**Arab American University**
**Faculty of Graduate Studies**
**Department of Administrative and Financial Sciences**
**Ph.D. Program in Strategic Management**

# Strategic Enablers (Quality 4.0, Green Strategies) and Its Impact on Performance (Sustainable Competitive Advantage, Business Performance and Sustainability)

**Mahmoud Awad Allah Daoud Amer**
**202020378**

**Dissertation Committee:**

**Dr. Amjad Al Ghanim**
**Dr. John Lipinski**
**Dr. Madan Batra**

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## Dissertation Approval

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This dissertation was defended successfully on 21.02.2026 and approved by:

Dissertation Committee Members:

| Name | Title | Signature |
|---|---|---|
| 1. Dr. Amjad Ghanim | Main Supervisor | |
| 2. Prof. Dr. John Lipinski | Member of Dissertation Committee | |
| 3. Dr. Madan Batra | Member of Dissertation Committee | |

Palestine, Feb/2026

## Declaration

I declare that, except where explicit reference is made to the contribution of others, this dissertation is substantially my own work and has not been submitted for any other degree at the Arab American University or any other institution.

Student Name: Mahmoud Awadallah Daoud Amer

Student ID: 202020378

Signature: 

Date of Submitting the Final Version of the Dissertation: 5.3.2026

## Dedication

This thesis is dedicated to my beloved parents, whose unwavering support, endless sacrifices, and constant prayers have been the foundation of my academic journey.

To my family (my wife Baraa, my daughters Ronza and Maria, and my son Adam) for their patience, support, encouragement, and belief in me throughout the years of study and research.

And to everyone who inspired me to pursue knowledge with integrity, perseverance, and purpose.

Mahmoud Awadallah Daoud Amer

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**Strategic Enablers (Quality 4.0, Green Strategies) and Its Impact on Performance (Sustainable Competitive Advantage, Business Performance and Sustainability).**

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## Abstract

This dissertation investigates the combined effects of Quality 4.0, Industry 4.0, and Circular Economy (CE) practices on organizational performance, sustainability, and competitive advantage within the Palestinian industrial sector. The study analyzes the mediating roles of organizational resilience and volatile business environments in these relationships. Using a mixed-methods approach, data were gathered through surveys from 217 industrial firms in Palestine and subsequently analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM).

The findings revealed that while Industry 4.0 and Quality 4.0 readiness positively influence organizational resilience, their direct impact on sustainability and sustainable competitive advantage is limited. Similarly, Circular Economy and Green Strategies significantly enhance sustainability and organizational resilience but do not directly improve organizational performance or competitive advantage in the short term. Organizational resilience emerges as a crucial mediator, positively affecting organizational performance and sustainability, although its impact on sustainable competitive advantage is less pronounced. Though the study is anchored in Industry 4.0 and Quality 4.0 technologies, the integrated framework conceptually advances beyond these paradigms by implicitly aligning with the emerging principles of Industry 5.0 and Quality 5.0, embedding sustainability and organizational resilience at the center of technological transformation.

The study emphasizes the importance of an integrated model that combines Industry 4.0, the Circular Economy, and organizational resilience to address the complex challenges industrial firms face in turbulent environments. It provides practical recommendations for policymakers, industry leaders, and academic researchers to promote sustainable development and resilience within the Palestinian industrial sector. Theoretically, this study builds on the Resource-Based View (RBV), Dynamic Capabilities Theory, the Triple Bottom Line, Technology, Organization, and Environment (TOE), and Institutional Theory to better align with the integration of Industry 4.0 and Circular Economy practices.

This research contributes to the literature by providing empirical evidence from a developing economy context and offering actionable insights for improving industrial performance and sustainability through advanced Quality 4.0, Circular Economy, and sustainable practices to achieve sustainability, sustainable competitive advantages, and organizational Performance. Finally, the research model

Keywords: Quality 4.0, Circular Economy, Organizational Resilience, Sustainability, Sustainable Competitive Advantage.

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## List of Definitions of Abbreviations

| # | Abbreviations | Title |
|---|---|---|
| 01 | RBV | Resources-Based View |
| 02 | DC | Dynamic Capabilities |
| 03 | OR | Organizational Resilience |
| 04 | SS | Sustainability |
| 05 | SC | Sustainable Competitive Advantage |
| 06 | DR | Dynamic resilience |
| 07 | CE | Circular Economy |
| 08 | I.40 | Industry 4.0 |
| 09 | Q 4.0 | Quality 4.0 |
| 10 | I.05 | Industry 5.0 |
| 11 | TOE | Technology, Organization, and Environment |
| 12 | TBL | Triple Bottom Theory |

## Chapter Number One: The Introduction

This research study examines the integrated impact of environmental strategies, the circular economy, and the readiness for Quality 4.0 and Industry 4.0 on performance in Palestinian manufacturing firms operating in turbulent business environments. This unique focus aims to intrigue and engage the audience as it explores how these firms understand and implement a circular economy alongside other environmental strategies to achieve their objectives and how the readiness for Quality 4.0 and Industry 4.0 shapes their impact performance.

This research aims to clarify the understanding of the circular economy and environmental strategies, and to offer practical solutions to global concerns about climate change and ecological degradation. It also aims to gauge and measure the mediation relations between turbulent environments and organizational resilience, offering actionable insights for businesses.

The motivation of this research stems from (i) the increased popularity of the circular economy and organizational resilience, (ii) the need to unpack the overlapping concept and identify the theoretical background for circular economy, Industry 4.0, and organizational resilience, and (iii) to obtain empirical test results of well-known strategy theories like the resources-based view theory and its extensions.

The business strategy concept was introduced in the 1950s; since then, many theories have arisen, developed in a Western, developed, stable economic environment. Two well-established business strategy theories were introduced: the Resource-Based View by Jay Barney (1991) and Porter's Five Forces (1985). The applicability of these theories in emerging and turbulent market environments was not well tested, according to the authors of the two main theories, who may require further extension to cover emerging markets and developing countries (Barney, 1991).

The progress in global supply chains and the adoption of advanced technologies, such as the Internet of Things and big data, create new opportunities. However, the rise of environmental protection and sustainability regulations presents additional pressures and challenges that must be integrated into theoretical extensions and business practices.

The extraordinary changes in the global supply chain added a new challenge for SMEs worldwide, influencing developed and developing countries. Likewise, the Russian-Ukrainian War and the impact of COVID-19 closure forced governments and industries to act out of the box to sustain their competitive advantage, (Dwikat et al., 2022, 2023).

Increased production costs due to higher energy, labor, and sea freight costs forced industries to search for alternative, sustainable solutions to remain competitive at the strategic and operational levels (Chomać-Pierzecka et al., 2022; GA Samawi, 2018; Mohsen Alawag et al., 2023). Scarcity of resources added another challenge for industrial sectors worldwide; thus, efficient resource management and adaptation to the circular economy are key to sustaining firms' competitive advantages (McMackin & Heffernan, 2021; Mollet & Kaudela-Baum, 2022).

Increased intention toward sustainability was evident in the global market, where businesses that focused solely on profit are no longer accepted due to pressure from governmental and non-governmental environmental groups. Therefore, the need for environmental protection and the global push toward a green and circular economy added challenges to industrial sectors' efforts to produce eco-friendly products and to enhance social and environmental responsibilities (Mamer, 2023a).

All these dynamics would pressure industrial firms to sustain their competitive advantages through flexible green strategies, which can be achieved through continuous updates to their operational and strategic strategies. However, the potential of green strategies to achieve a competitive advantage and a good level of stakeholder satisfaction, particularly among environmentally sensitive stakeholders, should be a source of optimism for the future (Rama et al., 2022).

The Palestinian context is unique in terms of additional external challenges resulting from the Israeli occupation, the movement restrictions, and import and export restrictions. Hence, the World Bank estimated the annual losses of the Palestinian economy due to the existence of Israeli occupation at around 3.5 billion USD, representing more than 22% of the Palestinian GDP (Gross Domestic Product). Additionally, the Palestinian National Authority was established after the signing of the Oslo Accords between the Israeli Occupation and the Palestinian Liberation Organization (PLO) in 1993. The economic

annex (Paris Protocol, a part of the Oslo Accords that regulates economic relations between Israel and Palestine) made the Palestinian economy depend on the Israeli economy through the same tax shell without considering the significant gaps between the two economies.

The three main challenges faced by SMEs, in general and in Palestine, are internal, external, and industry-specific. The external challenge is somehow a common challenge regardless of the SME sector, as it is related to the political situation, including the Israeli occupation restrictions and the Oslo accord-related issues and business environment, and the economic restriction and governmental interventions as a result of Israeli Occupation, which has a severe negative impact on the economic environment of Palestine, (UN, 2022). However, Palestinian SMEs' unique challenges underscore the need for specific solutions, highlighting the urgency and importance of the research.

The second main challenge is the industrial structural challenges, including regulations, standards, and guidelines that govern Palestinian industrial sectors. Different studies of Palestinian industrial sectors revealed that, in general, SMEs, and industrial SMEs in particular, suffer from non-regulated sectors and family-based small SMEs. These common industrial challenges are also affected by Israeli occupation restrictions regarding the movement of goods, as well as Palestinian-related standards and regulations. Nevertheless, these challenges are shared among all Palestinian SMEs (UN, 2022).

The market instability resulted from the political situation, Israeli occupation, technological advancement, innovations, eco-environmental increased awareness and competitiveness in the turbulence and dynamic business environments severed the sustainability of the firms and added additional pressure on the top management of these firms to improve their firms' sustainable performance by adopting strategies at strategic and tactical levels, (Dwikat et al., 2022).

The last challenge concerns internal challenges related to SMEs' operations and strategies for maintaining and improving their sustainable positions (Morrar & Gallouj, 2016; Robert & Brown, 2004; S. S. Sultan, 2014).

The potential of a circular economy, green supply chain, green strategies, and the utilization of Industry 4.0 and Quality 4.0 is immense. These technological advancements and the

Internet of Things could lead to sustainable competitive advantages and significant sustainability results, inspiring optimism for the future of industrial performance.

The circular economy is characterized by recycling, reuse, and waste reduction. Figure 1.1 below represents the circular economy framework. It is worth noting that the circular economy is a firm and industry/cluster-based strategy.

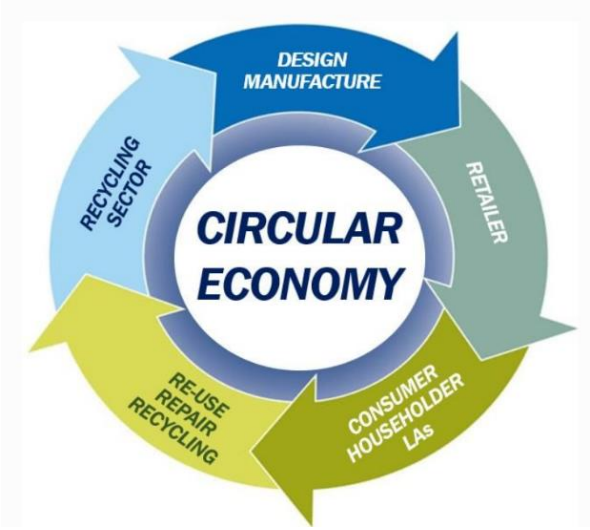


Figure (1.1): Circular Economy Conceptual Framework

Previous research has explored the circular economy, organizational resilience, and Industry 4.0/Quality 4.0, examining their overall effects on sustainability and performance. In contrast, this thesis focuses on the benefits of a green, circular economy and the readiness and maturity levels of Industry 4.0/Quality 4.0 for Palestinian SMEs amid a constantly changing, turbulent environment. It also underscores potential advantages that have not been previously examined in the literature.

Palestinian SMEs, primarily family-run businesses, are crucial to the nation's growth. They operate in various industrial sectors, including food and beverages, leather and footwear, stone and marble, construction materials, textiles, and pharmaceuticals.

Of the more than 1,005 registered industrial firms, according to the official register of the Ministry of National Economy, 97% or more are family businesses, which are characteristic of small and medium enterprises. These industrial SMEs operate across

various industrial sectors, including food and beverages, leather and shoes, stone and marble, construction materials, textiles, and Pharmaceuticals (Ministry of National Economy, MONE statistical reports, 2020).

The published literature on Palestinian SME sectors is limited, focusing on shaping the characteristics of industrial SMEs and their impact on performance levels. Most of these were focused on Total Quality Management (Altayeb & Alhasanat, 2014; Baidoun, 2004; A. Herzallah et al., 2017; A. M. Herzallah et al., 2014; Zaid et al., 2021)and different concepts like the KAIZEN, Six Sigma, ISO 9001 (Mamer, 2023b), Halal certification (Mamer, 2023c), Green Innovation (Kanan et al., 2023), and Human Capital Management (Dwikat & Arshad, 2023; Kanan et al., 2023).

The Palestinian industrial firms are characterized as small and medium as well as family businesses (S. Sultan et al., 2017; S. Sultan & Sultan, 2020), in which the structure of family businesses directly and indirectly impacts firms' performance, sustainable competitive advantages, and sustainability.

The Palestinian industrial sector faces challenges, including higher production costs than those in neighboring regions. To address these challenges and ensure sustainability, innovative approaches and interventions, including resource efficiency, operational excellence, Quality 4.0, Industry 4.0, technological adoption, and circular economy practices, are essential.

Despite the scattered efforts, the results of most of these funded programs, like the MED TEST II and MED TEST III, Green Forward Industries funded by UNIDO, Green Industries (GIZ Funded Project) revealed that resource efficiency, energy management, and green and circular economy initiatives positively contribute to improving the Palestinian industrial SMEs' competitive position through the adoption of environmentally friendly solutions that reduce operational and production costs. [1]Thus, Palestinian industrial firms must adopt good manufacturing practices and environmentally friendly solutions to achieve sustainability and improve business performance.

[1] https://www.test-toolkit.eu/best-practices/

The concepts of circular economy, organizational resilience, and Industry 4.0, along with their impact on firms' performance, are newly addressed in the literature. Growing empirical research across various contexts has revealed a positive relationship. However, these concepts remain in the inductive research phase, with limited attempts at theorization. They utilize rigorous, well-established theories from strategy and organization, such as the resource-based view, the triple bottom line, and dynamic capabilities.

As a scientific term, resilience means the ability to "bounce back." The term was initially introduced in ecology by Holling (1973), who defined resilience in that context. Building on Holling's efforts, the term resilience was introduced in several areas of research, (Tennakoon and Janadari 2021). Organizational resilience is characterized by how organizations respond to uncertainty. (Tennakoon and Janadari 2021).

Green, resilience, and other strategies require resources to be effective and are linked to qualified, dynamic human resources to achieve the intended results. (Dwikat, Arshad, and Mohd Shariff 2023). Nevertheless, it is worth mentioning that the Palestinian economy is most likely characterized by resilience and competent human resources. Therefore, an empirical effort might be needed to formulate and test such a relationship.

