs are a must-this will ensure that democracy is well established in terms of digital transformation and inculcates a culture of continued learning and innovation.

Promote Integrated Business Process Reengineering: Rethink and redesign business processes as one stop so SMEs can derive maximum value from digitally enabled technologies. Closely aligned with this are departments cooperating in matching technology adoption with operational workflow improvements. SMEs can adopt external consultancy or partners' services to establish process integration while assuring smooth transition from legacy systems to digital ones.

Encourage Formation and Empowerment of Dedicated Digital Teams: Dedicated teams for digital transformation are reportedly strong enablers of progress. This lack of teams should make SMEs create multidisciplinary groups that are capable of advocating, facilitating and supporting technology adoption by breaking functional communication barriers in their ongoing digital journeys.

Leverage Local and International Support Programs: Get in touch with government initiatives, NGOs, international development programs, and industry associations. Some of them offer resources, training, and even funding opportunities for digital transformation to SMEs in Tripoli. These partnerships should reduce financial barriers and knowledge limitations.

Encourage Digital Culture to be Inclusive and Gender Neutral: The data indicate no meaningful gender status difference in engagement with digital transformation, which is good news. Policymakers and SME heads must solidify that ground upon which equality will be achieved into access of digital tools, training, and leadership opportunities to keep this going.

Encourage Mid-Career Professionals as Digital Transformers: Mid-career employees are most engaged. Therefore, organizations should include them in decision-making and implementation of programs and empower them as digital champions. Simultaneously, initiatives should support better integrating and mentoring younger employees, increasing their strategic exposure.

Enhance Organizational Communication and Employee Participation: Business processes are attached to different levels of an organization. This offers opportunities for more inclusive communication. SMEs should establish mechanisms that encourage all staff to participate in their digital programs-from strategic planning to operational adjustments-in order to strengthen unity and accountability within the firm.

Implement Holistic and Continuous Evaluation Frameworks: A multi-dimensional assessment tool, such as the four above-identified key components- Adoption of Digital Technologies, Digital Transformation Strategy and Leadership, Change Readiness and Digital Talent, and Business Processes and Integration-would be beneficial for SMEs and policy creators in being able to track advancement, identify gaps, and adjust strategies on the fly.

Encourage Educational Advancement and Long-Term Capacity Building: Since increased digital readiness correlates highly with higher education levels, the longer-term measures will be directed towards inspiring educational attainment and continuous professional development of the workforce. Jointly working with educational institutions towards customizing curricula and training to the industry requirements would build a sustainable talent pipeline.

REFERENCES

Aga, G., Francis, D., & Meza, D. (2015). SMEs, age, and jobs: A review of the literature, metrics, and evidence. World Bank Group.

Al-Emran, M., Al-Sharafi, M. A., Al-Kabi, M. N., & Shaalan, K. (2021). Investigating the determinants of digital transformation: An evidence from MENA region. *Technology in Society*, 65, 101542.

Al-Emran, M., Al-Sharafi, M. A., Al-Kabi, M. N., & Shaalan, K. (2021). Investigating the determinants of digital transformation: An evidence from MENA region. *Technology in Society, 65*, 101542.

Alhaj, Y. (2022). The digital divide in Libya: Opportunities and barriers for SMEs. *Middle East Journal of Management, 9*(2), 113–129. https://doi.org/10.1504/MEJM.2022.10045678

Alhaj, Y. (2022). The digital divide in Libya: Opportunities and barriers for SMEs. *Middle East Journal of Management, 9*(2), 113–129.

Alshwiah, S., & Elferjani, R. (2022). The Impact of Digital Technologies on Libyan SMEs: Opportunities and Barriers. *Libyan Journal of Business Research*, 5(1), 35–52.

Antoldi, F., Cerrato, D., & Depperu, D. (2012). Export consortia in developing countries: Successful management of cooperation among SMEs. Springer. https://doi.org/10.1007/978-3-642-24878-8

Apreda, R., Bonaccorsi, A., Dell'Orletta, F., & Fantoni, G. (2016). Functional technology foresight: A novel methodology to identify emerging technologies. *European Journal of Futures Research*, *4*, 4–13.

Ardito, L., Petruzzelli, A. M., Panniello, U., & Garavelli, A. C. (2019). Digital transformation in the manufacturing industry: An overview of the state of the art. International Journal of Production Research, 57(15–16), 4875–4893. https://doi.org/10.1080/00207543.2019.1572842

Ardito, L., Raby, S., Albats, E., Petruzzelli, A. M., & Frattini, F. (2021). The role of digital technologies in open innovation processes: An integrative framework. *Technological Forecasting and Social Change*, 162, 120354.