This thesis is the author's attempt to close a literature gap in the circular economy, green strategies, green supply chain, and the holistic impact of Industry 4.0 on performance. Building on (Ghaithan et al., 2023a Luu et al., 2023; Patyal et al., 2022), The literature suggests a positive relationship and correlation between business enablers and organizational performance. Hence, previous efforts revealed a positive relationship. For instance, the circular economy and lean techniques positively impact performance. (Ghaithan et al., 2023b).Industry 4.0 has had a positive impact on the supply chain performance. (Filho et al., 2022a)

(Shayganmehr et al. 2021) They proposed a general, integrated framework that combined Industry 4.0, quality practices, and circular economy practices, and identified positive relationships among them. Al-Swidi, Hair, and Al-Hakimi 2023) empirically tested the relationship between Industry 4.0 and circular economy capabilities.

The study, through its methodology, answered the following main and sub-questions;

(1) What is the level of Industry 4.0 Readiness in the Palestinian Industrial Sector?
    a. What is the readiness and maturity level based on the IMPLUS framework?
    b. What is the readiness level of Quality 4.0 in the Palestinian industrial sector?
(2) Are quality 4.0 and industry 4.0 positively influencing sustainable performance, Business Performance, and Organizational Resilience?
(3) Do green strategies and the circular economy positively influence business and organizational performance, sustainable performance, and organizational resilience?
(4) Does Organizational Resilience mediate the effect between (Quality 4.0, Circular Economy) and Performance (Sustainable Performance, Organizational Performance)?
(5) Does Quality 4.0 Mediate the Effect of Circular Economy and Performance (Sustainable Performance and Organizational Performance)?
(6) Are RBV and dynamic capabilities theories applicable in the Palestinian context of "manufacturing SMEs"

## 1.1 Importance of the Study

On the one hand, the study's novelty lies in introducing new terms and theories, such as the circular economy and organizational resilience, within a unique business environment (the Palestinian context).

Furthermore, integrating environmental strategies with advanced management enhanced sound environmental practices, adding value to this thesis. It is essential to test the theoretical relationship between environmental practices and performance.

On the other hand, the study utilized the applicability of management and strategy theories, such as the Resource-Based View (RBV), alongside results from natural resource extensions and dynamic capability theory. Ultimately, the significance of this study lies in exploring the role of Organizational Resilience as a mediating variable, given that the literature acknowledges it in this capacity only minimally. Furthermore, the introduction

of dynamic resilience represents a new concept that could develop into a theory in the future.

### 1.2 Justifications of the Study

This study is unique in its attempt to holistically assess the comprehensive impact of management and environmental practices on performance. No previous published studies/articles have linked environmental and quality practices, sustainability, and the circular economy.

The study would also gauge and review the current related management theory and try to impose new dimensions related to a circular economy and green practices on these theories, for example, the knowledge-based view or the results-based view dimensions for results-based view theory, and the green environmental view as a new dimension to Porter's five forces, as well as RBV theories.

Finally, the study introduced dynamic resilience as an extension of organizational dynamic theory, linking organizational dynamic capabilities with resilience capabilities and performance.

### 1.3 Problems of the Study

Previous studies have not shed light on the linkage between strategies, Environmental strategies, and sustainability. A few publications tried to link one or more of these aspects without a holistic view. As there is a Gap in the literature linking strategies to sustainability, especially in developing and/or emerging markets, this Thesis would help close this gap.

Moreover, the proposed thesis would test the applicability of RBV and Dynamic Capabilities Theories in developed and emerging markets and their linkage with organizational resilience and turbulent business environments.

This study aimed to view different strategic aspects holistically, including green strategies and their impact on sustainability. It also sheds light on various business theories and their applicability to turbulent business environments, such as those in the Palestinian context.

### 1.4 Study Limitation:

The study faced many limitations: (1) research design limitation, as this study followed the cross-sectional research design; thus, generalization of the results to other contexts is questionable, and it is limited to the Palestinian context in the study era; (2) contextual limitation, as it is limited to the Palestinian context. The study's results could be applied in the Palestinian context.

### 1.5 The Research Process and Structure of Research:

The research process depicted in Figure 1.2 below was neither linear nor sequential, yet it summarizes the thesis flow.

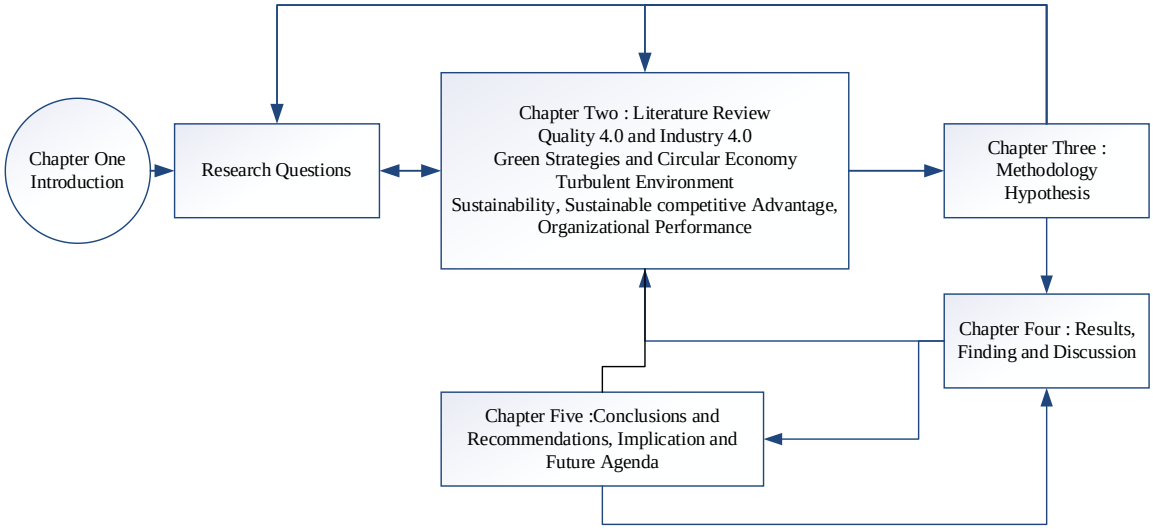


Figure (1.2): Research Process and Thesis Structure.

Chapter one (this chapter) introduces the concept, gives an overview of the Palestinian industrial sector, and includes the research questions. These questions are crucial as they guide the entire research process and aim to address key issues in the context of sustainability, circular economy, and quality management in the Palestinian industrial sector.

Chapter two of this thesis reviews the literature on the circular economy, green strategies, Industry 4.0, Quality 4.0, sustainability performance, turbulent environments, and dynamic human resources.

Chapter three outlines the research methodology used to explore the integration of Circular Economy (CE) and Industry 4.0 (I4.0) technologies, and their impact on sustainability. The study adopts a mixed-methods approach, combining both qualitative and quantitative methods. The research begins by establishing hypotheses, such as the positive relationship between Industry 4.0 technologies and the adoption of Circular Economy principles, and the impact of this integration on firms' sustainability performance. Data were collected from a sample of Palestinian industrial firms. The chapter explains the design of the research instruments, such as the questionnaires used for data collection. For quantitative data, statistical techniques such as regression analysis are applied using PLS-SEM, while qualitative data is analyzed through thematic coding. Ethical considerations, including informed consent and data confidentiality, are addressed to ensure the integrity of the research. Additionally, the study's limitations, including potential sample bias and the generalizability of its findings, are acknowledged.

Chapter four presents the research results, providing a detailed analysis of both quantitative and qualitative data. The quantitative section includes descriptive statistics and hypothesis testing to demonstrate the impact of Industry 4.0 technologies on the adoption of Circular Economy principles. Charts and graphs illustrate key findings, such as the correlation between I4.0 integration and improvements in sustainability outcomes. Common themes include the operational challenges of implementing digital technologies for circular processes and the perceived long-term benefits, such as increased resource efficiency and reduced waste. The results section also compares findings across sectors or firms, identifying trends in the adoption of these strategies. The chapter summarizes the main findings and clarifies whether the data support the hypotheses. The results indicate a brief overview of the findings.

Chapter five discusses the broader implications of the results and offers recommendations for industry practitioners, policymakers, and academics regarding the applicability of well-established strategy theory to the Palestinian context and the need to develop new theoretical extensions. The findings contribute to the theoretical understanding of how Industry 4.0 technologies can enhance Circular Economy practices, with significant

implications for sustainability, organizational performance, and sustainable competitive advantage.

Finally, chapter five summarizes the need for further extension of current related management and strategy theories, such as the RBV, Institutional Theory, and the TEO model. It also discusses the limited previous attempts to generate new theories, such as the circular economy theory.

## 1.6 Chapter Conclusion

This chapter introduced the research background, objectives, and conceptual framework of the study, positioning it within the growing need for industrial firms to balance sustainability requirements, technological transformation, and performance improvement under turbulent business conditions. The study proposed an integrated perspective linking environmental strategies, circular economy practices, and readiness for Quality 4.0 and Industry 4.0 to organizational resilience and performance outcomes in Palestinian manufacturing SMEs.

The chapter highlighted the limitations of traditional strategic management theories in unstable, emerging economic environments and emphasized the need to reassess them in the Palestinian context, characterized by political uncertainty, economic constraints, and structural industrial challenges. These conditions make resilience, innovation, and resource efficiency essential capabilities for sustaining competitiveness.

The introduction also addressed the global shift toward environmentally responsible production and digital transformation, presenting circular economy practices and Industry 4.0 technologies as complementary mechanisms that enhance operational efficiency and sustainable value creation. Despite growing scholarly attention, their combined influence remains underexplored, particularly in developing economies.

The chapter identified key research gaps and justified the study’s contribution by extending theoretical perspectives, such as the Resource-Based View and dynamic capabilities theory, while introducing organizational resilience as a mediating mechanism. Finally, it outlined the research questions, the study's significance, limitations, and the thesis structure, providing a foundation for the next chapter.

# Chapter Two: Literature Review

## 2.1 Introductions:

This chapter plays a crucial role in identifying the various influences from different fields of knowledge and their sub-disciplines that are currently shaping the circular economy, quality 4.0, and organizational resilience. This identification is paramount as it provides a comprehensive understanding of these concepts and their relevance to the research topic of sustainability in the Palestinian industrial sector.

As a result, this chapter explores both the academic and the non-academic literature used to understand these topics. We have relied on published reports by NOGs, Consultants, and private-sector organizations, as well as on electronic research databases such as Scopus and EBSCO, to ensure the credibility of our sources.

Carrying these efforts, identify the theories, concepts, and frameworks that better describe the circular economy (CE), organizational resilience, and quality 4.0 and industry 4.0, which will shape the general understanding of these concepts and their detailed variables. The concept of the circular economy is often confused with other concepts, such as the green economy, the collaborative economy, and the enabling economy.(Anisuddin 2020).

This chapter thoroughly summarizes the most recent related literature review using bibliometric and systematic literature. It covers all the thesis model variables, ensuring a comprehensive understanding of the topics.

A systematic literature review based on the PRISMA framework was conducted using the well-known Scopus database. Systematic literature review tables summarize articles related to each variable and are generated with proposed dimensions.

This chapter summarizes theories such as the TOE, RBV, and dynamic capabilities. These are analyzed in depth in chapter three of this thesis.

## 2.2 Systematic Literature Review PRISMA and Bibliometric Analysis:

This systematic literature review used the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. This methodological choice, along with the use of the Scopus database and specific keywords for literature reviews, ensures the rigor and Reliability of the review process.

The selection of Scopus is justified as Scopus includes most of the World of Science's well-known journals (Mongeon & Paul-Hus, 2016), methodology, which states, “Scopus includes most of the journals indexed in “World of Science: WoS.”

The title, abstract, keywords, authors' names, affiliations, journal name, and year of publication were exported to an Excel sheet, which served as a PRISMA checklist. A review screened the titles and abstracts of records that did not address the issue; these records were excluded. Then, a full-text review of the remaining records was conducted (Booth, 2016; Petticrew & Roberts, 2006; Pickering & Byrne, 2014).

Bibliometric analysis examines trends in research fields and academic production and is also used to study citations for academic promotion, academic positions, and decisions to obtain research funds. (Alsadi et al. 2023, 2024). This study used basic bibliometric analysis parameters: number of articles, number of citations per paper, and the average citation per year, as the number of citations measures the quality of the publication. (Bornmann and Haunschild 2017).

The VOS viewer software offers the R-studio with a bibliometric component, as described and developed by (Aria and Cuccurullo 2017)  Both tools provided an excellent platform for visualizing bibliometric analyses, including primary authors, countries, institutions, and co-citations. This facilitates comprehensive and visual analysis for a deeper understanding, (Alsadi et al. 2024).

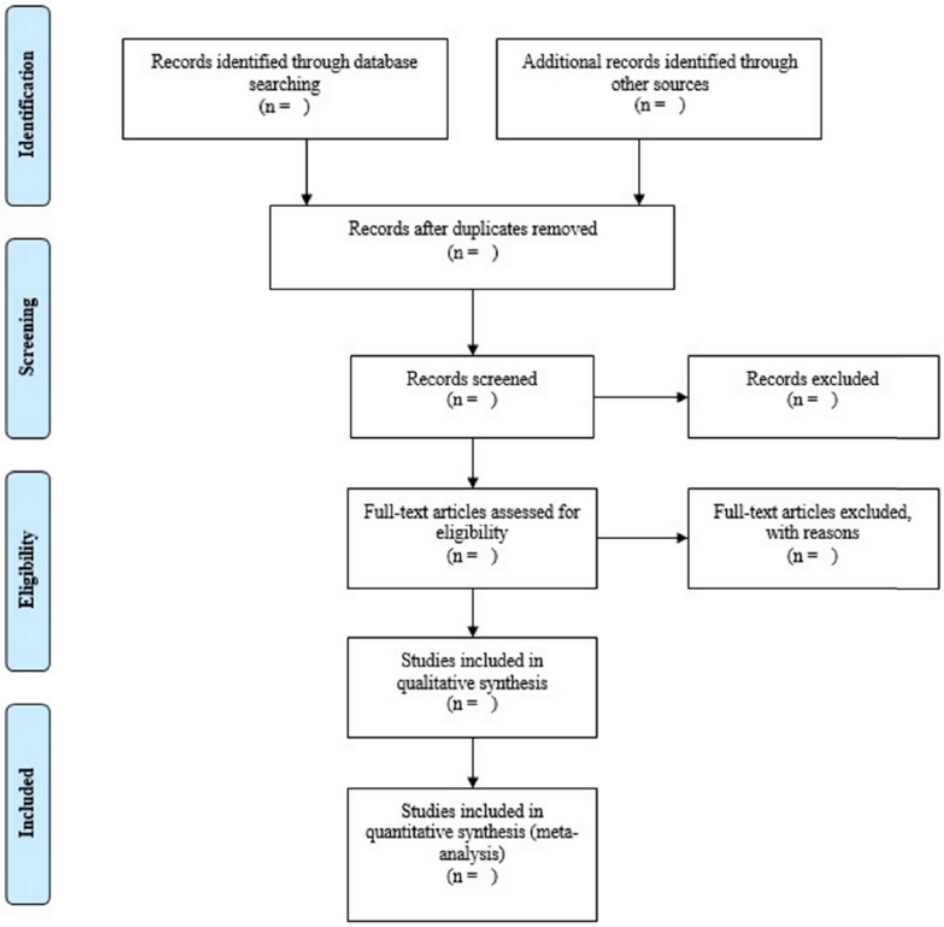


Figure (2.1): Prisma Systematic literature review methodology.