Ashton, D. N. (1999). Education and training: The case for economic performance. OECD Publishing.

Ashton, K. (1999). That 'Internet of Things' thing. RFID Journal, 22(7), 97–114.

Aspin, D. N. (1995). *Educational research, values and the academic: The concept of empirical research*. London: Routledge.

Avasarala, V. (2016). Digital transformation in manufacturing: A resource-based view. Avasant. https://www.avasant.com

Barney, J. B. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–120. https://doi.org/10.1177/014920639101700108

Barros, A. P., Galindo, G., & Verdecho, M. J. (2012). A systematic approach to supply chain risk management. Applied Mathematics and Computation, 218(20), 10302–10313. https://doi.org/10.1016/j.amc.2012.03.042

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. MIS Quarterly, 37(2), 471-482. https://doi.org/10.25300/MISQ/2013/37:2.3

Bogner, E., Voelklein, T., Schroedel, O., & Franke, J. (2016). Study based analysis on the current digitalization degree in the manufacturing industry in Germany. Procedia CIRP, 57, 14–19. https://doi.org/10.1016/j.procir.2016.11.004

Bogue, R. (2019). The role of Industry 4.0 technologies in the food and beverage sector. Assembly Automation, 39(4), 537-544. https://doi.org/10.1108/AA-05-2019-0085

Bottani, E. (2009). Benchmarking the performance of agile and traditional manufacturing systems with simulation. Benchmarking: An International Journal, 16(3), 330–353. https://doi.org/10.1108/14635770910951470

Bowersox, D. J., Closs, D. J., & Drayer, R. W. (2005). The digital transformation: Technology and beyond. Supply Chain Management Review, 9(1), 22–29.

Bowersox, D. J., Closs, D. J., & Drayer, R. W. (2005). The digital transformation: technology and beyond. Supply Chain Management Review. Framington: Peerless Media, LLC.

Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective. International Journal of Mechanical, Industrial Science and Engineering, 8(1), 37–44.

Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An

Industry 4.0 perspective. *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering, 8*(1), 37–44.

Bughrin, M. (2019). Virtualization and decentralization in Industry 4.0: Concepts and applications. Journal of Industrial Information Integration, 15, 1–10. https://doi.org/10.1016/j.jii.2019.01.001

Cegarra-Navarro, J. G., Soto-Acosta, P., & Wensley, A. (2022). Leveraging digital transformation for knowledge integration in SMEs: A resource-based view. *Journal of Small Business Management*, 60(1), 1–20.

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Chartered Institute of Procurement & Supply. (2020). Digitalisation in procurement and supply. https://www.cips.org
Chartered Institute of Procurement & Supply. (2020). Digitalisation in procurement and supply. https://www.cips.org
Chen, Y. (2015). The impacts of Internet and digitalization on supply chain integration and firm performance: An empirical study. Journal of Business & Industrial Marketing, 30(3/4), 238–246. https://doi.org/10.1108/JBIM-04-2013-0091

Chong, A. Y. L., & Chen, C. C. (2010). Towards an understanding of the adoption behavior of agile supply chains in the food industry. International Journal of Production Economics, 124(2), 330–339. https://doi.org/10.1016/j.ijpe.2010.01.017

Cimini, C., Pinto, R., & Cavalieri, S. (2021). A framework for digital transformation in manufacturing: A system-based view. *International Journal of Production Research*, 59(8), 2407–2432.

Coleman, J., Göpfert, J., & Kurle, D. (2017). Industry 4.0 – Opportunities and challenges of the industrial internet. In Proceedings of the 50th CIRP Conference on Manufacturing Systems, 63, 87–92.

Costa Melo, D. I., Queiroz, G. A., Alves Junior, P. N., de Sousa, T. B., Yushimito, W. F., & Pereira, J. (2023). Measuring digital transformation performance: Empirical applications and methodological gaps. Heliyon, 9(3), e13908. https://doi.org/10.1016/j.heliyon.2023.e13908

Costa Melo, D. I., Queiroz, G. A., Alves Junior, P. N., de Sousa, T. B., Yushimito, W. F., & Pereira, J. (2023). Measuring digital transformation performance: Empirical applications and methodological gaps. Heliyon, 9(3), e13908. https://doi.org/10.1016/j.heliyon.2023.e13908

Crawley, E. F. (2013). System architecture: Strategy and product development for complex systems. Pearson Education.