## 2.3. Q.04 (Quality.04 Literature Review:

### 2.3.1 Industry 4.0 (I 4.0)

Industry 4.0 refers to the fourth industrial revolution, characterized by cutting-edge technologies. Hannover Messe introduced the fourth industrial generation concept to the literature in 2011 at the International Economic Forum in Germany.

The first industrial revolution began in the UK in the eighteenth century, characterized by the invention of steam machinery; the second industrial revolution in the nineteenth century introduced electricity and was characterized by its widespread use. The third industrial revolution was characterized by the transition from analog to digital electronics. Therefore, the dependence on electronics was the main characteristic of this era, (Ooi, Ng, and Cheong 2023).

Thus, they were more dependent on electronic devices than electrical ones, and electronics were used to control electrical machines.

Industry 4.0 has recently received much attention in the literature, indicating its importance. Figure 2.2 below shows the annual publication of Industry 4.0 in the Scopus database.

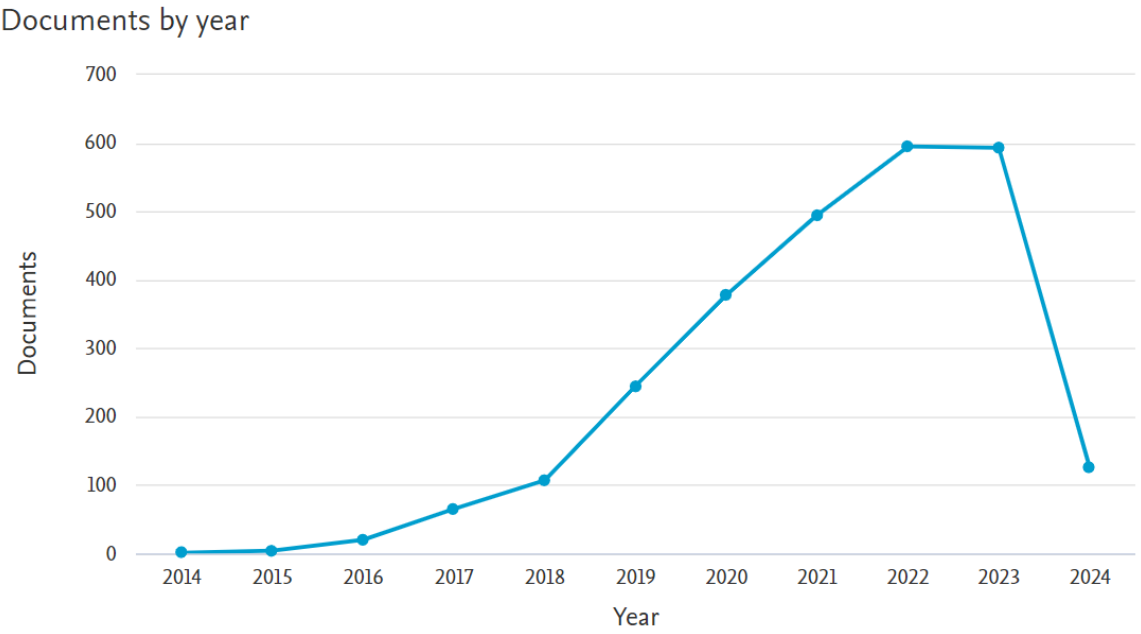


Figure (2.2): I.4.0 publication in Scopus database,

From the broader field of industry, 4.0 has emerged many subfields of research, like the agricultural 4.0 (Varella et al. 2024), quality 4.0 (Sader, Husti, and Daroczi 2022)Supply chain 4.0, (Ismail et al. 2024)and Lean 4.0, (Siphoro et al. 2020; Sun and Chu 2022).

The Industry 5.0 concept is emerging now. The main characteristics of Industry 5.0 over Industry 4.0 are the introduction of management flexibility and agility, as well as human-centric sustainability and resilience; figures (2-03) below illustrate the distinctions between each industrial revolution. Industry 5.0 is a relatively new research field, with fewer than 20 published articles by mid-2024 (Hattinger & Stylidis, 2023). Hence, through the general proposed model, our study considers Industry 5.0, which merges sustainability and resilience with the 4.0 and 4.0 quality concepts.

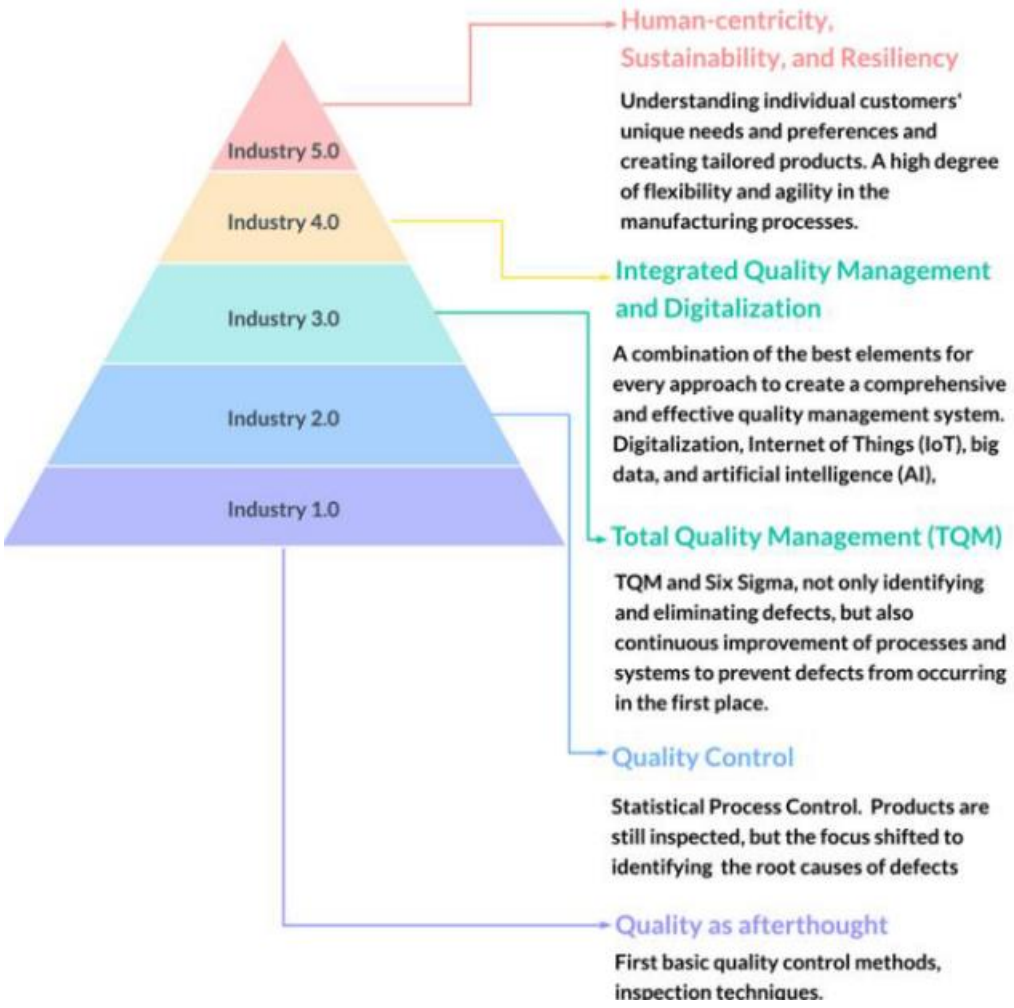


Figure (2.3): Evolution of Quality, (Hattinger & Stylidis, 2023, P:1602)

Generally, the field of Industry 4.0 research is still virgin compared with other industrial and management fields. For instance, total quality management, in which both inductive and deductive research are essential for introducing and testing theories.

Quality 4.0 is conceptually and theoretically linked to Industry 4.0 (Hattinger & Stylidis, 2023; Ismail et al., 2024). Any advancement in the concept of Industry 4.0 will likely have a corresponding impact on Quality 4.0. Similarly, the emergence of Industry 5.0 has begun to influence the development of Quality 5.0 concepts (Hattinger and Stylidis 2023; Ismail et al. 2024)

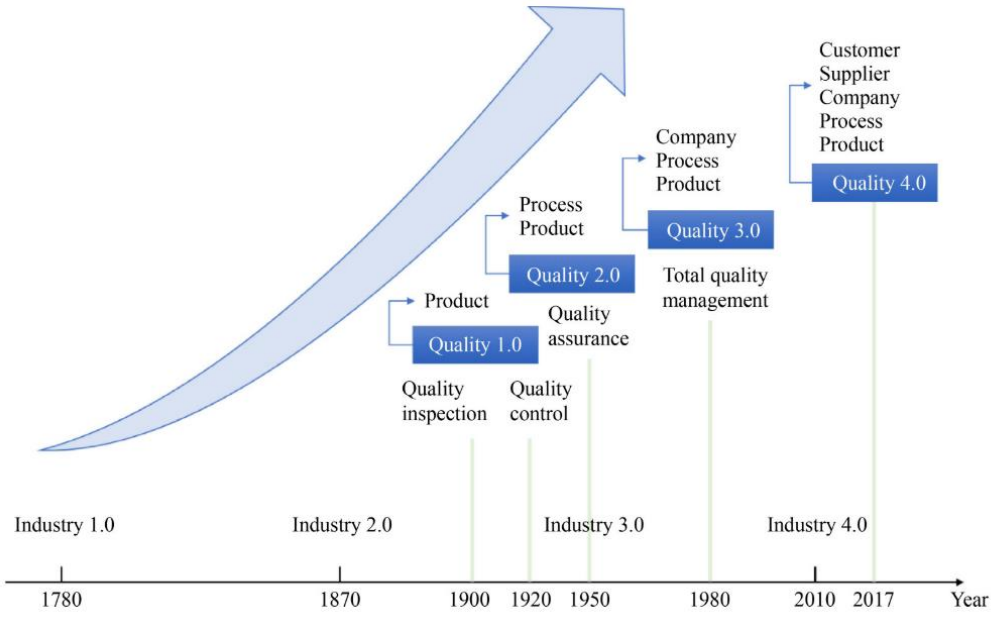


Figure (2.4): Evolution of quality 4.0 and industry 4.0, (H. C. Liu et al. 2023)

### 2.3.2 Quality 4.0 (Q 4.0)

Quality 4.0 is an emerging total quality management concept that has recently gained more attention due to increased customer requirements, changes in the business environment, and the impact of advanced technologies (H. C. Liu et al., 2023). The literature revealed that quality 4.0 (Q4.0) is a specific concept that emerged from Industry 4.0 with quality management. (Armani et al., 2020; Athooli, Dayanandan, and Elsaman, 2023). Moreover, there is no universally agreed-upon definition of the quality 4.0 concept (Sader et al., 2022). Q4.0 is defined as the merger between TQM practices and enabling technologies. Likewise, Dias, Carvalho, and Sampaio 2022) defined it as offering quality services and products by utilizing new technologies (Chiarini & Kumar, 2022). Defined quality 4.0 as customer-centric, merged with digital techniques. Chiarini (2020) defined quality 4.0 as the digitalization of TQM. Nevertheless, the most appropriate definition is the one offered by (Liu et al. (2023, p. 10)

*"The fourth quality management evolution phase is a framework applying cutting-edge technologies in the quality management activities of an organization to attain excellence in quality, enhance enterprise efficiency, and improve performance."*

Quality 4.0 comprehensively utilizes new technologies alongside total quality management practices to achieve operational excellence. It employs big data, artificial intelligence, and blockchain, (Mittal et al. 2024; Nenadál et al. 2022) Quality 4.0 is regarded as the new revolution in management and strategy. Big data, cloud computing, business analysis, and artificial intelligence are tools and approaches businesses use to address new challenges, such as dynamic customer needs, sustainability challenges, and changes in environmental regulations. (Singh et al. 2023)and to achieve operational excellence (Mittal et al. 2024).

Consequently, implementing traditional quality management practices without integrating Industry 4.0 can be perceived as inflexible, potentially restricting firms' ability to navigate dynamic environments and attain superior operational performance. Thus, integrating TQM with Industry 4.0, called Quality 4.0, offers a more advanced approach than traditional TQM alone (Mittal et al., 2024; Nenadál et al., 2022).

### 2.3.4 Bibliometric Analysis of Quality 4.0:

According to Scopus, most publications in the fields of Quality 4.0 were concentrated in 2023 and 2024, as shown in Figures 2.5 and 2.6.

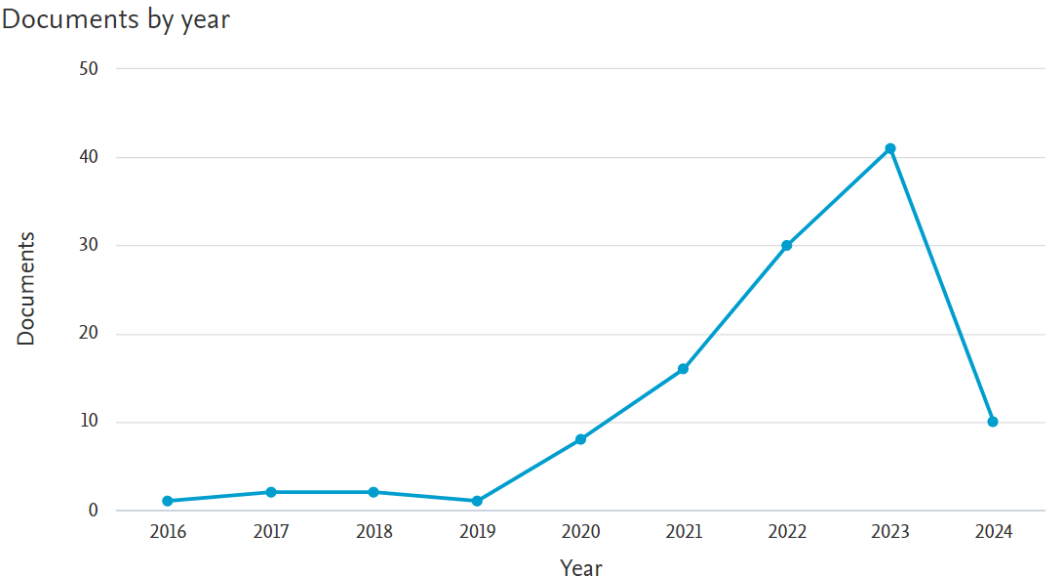


Figure (2.5): Scopus Database Quality 4.0 Chronological Publication.

Ten authors contributed to over 50% of the related publications, as shown in Figure 2.6. Notably, these publications were not dominated by developed countries. More than 50% of the research in this field originated from developing countries such as the United Arab Emirates, Pakistan, and India, as shown in Figure 2.6 (author's research).

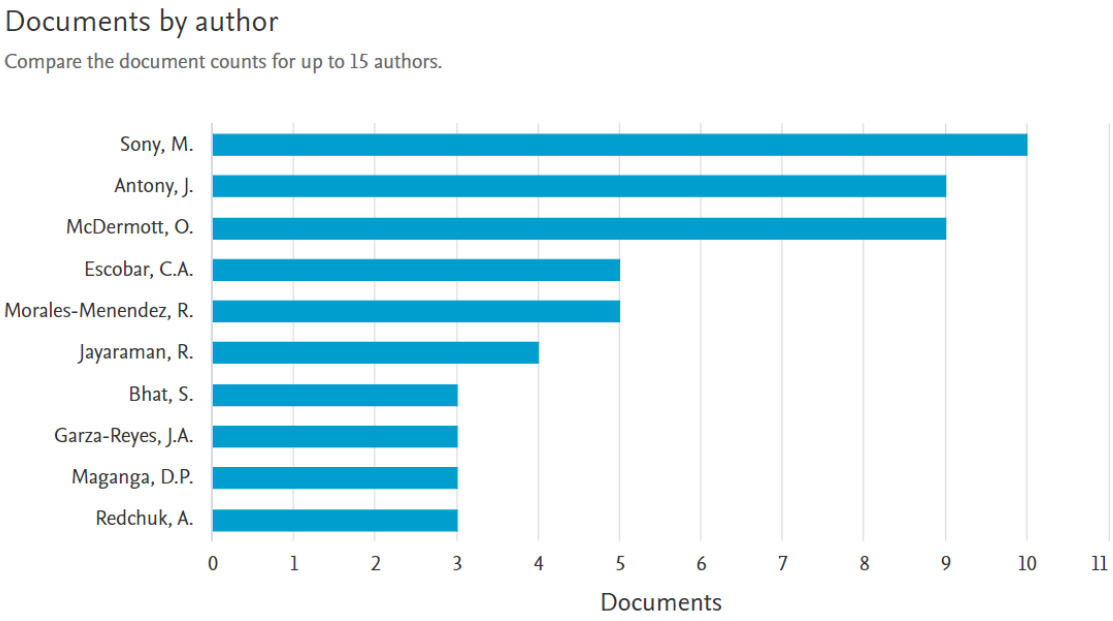


Figure (2.6): Publication per author in the field of quality 4.0.

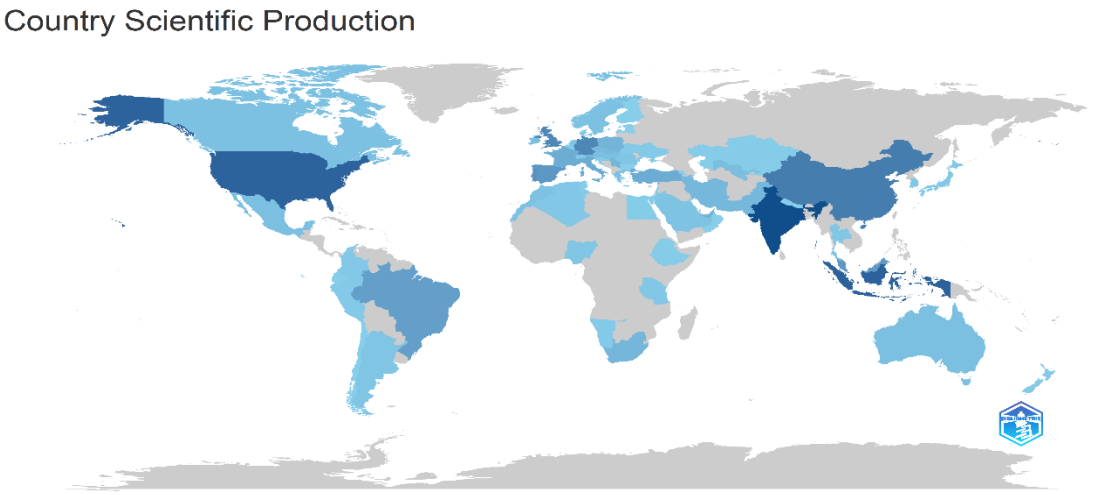


Figure (2.7): Publication per top 10 countries.

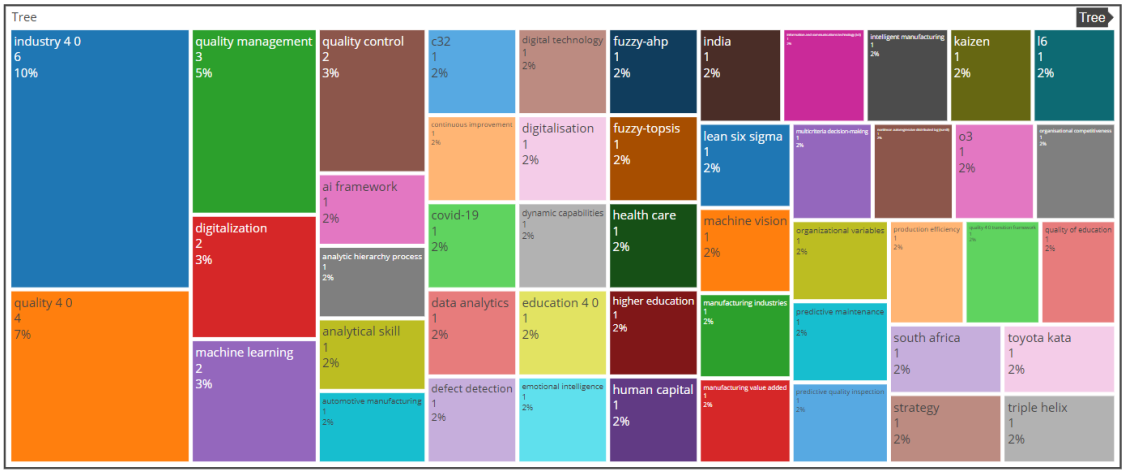


Figure (2.8): Keywords in quality 4.0 Scopus publications.

As shown in the figure above, a bibliometric analysis of "Quality 4.0" as a key term in the Scopus database identifies the keywords most frequently used in the Quality 4.0 literature. The study indicates that "quality," "innovation," "strategy," and "TQM" are the most commonly employed terms within the Quality 4.0 body of knowledge.

### 2.3.5 Systematic Literature Review and Analysis of Quality 4.0

The related literature was identified, screened, and included according to the PRISMA general framework described in Figure 2.1 above. Only 30 articles were included in the qualitative synthesis, as shown in Figure 2.9. These articles are summarized in Table 2.1 below.

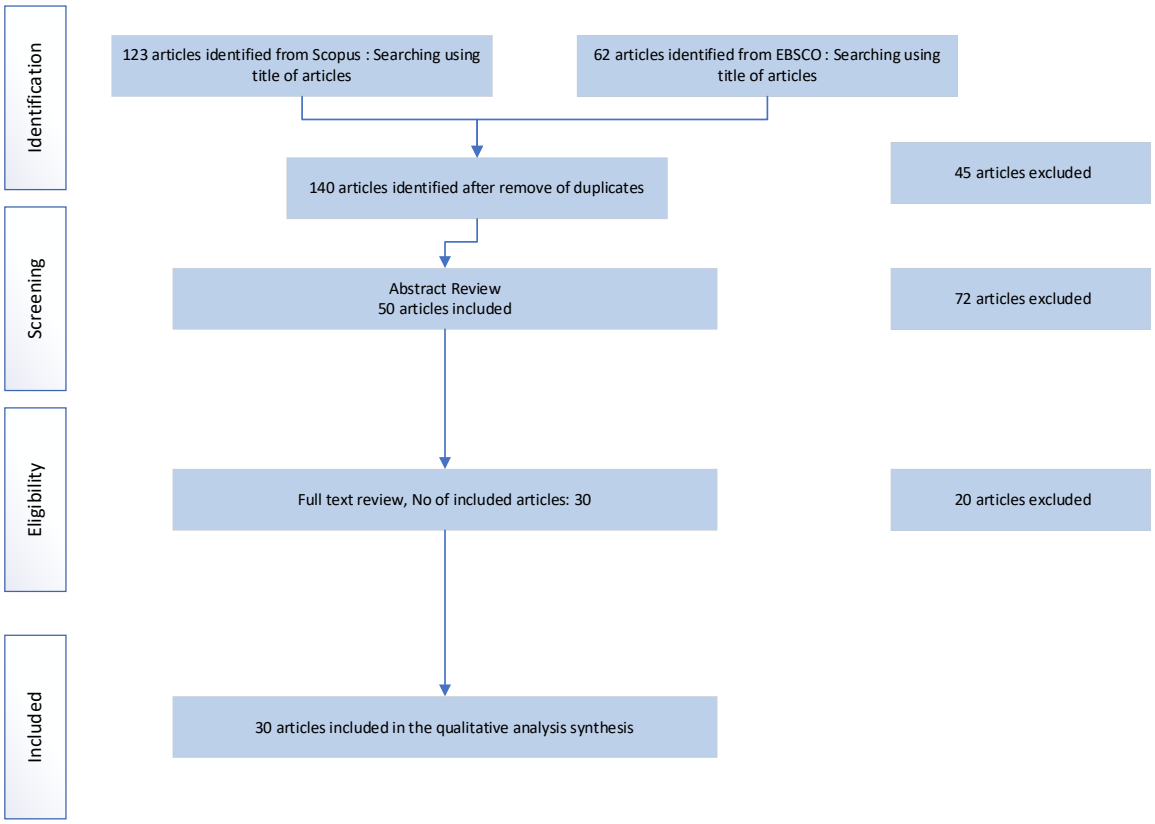


Figure (2.9): Articles Included in the qualitative synthesis

The following table summarizes the systematic literature review of Quality 4.0, including research on the PRISMA methodology.

Table (2.1): Systematic Literature review of quality 4.0.

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Hattinger and Stylidis 2023) | Concept Paper | Fostering circular economy concepts needs a data-driven system. However, these systems should address the human-centric requirement to achieve operator resilience. Hence, this paper introduces the concept of Industry 5.0 | It is recommended that the focus be balanced between data technology and human-centric issues to achieve operator resilience. | X | | | | | | | | | |
| (Fonseca, Amaral, and Oliveira 2021) | Systematic Literature Review-PRISMA | 111 articles reviewed related to EFQM and Industry 4.0, the paper concluded that the newest version of the EFQM model had adopted Industry 4.0 within its ecology system and evaluation creation | As the current research is inductive. Thus, empirical research is recommended to confirm the results. | | X | X | | | | | | | |
| (Swarnakar et al. 2023a) | Qualitative- Expert Opinion from developed and | This Study tried to shape and highlight the Q4 implementation benefits and obstacles | The current study can be explored in more detailed case studies | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | developing countries. | | | | | | | | | | | | |
| (Zulfiqar et al. 2023a) | Quantitative through a survey | The suggested developed tool captured the readiness as applied in six companies. | Firms wishing to assess their ability and quality 4.0 readiness should use the tool. Moreover, the tool can be further empirically tested to enrich the literature. | X | X | X | X | | | | | | |
| (Sader et al. 2022) | Literature Review | This article is unique in that it defines and describes the extinction of quality 4.0. The results showed that much of the literature still mixes quality 4.0 and industrial 4.0. The article summarized many of the key success factors that can be further empirically tested | It is recommended that empirical research be conducted further to test these key success factors. | X | X | X | | X | X | X | | | |
| (Siphoro et al. 2020) | Quantitative | This paper is among the most important, as it provides a general transition framework from quality system | The paper recommends starting with quality management systems and | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | practices to Industry 4.0/quality 4.0 practices. | practices and then moving to quality 4.0 practices. | | | | | | | | | | |
| (Zulqarnain, Wasif, and Iqbal 2022a) | Quantitative | The paper proposed a framework for implementing quality 4.0 based on Juran's quality concepts. The framework was empirically tested in the Pakistani context; the results showed that quality 4.0 is not well enhanced in Pakistani industries. Finally, the adoption of one dimension of quality 4. o resulted in the adoption of other dimensions | It is recommended to conduct the research in other developing countries | X | X | X | X | x | X | X | X | χ | |
| (Antony, McDermott, and Sony 2022) | Literature review | The paper summarized the recently published literature on quality 4.0 and its impact on performance. Hence, it was found that performance measurement is assessed across financial, customer, internal operational | This study recommends conducting an empirical analysis to determine the impact of quality 4.0 on each performance aspect. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | processes, learning and growth, and environmental and social performance. The results of the literature analysis showed a positive correlation between quality 4.0 and performance. | | | | | | | | | | | |
| (Mtotywa and Dube 2023) | Quantitative Study | The quality 4.0 maturity index was used to assess the impact of quality 4.0 on sustainable competitive advantage in South African mining industries. | From a practical point of view, developing country firms need to focus on quality systems with a technological flavor. Moreover, it is recommended that the same study be conducted in other mining industries to establish benchmarks. | X | X | X | X | X | X | X | X | | |
| (Mtotywa 2022) | Concept paper | The paper reviewed the quality 4.0 assessment index and proposed an index to test operational performance. | The study recommends using the quality 4.0 maturity matrix to assess quality 4.0 | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | maturity and its impact on performance. | | | | | | | | | | |
| (Chiarini and Kumar 2022) | Qualitative and quantitative | The qualitative phase involved interviews with industrial and consulting departments from different Italian firms to develop a quality 4.0 framework, which was empirically tested in the quantitative phase. The main result was the quality 4.0 framework; the framework is well organized and characterized under three themes (people, process, technology) | Given search limitations, conducting further research in other Italian contexts is recommended. | X | X | X | X | X | X | X | X | X | X |
| (Hassoun et al. 2023) | Literature review | Industry 4.0 can revolutionize food manufacturing quality and performance. It offers various forms of automation, smart sensors, and robotics for the food industry. | It is recommended that further literature research be conducted on food quality 4.0, exploring more databases beyond Scopus. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Singh et al. 2022) | Case study | The study compared performance before and after implementing Industry 4.0 technologies in the quality control of an automobile production company. It revealed a positive impact on performance. | As the current study is limited to one aspect of the auto industry (hub bolt products), it is recommended that Industry 4.0 be studied across the whole industry. | | | | | X | | | | | |
| (Antony, McDermott, et al. 2023) | Qualitative | The study provides a theoretical base for adopting quality 4.0 and identifies the challenges and key success factors for such programs.<br>The paper offered a quality 4.0-readiness framework for measuring 4.0 readiness. | A longitudinal study or case study should be conducted accordingly. Further studies to include developing countries' motivation toward quality 4.0 | | | | | | | | | | |
| (Antony et al. 2024) | Qualitative | The study found that many critical failure factors could affect Quality 4.0 programs, including the high cost of | Quality 4.0 is a new topic not supported by any educational program, so it opened the | X | X | X | X | X | X | X | X | X | X |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | programs and technologies, inadequate leadership support, and employee resistance to change. One of the remarkable results was the relationship between quality system implementation and quality 4.0 maturity. | door for academic institutions to offer quality 4.0 programs that support its implementation within organizations. | | | | | | | | | | |
| (Antony, Swarnakar, et al. 2023) | Qualitative-interviews 15 | Early Quality 4.0 adopters outperformed later adopters. Quality 4.0 had the highest impact on social performance. | Empirical research is recommended to support the current findings. | | | | | | | | | | |
| (Antony, Sony, et al. 2023a) | Qualitative by seeking the opinion of 147 experts regarding quality 4.0 readiness | The study showed that the linkage between quality 4.0 implementation and organizational top management commitment, leadership, planning, and people training is essential to maximizing its benefits.<br>Moreover, the lack of financial resources, unclear benefits, and higher investment costs are top-quality 4.0 | Most of the samples taken were in the early stage of quality 4.0. Thus, more significant results can be obtained in future studies. It is also recommended that the study be conducted in other contexts, such as Australia and South Africa. | X | | | | X | X | X | X | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | non-adoption factors. Leadership, top management support, and customer and supplier readiness are the top readiness factors.<br>Finally, quality 4.0 is more widely adopted in manufacturing than in services, and in big firms than in SMEs. Likewise, the benefits of quality 4.0 vary by organization type and size. | | | | | | | | | | | |
| (Sony, Antony, and Douglas, 2020) | Literature review | The study revealed eight success factors for implementing successful quality 4.0 programs (handling big data, analysis improvement, top management support, strategic adoption of quality 4.0 | It is recommended to take into consideration these success factors for the assessment of quality 4.0 readiness | x | | | X | X | X | X | X | X | X |
| (Antony, Sony, et al. 2022) | Critical literature review | The study suggested that quality 4.0 programs could achieve positive financial performance. | The results of this study could encourage firm managers to implement quality 4.0 programs. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| lit(Bousdekis et al., 2023) | Literature review | This study provides insight into data analysis as one of the significant aspects of both quality 4.0 and industry 4.0 | Future empirical and non-empirical research was proposed based on the identified literature gaps. | | | | | | | | | | |
| (Saihi, Awad, and Ben-Daya 2023) | Literature review | Various benefits can be achieved by implementing quality 4.0 in developing countries such as the UAE. | | | | | | | | | | | |
| (Barsalou 2023) | Literature review | When implementing quality 4.0 programs, traditional quality methods must be integrated with information technologies and Industry 4.0. The study includes many examples from previous research. | The study offers only one practical recommendation: planning for quality 4.0 programs. | | | | | | | | | | |
| (Carvalho et al. 2024) | Qualitative and quantitative | The study offers a Quality 4.0 roadmap, which is summarized under three pillars (strategy and value chain, people, and culture). | It is recommended that more research be conducted on the link between quality 4.0 and resilience. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Kulenović, Folta, and Veselinović 2021) | Systematic literature review | The six main critical success factors for TQM and technology implementation | Future research should focus on additional independent variables, such as performance. | X | X | X | X | X | | | | | |
| (Khourshed and Gouhar, 2023) | Quantitative using questionnaires | Analytical thinking was the main success factor for quality 4.0 programs in Egyptian industries. | More research is needed using Antoni's Quality 4.0 models. | X | X | X | X | X | X | X | X | X | X |
| (H. C. Liu et al. 2023) | Literature review | Although some articles have proposed definitions of quality 4.0, no agreed-upon definition exists. The study revealed considerable gaps in the literature on quality 4.0, including fragmented research and insufficient integration with theoretical perspectives. Some researchers have studied quality techniques of quality 4.0, but many quality tools, such as Six Sigma and | As most current quality 4.0 research remains conceptual, it is recommended that more empirical research be conducted to establish the quality 4.0 concept or to develop a new theoretical framework. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | Lean, have not yet been studied or addressed. | | | | | | | | | | | |
| (Wawak et al. 2023) | Quantitative | The study revealed different potential benefits. However, it almost revealed the same previous results regarding potential barriers. | | X | X | X | X | X | X | X | X | X | X |
| (Nenadál et al. 2022) | Conceptual and Quantitative | The research proposed a quality 4.0 framework across four dimensions (strategic directions, people and culture, process, methods, and tools) and a maturity-level assessment tool with seven levels. A survey of Czech production companies found that more than 60% are below the average maturity level. The paper concluded that the quality 4.0 proposed framework can be regarded as a comprehensive approach that blends quality, | It is recommended that quality 4.0 be linked with sustainability in future research. | X | X | X | X | X | X | X | X | X | X |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | technology, excellence, innovation, and performance. | | | | | | | | | | | |
| (Zonnenshain and Kenett 2020) | Concept | This paper offers a quality 4.0 assessment model and a quality 4.0 framework. The assessment model is a five-level ladder. Hence, the quality management market comprises quality models and standards that lack a comprehensive approach. Thus, organizations lose direction. | The study proposed several topics for further study, mainly in quality engineering. | | | | | | | | | | |
| (Salimbeni, Redchuk, and Rousserie 2023) | Quantitative | Results showed that Industry 4.0 technologies positively impact quality management in Argentina. Medium and large firms outperform small firms, and sectors and contexts differ. | | | | | | | | | | | |
| Total | | | | **8** | **7** | **6** | **7** | **9** | **7** | **7** | **8** | **6** | **5** |