Cueto, L. J., Frisnedi, A. F. D., Collera, R. B., Batac, K. I. T., & Agaton, C. B. (2022). Digital innovations in MSMEs during economic disruptions: Experiences and challenges of young entrepreneurs. Administrative Sciences, 12(1), 8. https://doi.org/10.3390/admsci12010008

Deloux, E., Pierreval, H., & Vallespir, B. (2009). A framework for agile supply chain performance monitoring. International Journal of Agile Systems and Management, 4(3), 251–261. https://doi.org/10.1504/IJASM.2009.026391

Elfitouri, S. A., & Mohamed, M. E. (2021). Barriers to digital transformation in Libyan SMEs: Evidence from the food and beverage industry. *Libyan Journal of Business Research, 5*(1), 25–40.

Elfitouri, S. A., & Mohamed, M. E. (2021). Barriers to digital transformation in Libyan SMEs: Evidence from the food and beverage industry. *Libyan Journal of Business Research, 5*(1), 25–40.

Ernst, D., Frische, M., & Hamill, J. (2015). Cybersecurity in the age of Industry 4.0: Challenges and solutions. Journal of Manufacturing Science and Engineering, 137(4), 1–10. https://doi.org/10.1115/1.4030322

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4.

Euchner, J. (2018). Building organizational agility. Research-Technology Management, 61(3), 12–19. https://doi.org/10.1080/08956308.2018.1471279

European Commission. (2020). *Annual report on European SMEs 2019/2020: SMEs coping with the COVID-19 crisis*. Publications Office of the European Union. https://doi.org/10.2873/195756

Farahani, R. Z., Rezapour, S., & Kardar, L. (2015). Logistics operations and management: Concepts and models. Elsevier.

Federal Ministry of Education and Research. (2011). Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative Industrie 4.0. Germany: Forschungsunion.

Federal Ministry of Education and Research. (2011). The High-Tech Strategy 2020 for Germany. Bonn: BMBF

Fischer, E., & Reuber, R. (2000). Industrial clusters and SME promotion in developing countries (Issue 3). Commonwealth Secretariat.

Ghasemi, M. (2012). E-commerce and its impact on supply chain management. International Journal of Business and Management, 7(24), 1–10. https://doi.org/10.5539/ijbm.v7n24p1

Ghezzi, A., & Cavallo, A. (2020). Agile business model innovation in digital entrepreneurship: Lean startup approaches. *Journal of Business Research, 110*, 519–537. https://doi.org/10.1016/j.jbusres.2018.06.013

Glas, A. H. (2016). The impact of digital technologies on supply chain management. International Journal of Logistics Management, 27(2), 1–20. https://doi.org/10.1108/IJLM-11-2015-0224

Gómez, K. F., & Titi, C. (2023). Facilitating access to investor-state dispute settlement for small and medium-sized enterprises: Tracing the path forward. European Business Law Review, 34(7), 1040–1041. https://doi.org/10.54648/EULR2023049

Gunadi, A. D., Lesmana, H., & Fachrizah, H. (2022). Dealing with the COVID-19 Pandemic in Indonesia: Coping Strategy, Recovery Path, and Business Transformation. Jurnal Ekonomi Indonesia, 11(1), 25–62.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2019). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (2nd ed.). Sage.

Halimatussadiah, A., et al. (2020). Thinking ahead: Indonesia's agenda on sustainable recovery from the COVID-19 pandemic. [Publisher, if available].

Hameed, R. A. (2018). Digital transformation and supply chain performance. Journal of Business and Management, 20(3), 45–53.

Hameed, W. U. (2018). Understanding digital transformation: A review of the literature and implications for future research. Journal of Business and Technology, 12(2), 45–62.

He, Y., Zhang, X., & Wang, J. (2017). The impact of 3D printing, IoT, and social media on supply chain management. International Journal of Advanced Manufacturing Technology, 88(1–4), 1–15. https://doi.org/10.1007/s00170-016-9060-3

Heinze, A., Griffiths, M., Fenton, A., & Fletcher, G. (2018). Knowledge exchange partnership leads to digital transformation at Hydro-X Water Treatment, Ltd. Global

Business and Organizational Excellence, 37(4), 6–13. https://doi.org/10.1002/joe.21859

Helu, M. T. (2017). Interoperability in Industry 4.0: Challenges and solutions. Journal of Manufacturing Science and Engineering, 139(6), 1–10. https://doi.org/10.1115/1.4038017

Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for Industrie 4.0 scenarios. In Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS), 3928–3937. https://doi.org/10.1109/HICSS.2016.488

Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for Industrie 4.0 scenarios: A literature review. Technological Forecasting and Social Change, 132, 59–72. https://doi.org/10.1016/j.techfore.2017.02.002

Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for Industrie 4.0 scenarios. In *2016 49th Hawaii International Conference on System Sciences (HICSS)* (pp. 3928–3937). IEEE. https://doi.org/10.1109/HICSS.2016.488

Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for Industrie 4.0 scenarios. In *2016 49th Hawaii International Conference on System Sciences (HICSS)* (pp. 3928–3937). IEEE. https://doi.org/10.1109/HICSS.2016.488

Hofmann, E. (2017). Industry 4.0: Opportunities and challenges for supply chain management. International Journal of Logistics Management, 28(2), 1–19. https://doi.org/10.1108/IJLM-12-2016-0275

Homburg, C. (2019). Customer-centric agile manufacturing: Linking the voice of the customer to manufacturing. Journal of Marketing Management, 35(1–2), 70–95. https://doi.org/10.1080/0267257X.2019.1576743

https://libyaherald.com/2023/08/workshop-launches-unified-smes-digital-platform/

https://www.bmbf.de/SharedDocs/Publikationen/DE/FS/657232_Bericht_zur_Hightech-Strategie_2025_en.pdf?__blob=publicationFile&v=2

Humpel, T., & Henke, M. (2017). Das Dortmunder Management-Modell Industrie 4.0: Ein Ordnungsrahmen für die Digitale Transformation. Fraunhofer IML.

Humpel, T., & Henke, M. (2017). Dortmund Management Model for Industry 4.0. Fraunhofer Institute for Material Flow and Logistics.

Imran, M. (2018). *Industry 4.0 and the future of manufacturing: Strategic challenges and opportunities*. Springer.

Imran, M. (2018). *Industry 4.0 and the future of manufacturing: Strategic challenges and opportunities*. Springer.

Jewapatarakul, D., & Ueasangkomsate, P. (2024). Digital organizational culture, organizational readiness, and knowledge acquisition affecting digital transformation in food manufacturing SMEs. *Asian Journal of Technology Innovation*.

Jonathan, M., & Kuika Watat, J. (2020). Challenges and opportunities for digital transformation in African SMEs. International Journal of Information Management, 52, 102067. https://doi.org/10.1016/j.ijinfomgt.2020.102067

Kagermann, H., Wahlster, W., & Helbig, J. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0: Securing the future of German manufacturing industry*. Acatech – National Academy of Science and Engineering. https://www.acatech.de/publikation/implementing-industry-4-0

Kagermann, H., Wahlster, W., & Helbig, J. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0: Securing the future of German manufacturing industry*. Acatech – National Academy of Science and Engineering. https://www.acatech.de/publikation/implementing-industry-4-0

Kamalaldin, A., Linde, L., Sjödin, D., & Parida, V. (2021). Transforming provider-customer relationships in digital servitization: A relational view on digitalization. *Industrial Marketing Management, 93*, 195–210. https://doi.org/10.1016/j.indmarman.2021.01.008

Kamble, S. S., Gunasekaran, A., & Sharma, R. (2020). Analysis of the driving and dependence power of barriers to Industry 4.0 adoption in the food industry. Technological Forecasting and Social Change, 150, 119762. https://doi.org/10.1016/j.techfore.2019.119762

Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2015). Strategy, not technology, drives digital transformation. MIT Sloan Management Review and Deloitte University Press. https://sloanreview.mit.edu/projects/strategy-not-technology-drives-digital-transformation/

Kline, R. B. (2015). *Principles and Practice of Structural Equation Modeling* (4th ed.). The Guilford Press.

KPMG. (2016, April). Future-proof procurement: Now or never – The big procurement transformation. https://home.kpmg

Kraus, S., Breier, M., & Dasí-Rodríguez, S. (2021). *The art of crafting a digital transformation strategy*. Technological Forecasting and Social Change, 162, 120385.

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2021). Digital transformation and entrepreneurship: A systematic review of the literature. *Journal of Small Business Management, 59*(1), 1–27. https://doi.org/10.1080/00472778.2021.1883035

Kretschmer, T., & Khashabi, P. (2020). Digital transformation and organization design: An integrated approach. California Management Review, 62(4), 86–104. https://doi.org/10.1177/0008125620940296

Kühnle, H., & Bitsch, V. (2015). Big data analytics in supply chain management: A survey. International Journal of Production Economics, 165, 1–13. https://doi.org/10.1016/j.ijpe.2014.12.010

Kurniawati, E., Handayati, P., & Osman, S. (2021). Digital transformation of MSMEs in Indonesia during the pandemic. Jurnal XYZ, 9(2), 316–331.