| | |
|---|---|
| 1 | Top Management Commitment, Leadership, and Collaboration |
| 2 | Customer Focus |
| 3 | Competency (Employees and Management) |
| 4 | Quality Standards Implementation/Management System |
| 5 | Enabling Technologies (VR, Cloud System, Apps) |
| 6 | Big Data, analysis, and root cause analysis |
| 7 | Block Chain |
| 8 | Innovation |
| 9 | Compliance with Quality 4.0 |
| 10 | Scalability and collectivity |

### 2.3.6 Quality 4.0 and Industry 4.0 Readiness Assessment Model;

The transition from current quality management practices to Quality 4.0 practices requires meticulous planning and a concrete roadmap. The literature indicates that between 70% and 80% of Quality 4.0 projects, especially those involving big data, fail. (Zulfiqar et al., 2023). Most failures are attributed to a lack of systematic understanding of needs, inadequate assessment of Quality 4.0 maturity, and insufficient planning. (Mittal et al. 2024).

Readiness for Quality 4.0 has been a topic extensively discussed in the literature (Antony, Sony, et al., 2023; Chonsawat & Sopadang, 2020; Dewi et al., 2024; Salimbeni et al., 2023; Zulfiqar et al., 2023). However, there is no common understanding or model for Quality 4.0 readiness, (Zulfiqar et al., 2023). Most of the suggested readiness and maturity models agree on three features;

Table (2.2): Quality 4.0 features.

| Features | References |
|---|---|
| Quality Practices | (Nenadál et al. 2022; Salimbeni et al. 2023; Zonnenshain and Kenett 2020; Zulfiqar et al. 2023a) |
| Innovation and Improvement | (Antony, Sony, et al. 2023a; Salimbeni et al. 2023; Zulfiqar et al. 2023a) |
| Readiness Assessment Component (mainly Industry 4.0 components) | (Antony, Sony, et al. 2023a; Nenadál et al. 2022; Salimbeni et al. 2023; Zulfiqar et al. 2023a; Zulqarnain et al. 2022a) |

None of the previously studied assessment tools comprehensively includes these three components. Most model authors have recommended further refinement of their models based on empirical testing results, (Antony, Sony, et al. 2023a; Antony, Swarnakar, et al. 2023; Antony, McDermott, et al. 2022; Sony et al. 2020).

In Comparison, Industry 4.0 literature offered a more extensive exploration of a readiness and maturity-level assessment model suitable for SMEs (Small and Medium Enterprises), with numerous proposed tools and models. (Skalli et al. 2024). Similarly, several scholars and major consulting firms like PwC "Price Waterhouse Cooper" have developed models for assessing the Industry 4.0 readiness and maturity levels, (Skalli et al. 2024). Therefore, reviewing the Industry 4.0 readiness model would enrich the literature on quality 4.0, as many previous quality 4.0 researchers treat Industry 4.0 as the defining feature of quality 4.0. (Jokovic et al. 2023).

Unlike the quality 4.0 assessment model, industry 4.0 assessment models are professional, empirically validated, and verified. (Jokovic et al. 2023)The next section of this chapter discusses and elaborates more on the most common Industry 4.0 readiness and maturity levels.

The search protocol "*Industry 4.0 readiness or maturity model industry* or manifest* or SME*" yielded 219 relevant published articles in engineering and business-related fields, compared to only 14 articles on Quality 4.0 readiness. This indicates that Industry 4.0 models have undergone more rigorous exploration and development than Quality 4.0 models.

Furthermore, a good linkage between the Industry 4.0 readiness model and total quality management was proved and established, (Ali et al. 2022; Ali and Waheed 2024)Thus, the Industry 4.0 model is suitable for assessing 4.0 quality readiness when integrated with Total Quality Management principles and drivers, such as customer focus, continuous improvement, and the involvement of everyone in the organization. (Ali and Waheed 2024).

#### 2.3.6.1 Industry 4.0 Readiness

Traditionally, Industry 4.0 has been more common in larger firms and organizations than in small and medium enterprises SMEs (Suleiman et al., 2021). Over 30 Industry 4.0 readiness models have been proposed in the literature, each offering unique insights and approaches for assessing readiness for the fourth industrial revolution. (Hizam-Hanafiah, Soomro, and Abdullah 2020), Developed by both academic institutions and private

consulting firms like Price Waterhouse Coopers (PwC) (Hizam-Hanafiah et al., 2020). Nevertheless, most of these models shared standard dimensions across four to six evolutionary levels (Molgazhdarova & Segura-Velandia, 2022).

Model the compass dimensions of Technology, People, Strategy, Leadership, Process, and Innovation. (Antony, Sony, et al. 2023a; Axmann and Harmoko 2020; Bastos et al. 2021; Chonsawat and Sopadang 2020; Dudukalov et al. 2021; Hizam-Hanafiah et al. 2020; Khin and Hung Kee 2022; Salimbeni et al. 2023; Suleiman et al. 2021; Todorovic et al. 2020; Tripathi and Gupta 2023; Zulfiqar et al. 2023b, 2023a).

To analyze these readiness and maturity models in depth and select the most suitable for the Palestinian context, the most popular models will be compared on empirical validity, suitability for a developing context, and other criteria.

Table (2.3): Industry 4 readiness model evaluation assessment.

| Model | Dimensions | Contributions/Description | Developing Context | Suitable for SME | Empirically Tested |
|---|---|---|---|---|---|
| **Industry 4.0 maturity assessment model (Nikolay, 2015)** | (People and culture; Industry 4.0 Awareness; Organization and strategy; Value Chain; Product and technology; Industry 4.0 | The contributions include enhancing people and culture, raising Industry 4.0 awareness, developing organizations and strategies, optimizing the value chain, advancing products and technology, and integrating Industry 4.0 technologies. | No | No | YES, (Nikolay, 2015) |

| | | | | | |
|---|---|---|---|---|---|
| | technology ). | | | | |
| **Smart Manufacturing System Assessment Model SMSRA 4.0 (Sony & Naik, 2020)** | (organization maturity; IT; (performance maturity; information connectivity maturity). The model includes six evaluation levels | The authors propose an implementation strategy comprising a readiness assessment, a framework, a roadmap, and a maturity model. They assess organizational maturity across dimensions like process design, IT, and performance, focusing on tools for monitoring and information connectivity. | No | NO | The Scopus database does not include specific articles related to this model. |
| **System Integration Maturity Model SIMMI 4.0 (Leyh et al., 2016, 2017)** | Vertical and horizontal integration ; digitization , technology criteria | It emphasizes evaluating the technological infrastructure required to implement the Industry 4.0 model. | YES | YES,(Leyh et al. 2016, 2017) | YES, (Leyh et al. 2016, 2017) |
| **Acatech model,(Coll** | (Resources , | Developed by the National Academy | YES,(Nikolay 2015) | YES, (Nääs et | YES, (Nääs et |

| | | | | | |
|---|---|---|---|---|---|
| **i et al. 2018; Nikolay 2015)** | Information System; Culture; Org Structure; ICT; Employees ) the model includes six levels | of Science and Engineering in Germany, the model outlines six stages of maturity: computerization, connectivity, visibility, transparency, predictive capability, and adaptability. These levels are applied across resources, information systems, organizational structure, and culture. | | al., 2016; Nikolay, 2015) | al., 2016; Nikolay, 2015) |
| **IMPLUS Industry 4.0 model,** | organizational strategy, smart factory, intelligent operations, innovative products, data-driven services, | The model, encompassing six, was presented by the German Engineering Federation (VDMA), the Cologne Institute for Economic Research Consult GmbH (IW Consult), and the Institute for | YES,(Shqair & Altarazi, 2022) | YES,(Shqair and Altarazi 2022a) | YES, (Shqair & Altarazi, 2022a) |

| | | |
|---|---|---|
| | and employees | Industrial Management (FIR) at RWTH Aachen. It is most suitable for manufacturing firms. |

Most industry-readiness models have been studied in developed contexts, with limited application in developing countries and emerging markets. (Shqair and Altarazi 2022b). The IMPLUS model, developed by the German Association of Mechanical Engineering (VDMA) in 2015, serves as the foundation for other national and international models, including the Malaysian government model. (Khin and Hung Kee 2022; Ooi et al. 2023). Likewise, the Acatech model suits developing, developed, and SME sectors.

Furthermore, the IMPLUS model is dedicated to evaluating industrial SMEs and is well-suited to this context, having previously been tested in developing contexts such as Pakistan. (Fauskanger and Fatemi 2014), Indonesia, (H. Hasbullah & S.A. Bareduan, 2023)Jordan and Kuwait, (Mohammad et al. 2021). IMPLUS combines the readiness and maturity into one model, which is suitable for assessing firms with inductive and initial phases of Industry 4.0 (Fauskanger & Fatemi, 2014)

Figure (2.10) below shows the IMPLUS Industry 4.0 model's measurements and levels, indicating that it includes aspects of quality management practices, such as innovation management and processes. (Grufman, Lyons, and Sneiders, 2020; Mohammad et al., 2021)

Accordingly, the IMPLUS assessment model can be applied in other developing and emerging contexts, such as the Palestinian context. Moreover, the implied model was chosen because it is flexible and can be applied across industries, and is not explicitly designed for a specific sector. (Grufman et al., 2020).

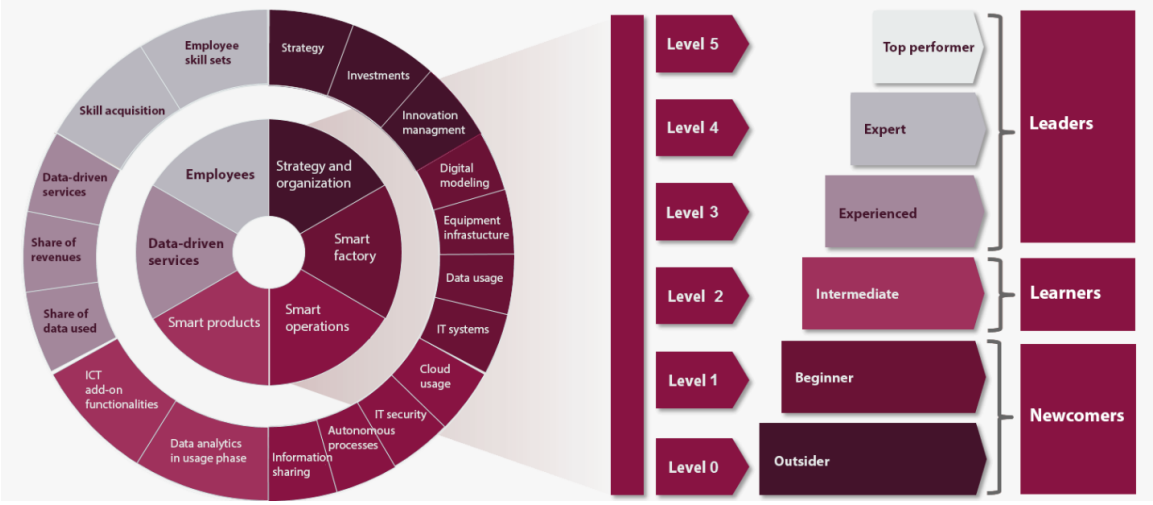


Figure (2.10): IMPLUS Model, Source Achene Institute- Germany.