Kurniawati, E., Handayati, P., & Osman, S. (2021). Digital transformation of MSMEs in Indonesia during the pandemic. Jurnal XYZ, 9(2), 316–331.

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T. M., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering, 6*(2), 239–242.

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. Business & Information Systems Engineering, 6(4), 239-242. https://doi.org/10.1007/s12599-014-0334-4

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering, 6*(4), 239–242. https://doi.org/10.1007/s12599-014-0334-4

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering, 6*(4), 239–242.

Leibniz, G. W. (1703). Explication de l’arithmétique binaire. Mémoires de l’Académie Royale des Sciences de Paris, 1703, 85–89.

Leibniz, Gottfried (1703). “Explication de l’arithmetique binaire”. In: ´ Memoires de l’Academie Royale des Sciences ´ 3, pp. 85–93.

Libya Herald. (2023, August 10). Workshop launches unified SMEs digital platform. https://libyaherald.com/2023/08/workshop-launches-unified-smes-digital-platform/

Libya Herald. (2023, August 10). Workshop launches unified SMEs digital platform.

Limani, Y., Hajrizi, E., Stapleton, L., & Retkoceri, M. (2019). Digital Transformation Readiness in Higher Education Institutions (HEI): The Case of Kosovo. *IFAC PapersOnLine, 52*(25), 52–57. https://doi.org/10.1016/j.ifacol.2019.12.445

Lu, Y. (2017). Industry 4.0: A survey on technologies, applications and open research issues. Journal of Industrial Information Integration, 6, 1-10. https://doi.org/10.1016/j.jii.2017.04.005

Lu, Y. (2017). Industry 4.0: A survey on technologies, applications and open research issues. *Journal of Industrial Information Integration, 6*, 1–10. https://doi.org/10.1016/j.jii.2017.04.005

Lu, Y. (2017). Industry 4.0: A survey on technologies, applications and open research issues. *Journal of Industrial Information Integration, 6*, 1–10.

Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. Business & Information Systems Engineering, 57(5), 339–349. https://doi.org/10.1007/s12599-015-0401-5

Matt, C., Hess, T., & Benlian, A. (2015). *Digital transformation strategies*. Business & Information Systems Engineering, 57(5), 339–343.

Mattern, F., & Floerkemeier, C. (2010). From the internet of computers to the internet of things. In Proceedings of the 2010 European Conference on Ambient Intelligence (pp. 242–259). Springer. https://doi.org/10.1007/978-3-642-17973-8_17

McGrath, R., & McManus, R. (2020, May 1). Discovery-driven digital transformation. Harvard Business Review. https://hbr.org/2020/05/discovery-driven-digital-transformation

Mertens P, Barbian D (2014) Die Wirtschaftsinformatik der Zukunft – auch eine Wissenschaft der Netze? HMD 51(6):729–743

Mertens, P. (2014). Digitalization in business – From buzzword to value creation. Business & Information Systems Engineering, 6(6), 269–278. https://doi.org/10.1007/s12599-014-0355-6

Mirzagayeva, S., & Aslanov, H. (2022). The digitalization process: What has it led to, and what can we expect in the future? Metafizika, 5(4), 10–21. https://doi.org/10.31250/metafizika.2022.04.02 (If no DOI, link to journal or archive site)

Mittal, S., Khan, M. A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). Journal of Manufacturing Systems, 49, 194-214. https://doi.org/10.1016/j.jmsy.2018.10.005

Mittal, S., Khan, M. A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of Manufacturing Systems*, 49, 194–214. https://doi.org/10.1016/j.jmsy.2018.10.005

Mourtzis, D. (2018). Development of skills and competences in manufacturing towards Industry 4.0. *Procedia CIRP, 52*, 1–6. https://doi.org/10.1016/j.procir.2018.03.129

Mourtzis, D. (2018). Development of skills and competences in manufacturing towards Industry 4.0. *Procedia CIRP, 52*, 1–6.

Mubarik, M. S. (2016). Service orientation in Industry 4.0: A conceptual framework. Journal of Service Science and Management, 9(2), 1–10. https://doi.org/10.4236/jssm.2016.92011

Müller, J. M., Buliga, O., & Voigt, K.-I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. Technological Forecasting and Social Change, 132, 2-17. https://doi.org/10.1016/j.techfore.2017.12.019

Müller, J. M., Buliga, O., & Voigt, K.-I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological Forecasting and Social Change*, 132, 2–17.

Nahrkhalaji, S. S., Shafiee, M., Shafiee, S., & Hvam, L. (2018). Leadership and digital transformation: A review and future research agenda. International Journal of Production Research, 56(18), 5840–5853. https://doi.org/10.1080/00207543.2018.1449976

Nicolas, J., Goh, M., & Lee, C. (2020). The impact of globalization on supply chain visibility. International Journal of Production Research, 58(16), 1–15. https://doi.org/10.1080/00207543.2020.1751042

OECD. (2016). Chile. In Financing SMEs and entrepreneurs 2016 (pp. 155–173). OECD Publishing. https://doi.org/10.1787/fin_sme_ent-2016-11-en

OECD. (2021). *Digital Transformation in the MENA Region: Policy Approaches*. OECD Publishing.

OECD. (2021). *The digital transformation of SMEs*. OECD Studies on SMEs and Entrepreneurship. OECD Publishing. https://doi.org/10.1787/bdb9256a-en

OECD. (2021). *The digital transformation of SMEs*. OECD Studies on SMEs and Entrepreneurship. OECD Publishing.

Olorunshola, D. T., & Odeyemi, T. I. (2022). Virtue or vice? Public policies and Nigerian entrepreneurial venture performance. Journal of Small Business and Enterprise Development, 30, 100–119. https://doi.org/10.1108/JSBED-07-2021-0279

Porter, M. E. (1979). Competitive strategy: Techniques for analyzing industries and competitors. Free Press.

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92(11), 64–88. https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

Qabas. (2025). Digital transformation in Libya: Dominate your market today. https://qabas.ly [Replace with actual URL if different]

Qabas. (2025). Digital transformation in Libya: Dominate your market today. https://qabas.ly

Qabas. (2025). Digital transformation in Libya: Opportunities and challenges. Qabas Digital Solutions Report. Tripoli, Libya.

Riel, A., Kreiner, C., Macher, G., & Messnarz, R. (2017). Integrated design for tackling safety and security challenges of smart products and digital manufacturing. *CIRP Annals – Manufacturing Technology*.

Rijkers, B., Arouri, H., Freund, C., & Nucifora, A. (2014). Which firms create the most jobs in developing countries? Labour Economics, 31, 84–102. https://doi.org/10.1016/j.labeco.2014.09.003

Roblek, V., Meško, M., & Krapež, A. (2016). A complex view of Industry 4.0. *SAGE Open, 6*(2), 1–12. https://doi.org/10.1177/2158244016653987

Salameh, E. (2021). *Digital transformation: Readiness of the Lebanese manufacturing industry* (Master's thesis, Notre Dame University-Louaize, Lebanon). Notre Dame University-Louaize Institutional Repository.

Salkind, N. J. (2010). *Encyclopedia of research design*. SAGE Publications.

Schmarzo, B. (2017, May 31). What is digital transformation? Schmarzo Blog. https://www.schmarzo.com (Use actual URL if available)

Schuh, G., Potente, T., Wesch-Potente, C., Weber, A. R., & Prote, J.-P. (2014). Collaboration mechanisms to increase productivity in the context of Industrie 4.0. *Procedia CIRP, 19*, 51–56. https://doi.org/10.1016/j.procir.2014.05.016

Schuh, G., Potente, T., Wesch-Potente, C., Weber, A. R., & Prote, J.-P. (2014). Collaboration mechanisms to increase productivity in the context of Industrie 4.0. *Procedia CIRP, 19*, 51–56.

Schuh, G., Potente, T., Wesch-Potente, C., Weber, A. R., & Prote, J.-P. (2014). Collaboration mechanisms to increase productivity in the context of Industrie 4.0. *Procedia CIRP*, 19, 51–56.

Senusi, I. (2023). Workshop launches unified SMEs digital platform. Libya Herald. Retrieved from https://www.libyaherald.com/

Sidabutar, A., & Siswanto, J. (2024). The impact of digital transformation in food and beverage sector SMEs: The role of leadership and organizational agility. In E3S Web of Conferences, 484, 01017. https://doi.org/10.1051/e3sconf/202448401017

Smit, J., Kreutzer, S., Moeller, C., & Carlberg, M. (2016). *Industry 4.0 – Study for the ITRE Committee*. Policy Department A: Economic and Scientific Policy, European Parliament. http://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL_STU(2016)570007_EN.pdf

Spath, D., Ganschar, O., Gerlach, S., Hämmerle, M., Krause, T., & Schlund, S. (2013). *Production work in the Industry 4.0 era: Transformations of work in a digitalised world of production*. Fraunhofer IAO.