## 2.4 Industry 4.0, Quality 4.0, linkage with sustainability, Sustainable competitive advantage, Sustainability and organizational performance

The linkage among Industry 4.0, Quality 4.0, organizational performance, and sustainable competitive advantage has not been thoroughly explored in the literature, underscoring the need for further empirical research, particularly in developing countries. (Tasmin et al. 2020).

The literature revealed the positive relationship between Industry 4.0 and sustainable competitive advantage (Yuldashev et al., 2023), sustainability performance (Balouei Jamkhaneh et al., 2022; Tolmachev et al., 2023), circular economy performance (Varella et al., 2024), organizational performance (Mtotywa, 2022), and operational performance (Tasmin et al., 2020).

Industry 4.0 has also been studied as a dependent variable. For instance, (Balouei Jamkhaneh, Shahin, and Tortorella, 2022; Shqair & Altarazi, 2022b) Research has examined the impact of logistics and supply chain management on Industry 4.0 readiness and The influence of environmental and agricultural factors on Industry 4.0 (Balouei Jamkhaneh et al., 2022; Shqair & Altarazi, 2022b; Sun & Chu, 2022). Additionally, the impact of quality management on Industry 4.0 has been explored. (Nguyen et al. 2021).

(Nguyen et al. 2021) It also investigated the moderating effect of Industry 4.0 on the relationship between quality management practices and business performance, revealing that Industry 4.0 can influence the extent of quality management's impact on business outcomes.

A search of the Scopus database found only seven published articles linking Industry 4.0 and sustainable performance. All these articles revealed a positive relationship, instilling optimism about Industry 4.0's potential. (Alkaraan et al. 2024; Alsadi et al. 2023; Bornmann and Haunschild 2017; Das 2023; Ghaithan et al. 2021, 2023a; Kaarlela et al. 2024; Nasir, Zakaria, and Zien Yusoff 2022; Saha et al. 2022). Two of these are conducted in developing and emerging markets, Saudi Arabia and Pakistan." (Ghaithan et al. 2021; Saha et al. 2022).

Three published articles explored the relationship between industry practices and competitive advantage. Both (Ed-Dafali et al. 2023; Gupta et al. 2022) Found that firms can achieve sustainable competitive advantage by integrating Industry 4.0 with industrial engineering and total quality management (TQM) practices. Additionally, (Rifqi et al. 2024) Note that the adoption of Industry 4.0 technologies remains ineffective without the implementation of TQM. Furthermore, Ed-Dafali et al. (2023) highlighted Industry 4.0 as a ***mediator*** between strategic initiatives and competitive advantage. The third article addressed the knowledge of Industry 4.0 and its impact on sustainable competitive advantage. (Gupta et al. 2022)

Similarly, two published articles in the Scopus database examined the relationship between Industry 4.0 and organizational resilience; both revealed a positive relationship, providing reassurance about its potential benefits. (Lopes de Sousa et al, 2023; Marcucci et al., 2022).

Lastly, most studies on Quality 4.0 and Industry 4.0 have considered Quality 4.0 as an independent variable, with fewer studies exploring it as a mediating variable. (Olayeni et al. 2021)Therefore, exploring Quality 4.0 as a mediating variable could significantly enrich the existing literature and open new avenues for research.

## 2.5 Green Strategies and Circular Economy

Manufacturing firms are increasingly confronted with environmental and societal challenges that continuously affect their strategies and operations. To respond effectively, firms must adopt more flexible strategies, tactics, and operations. (Dwikat et al. 2023; Zahari et al. 2023).

Environmental regulations are becoming increasingly stringent in both developed and developing countries. Globally, most businesses are Small and Medium Enterprises (SMEs). SMEs contribute over 50% of the global GDP (Gross Domestic Product) and employ more than 70% of the worldwide workforce (Dwikat et al., 2023; Zahari et al., 2023). In countries such as Palestine, SMEs account for more than 90% of the economic activities.[2]

Therefore, SMEs must adopt flexible strategies and enhance their dynamic capabilities and resilience to respond effectively to constantly evolving environmental regulations and requirements. (Verrier, Rose, and Caillaud 2016; Zhang 2017).

Over the past decade, there has been growing interest in green strategies, such as green supply chains and circular economies, across both the academic and practical spheres. This has increased the number of scholarly publications. However, research on green strategies remains limited compared to more established fields such as general management and strategy. (Moini, Sorensen, and Szuchy-Kristiansen 2014).

Figure 2.11 below shows publications on green strategies from the last three decades, obtained from the Scopus database.

[2] https://webapps.ilo.org/infostories/en-GB/Stories/Employment/SMEs#power-of-small

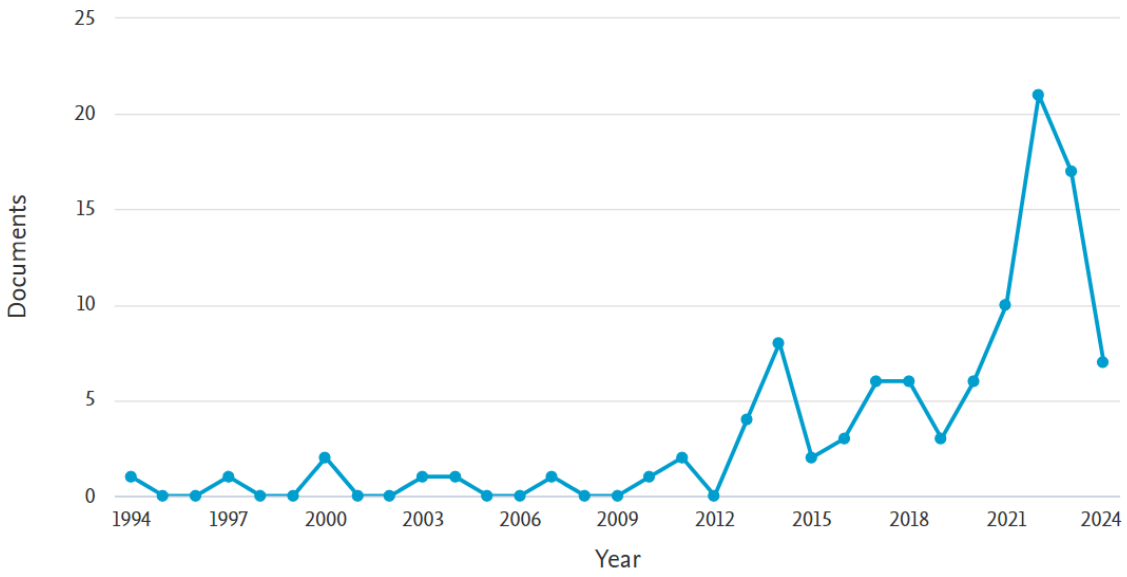


Figure (2.11): Number of publications on green strategies by year.

The identification, screening, eligibility, and inclusion of literature related to green strategies were conducted according to the PRISMA framework, as outlined in Figure 2.1. Consequently, 30 articles were included in the qualitative synthesis, shown in Figure 2.12. Table 2.4 below summarizes these articles. The search protocol used was 'Green Strategies and Firms.

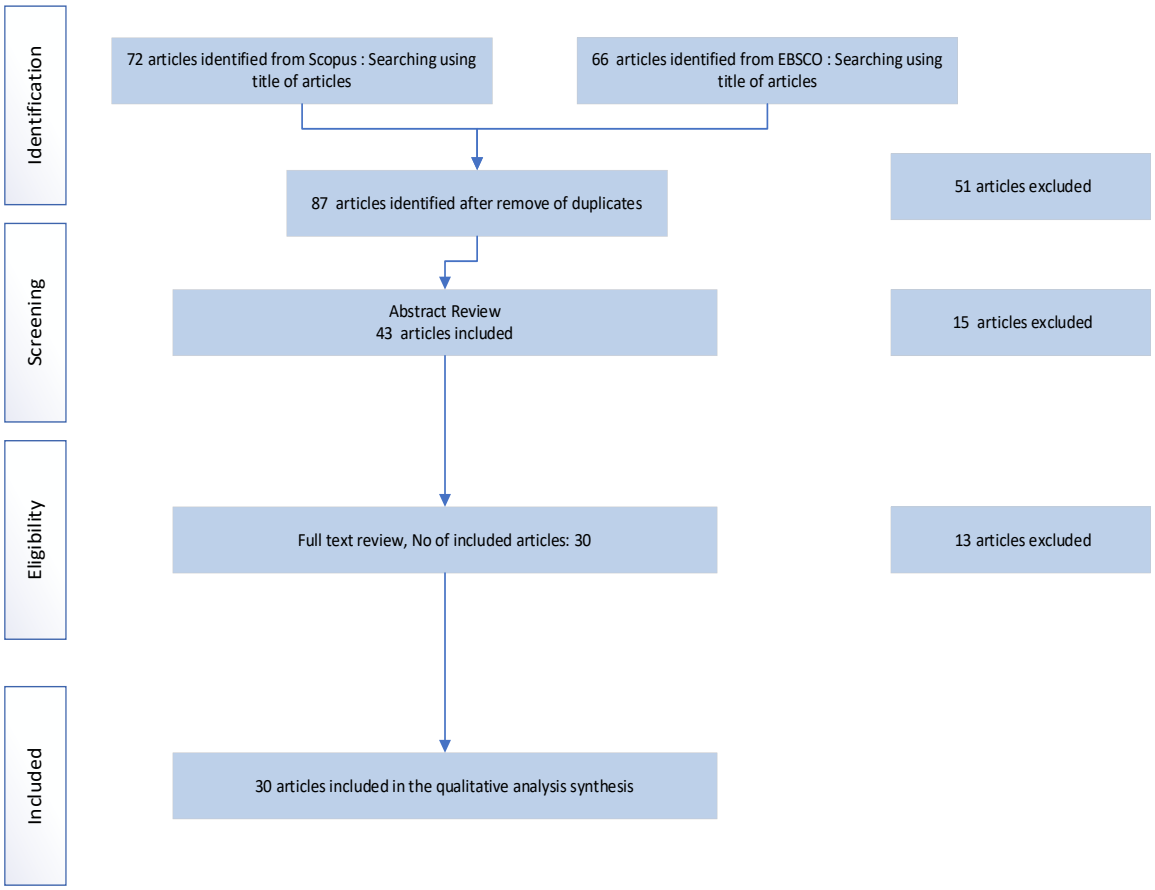


Figure (2.12): Articles included in the qualitative synthesis.

Figure 2.13 below illustrates the keywords used in the literature on Green Strategies, analyzed using VOS software. The analysis involved searching for 'Green strategy' as a key term in the Scopus database. The figure highlights the most frequently used keywords in the Green Strategies literature, including Manufacturing Uncertainty, SME, Competition, and Green Business Strategy.

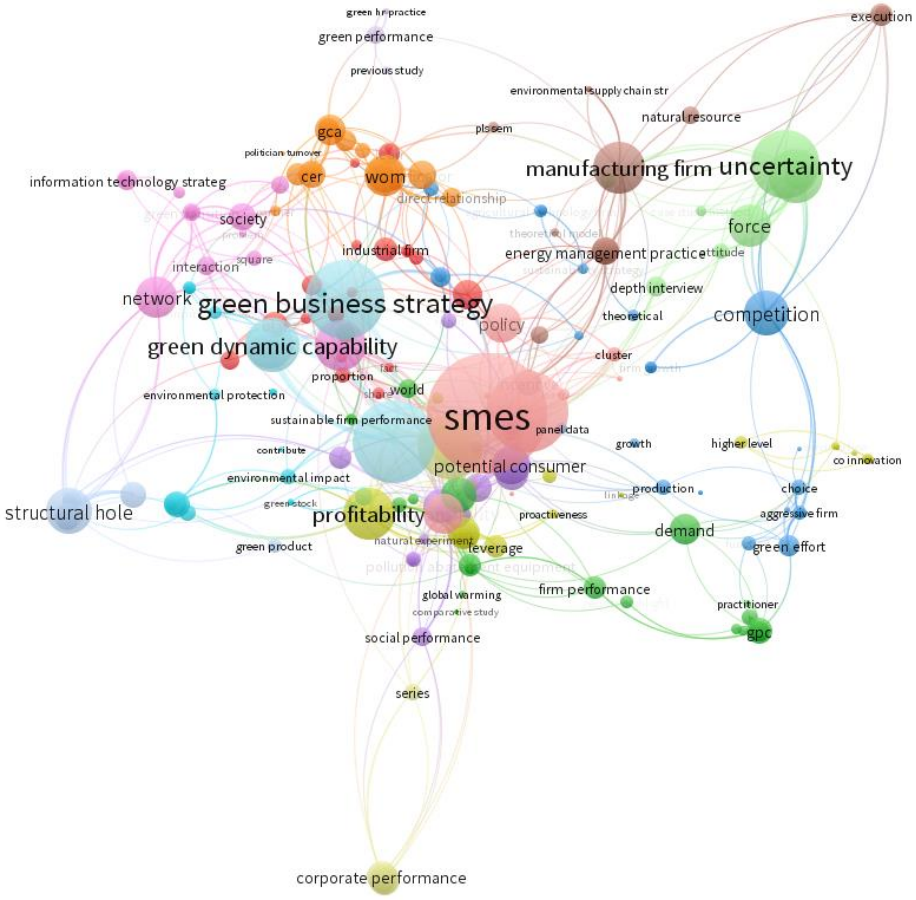


Figure (2.13): Keywords used in the green strategy literature.

Table (2.4): Systematic Literature Review Summary Table- Green Strategies.