Spath, D., Ganschar, O., Gerlach, S., Hämmerle, M., Krause, T., & Schlund, S. (2013). *Production work in the Industry 4.0 era: Transformations of work in a digitalised world of production*. Fraunhofer IAO.

Tan, J., & Wang, X. (2010). The internet of things: A survey. International Journal of Computer Applications, 1(1), 1–7. https://doi.org/10.5120/1-4239-1352

Trappey, A. J. C., Trappey, C. V., Govindarajan, U. H., Sun, J. J., & Chuang, A. C. (2016). A review of technology standards and patent portfolios for enabling cyber-physical systems in advanced manufacturing. *Advanced Engineering Informatics, 30*(4), 546–561. https://doi.org/10.1016/j.aei.2016.07.002

UNCTAD. (2023). *Digital Economy Report 2023: Leveraging digital transformation for development*. United Nations Conference on Trade and Development. https://unctad.org/publication/digital-economy-report-2023

UNCTAD. (2023). *Digital economy report 2023: Leveraging digital transformation for development*. United Nations Conference on Trade and Development. https://unctad.org/publication/digital-economy-report-2023

United Nations Economic Commission for Africa (UNECA). (2022). *Harnessing the Digital Economy in Fragile States*. Addis Ababa: UNECA.

United States. Department of State. (2004). Report to the President: Commission for Assistance to a Free Cuba (Vol. 11164). U.S. Department of State.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, 28(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Vial, G. (2019). *Understanding digital transformation: A review and a research agenda*. The Journal of Strategic Information Systems, 28(2), 118–144.

Wamba, S. F., & Queiroz, M. M. (2022). Managing the digital transformation: Aligning technologies, business models, and operations. CRC Press. https://doi.org/10.1201/9781003226468

Wan, J., Cai, H., & Zhou, K. (2015). Industrie 4.0: Enabling technologies. *Proceedings of the IEEE International Conference on Intelligent Computing and Internet of Things*, 135–140. https://doi.org/10.1109/ICAIOT.2015.7111545

Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. Long Range Planning, 52(3), 326–349. https://doi.org/10.1016/j.lrp.2018.12.001

Weinman, J. (2015). The impact of digital transformation on manufacturing. Journal of Manufacturing Science and Engineering, 137(4), 1–10. https://doi.org/10.1115/1.4030323

Westerman, G., Bonnet, D., & McAfee, A. (2014). Leading digital: Turning technology into business transformation. Harvard Business Press.

Westerman, G., Bonnet, D., & McAfee, A. (2014). Leading digital: Turning technology into business transformation. Harvard Business Review Press.

Wiyono, G., & Kirana, K. C. (2021). Digital Transformation of SMEs Financial Behavior in the New Normal Era. Jurnal Keuangan dan Perbankan, 25(1), 191–211. https://doi.org/10.26905/jkdp.v25i1.4954

World Bank. (2022). *World Development Report 2022: Finance for an equitable recovery*. World Bank Group. https://www.worldbank.org/en/publication/wdr2022

World Bank. (2022). *World Development Report 2022: Finance for an equitable recovery*. World Bank Group. https://www.worldbank.org/en/publication/wdr2022

World Bank. (2023). *Libya Country Digital Development Overview*. Retrieved from https://www.worldbank.org

Wren, H. (2020, December 1). What is digital transformation? Definition, examples, main areas. Digital Innovation Blog. https://www.example.com (Replace with actual URL if available)

Xu, C., Xu, L. D., & Li, L. (2018). Industry 4.0: State of the art and future trends. *International Journal of Production Research, 56*(8), 2941–2962. https://doi.org/10.1080/00207543.2018.1444806

Xu, C., Xu, L. D., & Li, L. (2018). Industry 4.0: State of the art and future trends. *International Journal of Production Research, 56*(8), 2941–2962.