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Aarstad and Jakobsen 2020) | Quantitative | In the Norwegian developed context, significant and innovative firms have more green strategies than smaller ones. Therefore, the size of the firms controlled or mediated the green strategy. | The study recommends a longitudinal rather than a cross-sectional design. | | | | | | | | | | |
| (Saether, Eide, and Bjørgum 2021) | Quantitative | The study revealed that the green strategies of Norwegian marine vessel companies positively correlated with emission reduction. However, moving from fossil fuels to greener fuels requires higher financial investment. | The main recommendation is to test the impact of green strategies on financial performance and sustainability. | | | | | | | | | | |
| (Tang 2021) | Quantitative | Duplication of public firms in the chain positively impacts green innovation. This study considered green innovation and strategies as the dependent variable. | | | | | | | | | | | |
| (De Marchi, Di Maria, | Case study | Proposed an integrated theoretical framework based on Porter's Competitive Advantage general strategies (cost leadership and | | x | x | x | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| and Micelli 2013) | | differentiation). The model proposed environmental strategies for industrial firms in the process, product, and supply chain. | | | | | | | | | | | |
| (Braglia and Petroni 2000) | Quantitative | To achieve a positive environmental impact, manufacturing industries must focus on the product life cycle, including all production and supply chains. | The article urged further research to link green impact with quality management or quality assurance practices, such as ISO 9001 and ISO 14000, as well as with the implementation of environmental impact measures. | | | X | | | | | | | |
| (Pattinson et al. 2023) | Concept paper | Balancing profit and environmental and social impact results is difficult for firms. Hence, a multi-level analysis framework was proposed. The multi-level assessment model consists of three primary levels (society and environment | The current study does not consider the macro-level impact of CSR efforts, such as CSR reporting. Empirical testing needs to be performed at the meso level. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | level, Meso level: industry level, firms level: internal processes, HR, supply chain) | | | | | | | | | | | |
| (Song et al. 2024) | Quantitative | Effective environmental scanning enhances firms' ability to respond to environmental uncertainty. Hence, two green strategies were tested: reactive and proactive. | It is recommended that more similar studies be conducted in other Chinese contexts. | | | | X | X | | | | | |
| (Helmina, Sutomo, and Respati 2022) | Quantitative | The study revealed that eco-efficiency strategies positively impact firms' performance, and thus, ISO 14,000 implementation could increase a firm's value in the Indonesian context. | Future studies should focus more on financial performance rather than return on assets. | X | | | X | | | | | | |
| (Asif 2023) | Quantitative | Green Process Innovation and green entrepreneurial strategies positively impact the environmental performance of agricultural firms in Italy. | The current study considers internal factors (green process). Future studies can also consider external factors, such as the market and product. | X | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Chan and Ma 2017) | Quantitative | Top management fixed compensation and bonuses negatively affect the Information technology green strategies and performance. | | | | | | | | | | | |
| (Fraj, Martínez, and Matute 2011) | Quantitative | Green Marketing Strategies positively impact economic performance, including operational and marketing performance. | Further empirical studies in different contexts are recommended to capture the cultural differences. | | X | | | | | | | | |
| (Marin, Marzucchi, and Zoboli 2015) | Quantitative | The study identified econ-innovation barriers in the EU industry across six main clusters (industries); the intensity of the obstacles depends on many factors related to firms and clusters. However, the barriers can be summarized as Market Barriers, Knowledge, and Financial/Cost. | | | | | | | | | | | |
| (Liu, Srai, and Evans 2016) | Quantitative | Supply chain capabilities positively affect green strategies. However, the firm's size does not affect Auto manufacturing firms. Moreover, the regional and industrial contexts | | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | affect the level of green strategy implementation, which may result from differences in industrial capabilities and environmental regulations. | | | | | | | | | | | |
| (Hu, Wang, and Yang 2019) | Quantitative | The trade-off between non-green and green strategies is difficult for firms, especially in developing and emerging markets. Hence, environmental regulations promote green innovation and foster performance while limiting firms' ability to diversify. | Further studies shall examine strategies beyond green and diversification, such as globalization and geographical expansion. | X | | | | | | | | | |
| (Rajapakse, Azam, and Khatibi 2022) | Interviews | The top management of Siri Lanka is conscious of environmental and green strategies. According to CEOs, the barriers to green strategies adoption and implementation are (1) lack of environmental policies, (2) lack of national institutional interventions like solid waste management, (3) weak monitoring of environmental legislations, (4) low knowledge | Empirical testing is recommended. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | of industry-specific technologies, including environmental ones, and (5) profit rather than sustainability interests of SMEs in Sri Lanka | | | | | | | | | | | |
| (Olayeni et al. 2021) | Quantitative | There is a positive relationship between green strategies, on the one hand, and environmental and financial performance in developing countries (Ghana). Product quality mediates the effect of green strategies on (economic and environmental performance). | It is recommended that more empirical studies be conducted in different contexts. | | | | | | | | | | |
| (Jirakraisiri, Badir, and Frank 2021) | Quantitative | Green strategies (human capital, organizational capital, and relational capital) positively impact green process performance. Hence, green human capital is more important than other factors. Moreover, the study proposed a control variable (firm size) | | | | | | | X | | | | |
| (Buysse and Verbeke 2003) | Quantitative | Regulatory pressure on pollution prevention strategies and stakeholders affects the | This study is relatively old, and repeating it might enrich the literature, given that | | | X | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | environmental leadership in large firms in developed countries. | environmental legislation has changed over the last decade. | | | | | | | | | | |
| (Verrier et al. 2016) | Descriptive | The study proposed a theoretical framework based on TBL theory that combines quality management (Lean techniques) and green strategies to foster sustainability. It also proposed a five-step maturity model ladder. | To empirically test the joint effect of quality and green strategies. | | | | | | | | | | |
| (Souhli and En-nadi 2023) | Quantitative | Early adoption of environmental policies and top management commitment are the main drivers of successful green supply chain management practices as part of broader green strategies in the Moroccan developing context. Hence, the majority of the study sample was SMEs. | | | | | | | | X | | | |
| (Jiang, Han, and Huo 2020) | Quantitative | Positive relationship between green strategies and economic performance | A longitudinal study is recommended for future studies | | | | | | | x | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Bıçakcıoğlu-Peynirci and Tanyeri 2022) | Quantitative | Positive relationship between stakeholder pressure and green export strategies in the emerging/developing Turkish market | It is recommended that other variables related to green strategies and stakeholder pressure be studied rather than those related to exports. | | x | | | | | | | | |
| (Moini et al. 2014) | Quantitative | Good planning and implementation of green strategies are key success factors for achieving sustainable competitive advantage. | | | | | | X | | | | | |
| (Xu et al. 2013) | Quantitative | A firm's size and industrial cluster affect its green supply chain strategies. For example, the Indian auto industry has superior environmental performance and a green supply chain compared to other industries, such as textiles, due to its size and the fact that most of these firms have dedicated human resources to address environmental issues, including regulatory requirements. | | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Qian and Xing 2018) | Quantitative | This study is likely one of the rare studies that linked environmental issues and financial performance for SMEs. Hence, SME environmental initiatives and strategies are not directly connected with stakeholder rewards. However, they are more likely to offer operational and resource-saving benefits. Unlike ecological initiatives, the results of carbon-saving strategies were mixed and unclear; hence, for firms with prior carbon and environmental experience, the impact of carbon-reduction initiatives is not financial. However, companies and firms are not exposed to strategies that do not yield good economic results. | Further studies on carbon emission reduction and its impact on SMEs are recommended to conclude, as the current research does not provide direction. | | | | | | | | | | |
| (Lartey et al. 2020) | Quantitative | This article further demonstrates that integrating quality techniques, such as Lean, with environmental strategies positively | It is recommended that the proposed model be tested in other developed and | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | impacts performance and firms' future growth in developed countries. | developing countries, as the current study considers only four developed countries. | | | | | | | | | | |
| (Antonioli, Mancinelli, and Mazzanti 2013) | Quantitative | This article is unique in that it examines the joint effect of Human Resources practices and green strategies on performance. The study revealed that training and awareness of environmental strategies as part of human resources management enhance the firm's performance. | | X | | | | X | | | | | |
| (Dzomonda 2021) | Quantitative | The environmental strategies (green strategies) positively impact the firms' performance in publicly listed large firms in the south of Africa (developing and emerging markets) | Industry type and cluster can further be analyzed in future studies | X | | | | x | | | | | |
| (Calza, Parmentola, and Tutore 2020) | Quantitative | The study revealed that big data analysis (as part of Industry 4.0) positively correlates with the design, adoption, and implementation of green strategies. | Companies must consider using big data to develop more sustainable strategies | X | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | that meet customers' and other stakeholders' requirements. | | | | | | | | | | |
| (Lo 2014) | Case study | Design and manufacturing IT firms in Taiwan showed more interest in and a tendency to implement green strategies than firms characterized as materials suppliers. | | | | | | | | | | | |
| | | | | 8 | 3 | 3 | 2 | 4 | 1 | 2 | | | |

| # | Item/ Variable |
|---|---|
| 1 | Eco-efficiency strategies and the implementation of standards like ISO 14000 |
| 2 | Eco-Branding and Green Marketing, exporting. |
| 3 | Environmental Leadership |
| 4 | Environmental scanning and assessment |
| 5 | Proactive and reactive green strategies |
| 6 | Green Human Capital |
| 7 | Green Governance (Code of Conduct) |

The Resource-Based View (RBV) and its extension, the Natural Resource-Based View (NRBV), are the most frequently cited frameworks in the green strategy literature. Figure 2.14 below illustrates the theoretical references used in this research. Notably, most articles incorporate multiple theories in their analyses due to the lack of theories or models, including precise environmental and ecological components. (Mhatre et al. 2021).

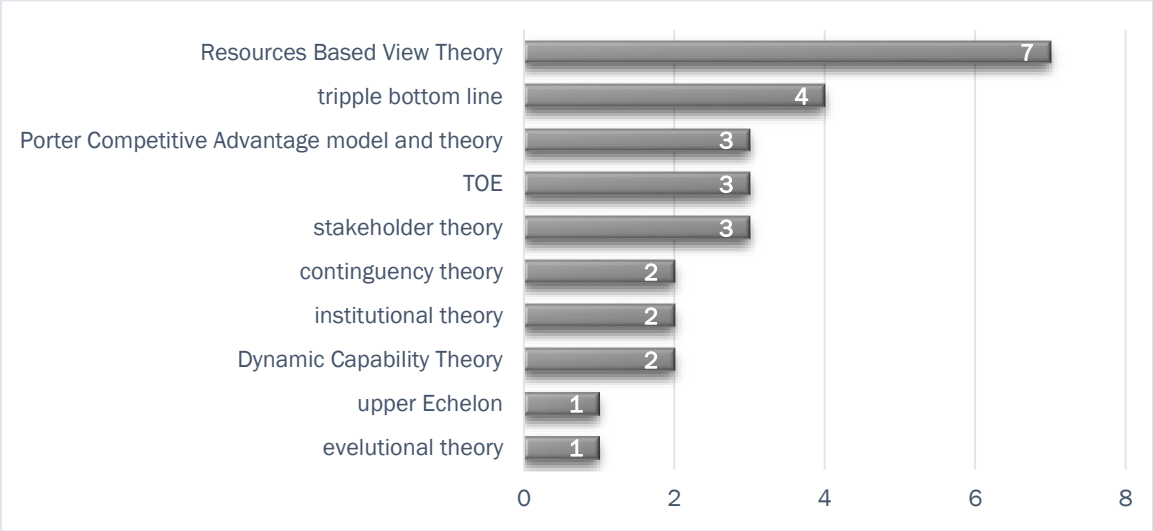


Figure (2.14): Green Strategies Referred Theories.

### 2.5.1 Circular Economy

The circular economy is defined as a set of strategies and practices focused on restoring resources through (Reducing, Re-using, and Recycling). (Bimpizas-Pinis, Calzolari, and Genovese 2022a). One key objective of the circular economy is to promote eco-efficiency strategies. (Heyes et al. 2018). These strategies are crucial for achieving sustainability in the 21st century, especially given the rapid industrialization that negatively impacts the environment. (Nikolakis et al. 2024; Schöggl, Stumpf, and Baumgartner 2024).

The circular economy aims to minimize the use of natural resources, encourage the reuse of materials, and enhance recycling, including waste reduction (Ghaithan et al., 2023b; Schöggl et al., 2024; Bimpizas-Pinis et al., 2022). To implement circular economy strategies, two levels of coordination and cooperation must be harmonized: the industrial or cluster level and the firm's level. (Heyes et al., 2018; de Souza et al., 2020).

Interest in circular economy strategies, practices, and techniques extends beyond developed countries to developing nations as well. Numerous projects promoting the circular economy have been implemented in developed and developing regions, such as the MED TEST III project, which seeks to advance sustainable circular economy practices in the Middle East, including Palestine. This shows growing interest in the circular economy.

However, transitioning from traditional economic strategies to a circular economy poses significant challenges that require careful management. Few scholars have focused on the process of shifting from a conventional business model to one based on circular economy principles, (Skärin et al., 2022).Figure 2.15 below illustrates a model proposed in the literature for transitioning from a traditional business model to a circular economy business model. (Skärin et al., 2022).

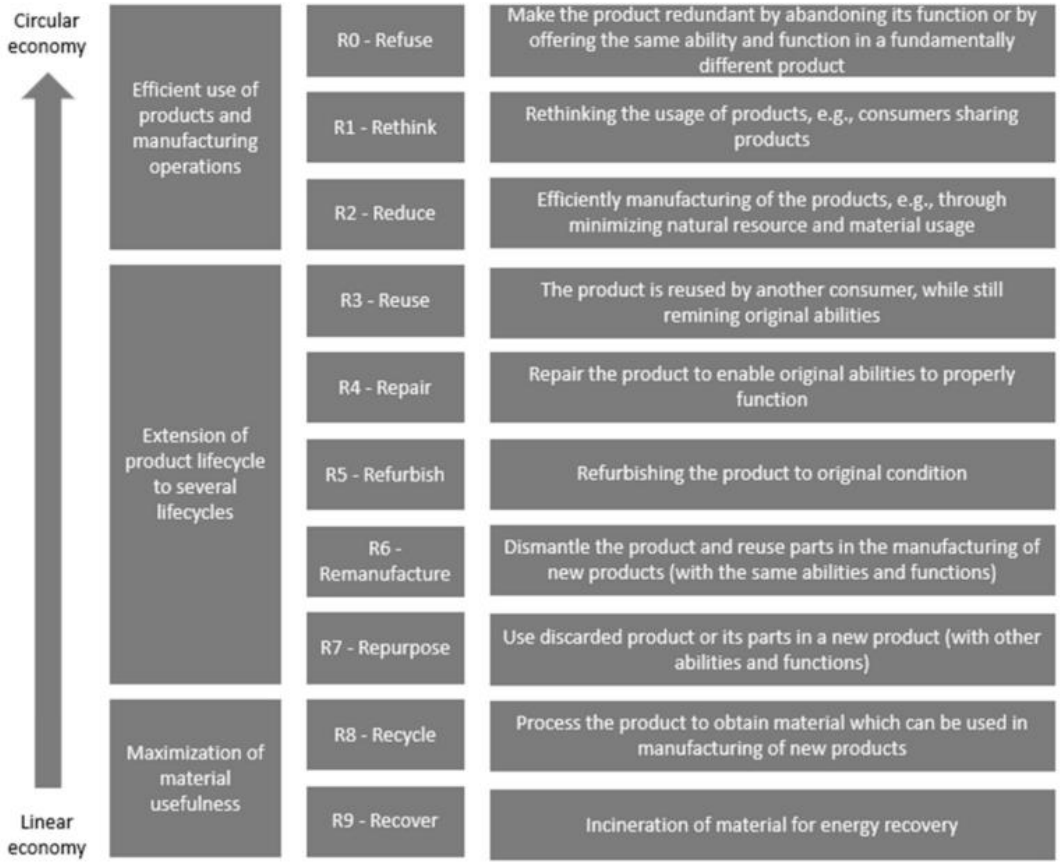


Figure (2.15): Model to transfer from traditional to circular economy.