Zhang, M., Zhao, X., & Lyles, M. A. (2018). Effects of absorptive capacity, trust and information systems on product innovation: A supplier perspective. Journal of Business Research, 93, 276–286. https://doi.org/10.1016/j.jbusres.2018.01.051

Zhou, Y. (2013). Simulation in Industry 4.0: Applications and challenges. Procedia CIRP, 7, 1–6. https://doi.org/10.1016/j.procir.2013.06.024

Zuehlke, D. (2010). SmartFactory—Towards a factory-of-things. *Annual Reviews in Control, 34*(1), 129–138. https://doi.org/10.1016/j.arcontrol.2010.02.008

APPENDIX 1. SCALE

Survey on Digital Transformation Readiness in Food and Beverage SMEs in Tripoli, Libya

This survey is adapted from Limani et al. (2019), with modifications to fit the context of digital transformation readiness in food and beverage SMEs in Tripoli, Libya.

Section 1: Demographic Information

1. **What is your gender?**
   - ☐ Male
   - ☐ Female
   - ☐ Prefer not to say
2. **What is your age?**
   - ☐ 18-24
   - ☐ 25-34
   - ☐ 35-44
   - ☐ 45 and above
3. **What is your educational level?**
   - ☐ Grade 12 / Terminal
   - ☐ National and Technical Education (BT, TS)
   - ☐ Bachelor's Degree
   - ☐ Master's Degree
   - ☐ PhD
4. **What is your current position in the company?**
   - ☐ Owner/CEO
   - ☐ Manager (Top, General, Operations, Production, Quality, Regional)
   - ☐ Technician
   - ☐ Supervisor
   - ☐ Quality Officer
   - ☐ Administrative Staff
   - ☐ Other (please specify)
5. **How many years of work experience do you have?**
   - ☐ Less than 1 year
   - ☐ 1-5 years
   - ☐ 6-9 years

- ☐ 10-15 years
- ☐ More than 15 years

6. **What year was the company established?**
   - ☐ Before 1980
   - ☐ 1980-1990
   - ☐ 1990-2000
   - ☐ 2000-2010
   - ☐ 2010-Present

7. **How many employees does your company have?**
   - ☐ Less than 10
   - ☐ 10-50
   - ☐ 51-100
   - ☐ 100-200
   - ☐ More than 200

8. **What is your company's yearly turnover?**
   - ☐ $1 - $100,000
   - ☐ $100,000 - $500,000
   - ☐ $500,000 - $1 million
   - ☐ $1 million - $5 million
   - ☐ Above $5 million

9. **In which countries does your company operate?**
   - ☐ Lebanon only
   - ☐ Multinational (operating in multiple countries)

10. **Does your company have any digital transformation implemented? If yes, what type?**
    - ☐ Yes (Please specify)
    - ☐ No

11. **Does your company have a dedicated team or individual responsible for digital transformation or IT services?**
    - ☐ Yes
    - ☐ No

Section 3: Adoption of Digital Technologies

10. **The company uses digital platforms (e.g., online ordering, e-commerce, social media) to engage with customers.**
11. **Mobile technology (e.g., apps, mobile payments) is effectively utilized to support business operations.**
12. **Cloud computing services are used for data storage, communication, or collaboration.**
13. **Data analytics (e.g., customer behavior analysis, sales forecasting) is used to improve decision-making.**
14. **Artificial Intelligence (AI) or Machine Learning is explored or implemented in business processes.**
15. **Our business processes are automated to improve efficiency.**

Section 4: Business Processes and Integration

16. **Our company has mapped out all key business processes and workflows.**
17. **Our business processes are well-integrated with digital tools (e.g., ERP, CRM, POS systems).**
18. **Do inefficiencies in manual processes impact your company's productivity?**

- ☐ Yes, significantly
- ☐ Somewhat
- ☐ No

19. **How do you measure customer experience and satisfaction?**

- ☐ Surveys and feedback
- ☐ Sales performance
- ☐ No specific method

- ☐ Sales performance
- ☐ No specific method

Section 5: Challenges and Readiness for Digital Transformation

20. **What are the main barriers to digital transformation in your company?** *(Select all that apply)*

- ☐ Lack of funding
- ☐ Resistance to change
- ☐ Lack of digital skills among staff
- ☐ Insufficient IT infrastructure
- ☐ High costs of technology adoption
- ☐ Other (please specify):

21. **Compared to other SMEs in Tripoli, my company is ahead in adopting digital transformation.**
22. **My company collaborates with external partners (e.g., technology companies, business consultants) for digital innovation.**
23. **Have you assessed potential risks in your digital transformation strategy?**

- ☐ Yes
- ☐ No

24. **Do you have plans to upgrade or invest in new technologies?**

- ☐ Yes, within the next 6-12 months
- ☐ Maybe in the future
- ☐ No, not planned