Similar to other green practices, literature on the circular economy is relatively limited, (Patyal et al. 2022) Figure 2.16 below shows the number of publications per year in the field of the circular economy. Additionally, Figure 2.17 highlights the top 15 authors in this research area.

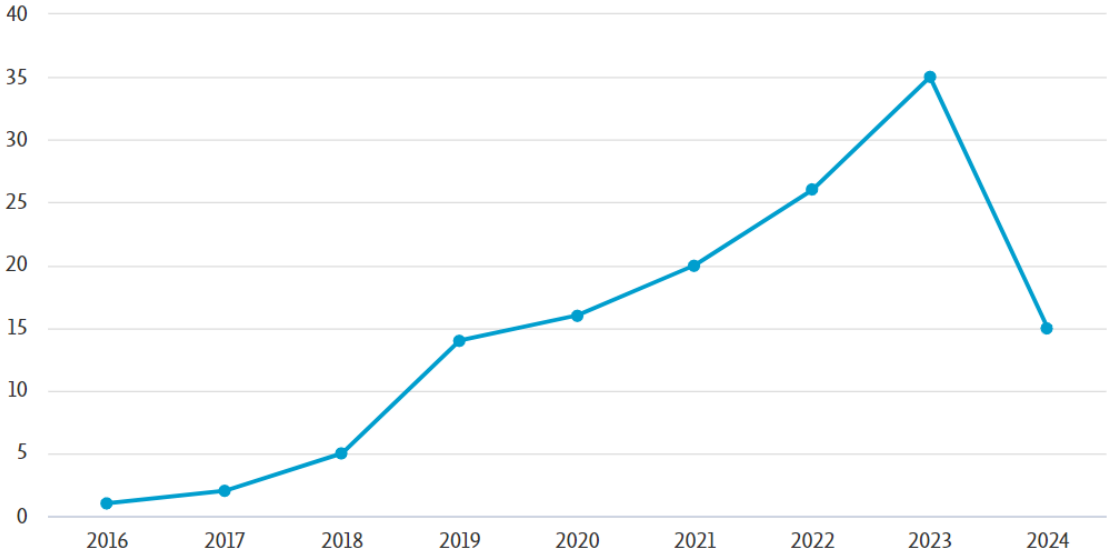


Figure (2.16): Annual Publication in the field of Circular Economy, source Scopus database.

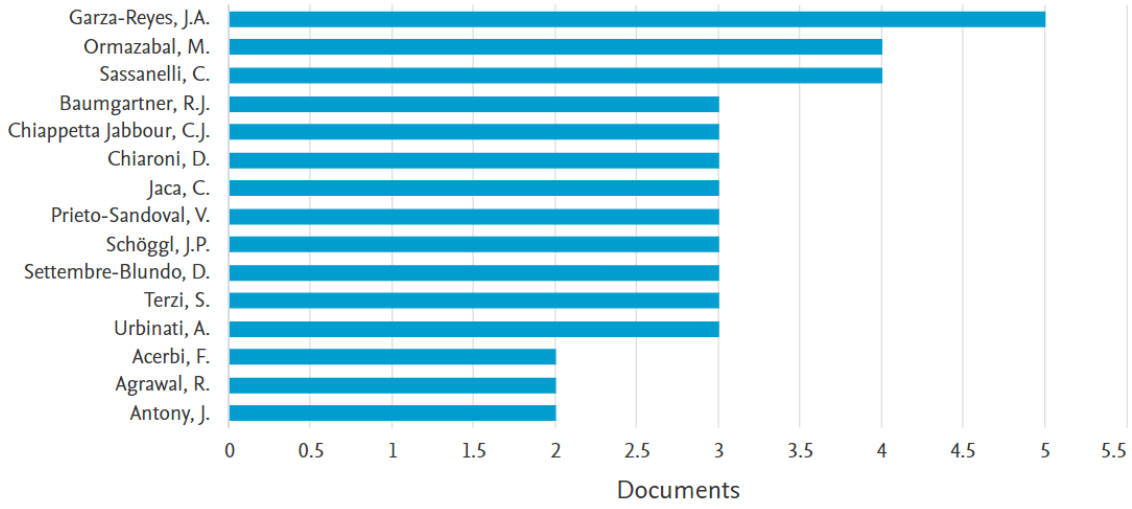

Figure (2.17): Top 15 Authors, source Scopus Database

Based on the RStudio bibliometric literature review, the Circular Economy (CE) field research frequently uses keywords such as 'CE practice' and 'CE business model.' Figure 2.18 displays the most commonly used keywords in Circular Economy literature.

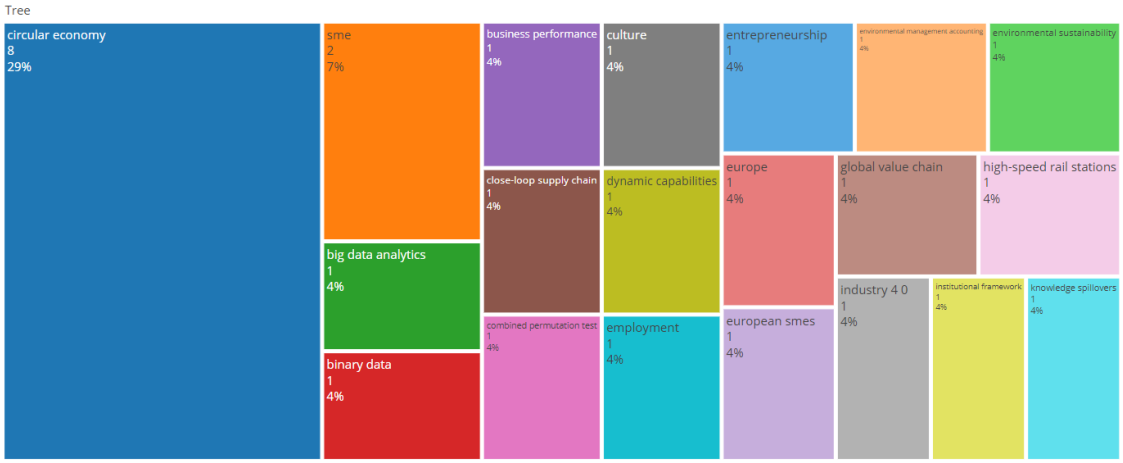


Figure (2.18) Circular economy literature keywords (top 20).

Numerous systematic literature review articles were identified in the Scopus database. However, only one study has attempted to connect the Circular Economy with the industrial sector and SMEs, (Nadeem, Garza-Reyes, and Anosike 2023) It aimed to offer a new conceptual model that merges the circular economy framework with lean management techniques for industrial SMEs; the model is new and not empirically tested. Therefore, it is essential to conduct a systematic literature review that explores the connections between Circular Economy, industrial SMEs, Sustainability, and Industry 4.0."

The systematic literature review using the PRISMA methodology employed the following search protocol: 'circular economy AND (SME OR industrial OR manufacturing firms'.

Table (2.5): Circular economy systematic literature review table.

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Acerbi, Sassanelli, and Taisch 2022) | Literature review | This article proposes a circular economy model for manufacturing firms, comprising strategies and practices to advance the circular economy principle. The model consists of (top management decisions, products, processes, and technologies) | To test the model empirically | | | | | | | | | | |
| (Cerya, Idris, and Marta, 2023) | Quantitative | The results and findings of this article are divided into three groups;<br>• Circular Economy (CE) Enablers: increase the prestigious image "Branding," business continuity, and cost reduction.<br>• Circular Economy (CE) Barriers include a lack of financial resources to implement CE, CE regulations and governmental policies, awareness, customer interest in CE, and a lack of top management commitment. | | X | x | x | x | x | x | x | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | • Circular Economy (CE) Practices: supportive infrastructure, waste separation, HR competence and capabilities, and environmentally friendly materials. | | | | | | | | | | | |
| (Bimpizas-Pinis, Calzolari, and Genovese 2022b) | Case studies | Collaboration and coordination between the public and private sectors are vital for achieving high levels of circularity. | | | | | | | | | X | | |
| (Andersen, Ogallo, and Diniz Faria 2022) | Quantitative | The results showed that African (Kenya) industrial firms reached a medium level of green strategies and circular economy principles. | The study recommends conducting the same research in another African context. | X | X | X | X | X | X | X | X | | |
| (de Souza et al. 2020) | Quantitative | A comparison of circular economy practices in Brazilian companies between 2014 and 2019 showed that industrial clustering is a key success | | | | | | | | | X | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | factor in promoting circularity, especially among neighboring firms. | | | | | | | | | | | |
| (Bozzano et al. 2021) | Interview and case studies | The article identified key success factors for a circular economy in a developed EU context (Italy) that would achieve firms' strategies and sustainability trends. | To test the initial finding empirically. | | x | x | x | x | x | x | x | | |
| (Corral-Marfil et al. 2021) | Case study | This case study can be regarded as a real example of how to generate financial benefits from waste recycling (Cooper Recycling). The company's results showed a strong financial position and solid returns. | | | | | | | | | | x | |
| (Pigosso and McAloone 2021) | Focus group and interview | Despite the successful implementation of CE, challenges remain, even in developed countries. Thus, a self-assessment model that helps firms assess their readiness for CE could be a solution. Therefore, this article, based on the industrial firms' CE implementation in Denmark, proposed a CE readiness model that was built on the Likert scale | Going deeper into a model to develop submodules for industrial activities is recommended. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | that covers (Organization, Strategy and Business Model Innovation, Products and Services Innovation, Manufacturing and Value Chain, Technology and Data, Maintenance, Takeback and end of life strategies, Market and Policies) | | | | | | | | | | | |
| (Awan and Sroufe 2022) | Case studies of industrial firms in the USA | This article sought to identify the critical success factors for CE programs by reviewing various CE models. It verified these key success factors through case studies in the USA. | It is recommended that manufacturing firms use the findings of this study to transition from a traditional business model to a circular business model (CE business model) | | | | | | | | | | |
| (Chiarot, Cooper Ordoñez, | Case study | This study tried to link equipment maintenance and the circular economy. This article is based on the resource efficiency principle of circular and green strategies and economies. | | | | x | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| and Lahura 2022) | | | | | | | | | | | | | |
| (Skärin et al. 2022) | Data analysis of CSR reports for the 20 largest firms in Sweden | The most important result of this study is the extension of previous circular economy models to focus on process and product. For example, in the reuse. Although the focus is on the reuse of excess raw materials or products, there should be a focus on process, for example, excess heat (heat recovery, for example) | As the study focused on disclosed sustainability information, it was recommended that empirical studies be conducted to obtain data on the real situation and obtain more accurate, objective information. | x | x | x | x | x | x | x | x | x | |
| (Prieto-Sandoval et al. 2021) | Concept paper- focus group | The article proposed a model to transfer firms from a linear to a circular economic model. The proposed model is based on the CE assessment tool developed by the authors; the model is comprehensive and is based on the following:<br>• Macro-level and state-level regulations and policies related to the circular economy. | To empirically test the model. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | • Meso or Industrial Cluster/Sector level; industrial cluster.<br>• Micro or firm level.<br>Accordingly, an assessment tool was developed. | | | | | | | | | | | |
| (Smol, Marcinek, and Koda 2021) | Literature and document review | This article sought to shed light on circular economy model documents in the EU and Poland, specifically on the use and reuse of raw materials. The reviewed document was the EU Green Deal document.<br>The paper conducts a SWOT analysis of Poland's raw material sector and gives recommendations accordingly. | Similar studies can be developed for different contexts | X | | | | X | X | | | | |
| | | | | | | | | | | | | | |
| (Bozzano et al. 2021) | Case study-Italy | This study proposed an assessment model for food production that focuses on the food processing value chain and applied it to analyze the case of citrus production in Italy. The model covers the | | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | value chain from raw materials to wastewater and wastewater recycling. | | | | | | | | | | | |
| (Rodríguez-González et al. 2022) | Quantitative | The study revealed a positive relationship between CE and financial performance in the Mexican auto industry, as government regulations offer tax reductions for environmental activities and practices. | To conduct the study in other contexts where there are no governmental environmental incentives. | | | | | | | | | | |
| (Schöggl et al. 2023) | Quantitative | The positive relationship among digitization (industry 4.0 technologies), circular economy practices, and sustainability also varies across contextual conditions and industrial clusters. | To conduct more related empirical research | | | | | | | | | | |
| (Batool, Ye, and Wang, 2023) | Quantitative | The chain positively impacts the circular economy in Pakistan's context | More empirical studies, including other Industry 4.0 technologies, are recommended | | | | | | | | | | |
| (Krmela and Šimberová 2023) | Quantitative | The results of this study showed that higher-level circular economy practices would lead to lower competitive advantage, whereas lower levels of CE | | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | would lead to higher competitive advantage. Hence, this research's results oppose the vast majority of the literature. | | | | | | | | | | | |
| (Al-Swidi et al. 2023) | Quantitative | Regulatory and competitive pressure positively promote the circular economy and adoption of Industry 4.0 strategies. | It is recommended that case studies be conducted to support the theoretical model proposed in the study. | | | X | X | | X | | | | |
| (Castro-Lopez, Iglesias, and Santos-Vijande 2023) | Quantitative | Institutional pressure and Organizational capabilities (mainly organizational agility) promote specific circular economy practices as follows;<br>• Organizational agility affects the circular product design and circular production.<br>• Dynamic capabilities (internal drivers) do not directly relate to circular economy practices (environmental practices). However, it does have an indirect effect. | Other organizational capabilities other than agility can be examined in future studies. | | X | X | X | X | X | x | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | • Institutional pressure does have an indirect effect on circular product innovations. | | | | | | | | | | | |
| (Mora-Contreras et al. 2023) | Quantitative | Environmental practices positively lead to sustainability, circular economy performance, and organizational performance in Colombia. | | | | | | | | | | | |
| (Luu et al. 2023a) | Quantitative | According to the RBV theory, Industry 4.0 and the circular economy constitute valuable intangible resources that drive good performance in a green supply chain. | It is recommended that additional related research be conducted to examine performance beyond the green supply chain. | | | | | | | | | | |
| (Matos et al. 2023) | Concept | This paper is unique and specific to the automotive industry, which uses vast amounts of plastic materials. The paper identifies specific circular economy practices that reduce, reuse, and recycle plastic materials within the automotive industry. | | | | | | | | | | | |
| (Palea, Migliavacca, | Quantitative | The study revealed that stakeholder involvement in CSR activities and reporting can promote circular economy practices. | | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Green Strategies) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| and Gordano 2024) | | | | | | | | | | | | | |
| | | | **Total** | 4 | 5 | 7 | 6 | 3 | 7 | 5 | 5 | 2 | |

| # | Item/ Variable |
|---|---|
| 1 | CE Branding |
| 2 | Financial Gains and Production Efficiency |
| 3 | Resources Efficiency |
| 4 | Usage of Eco-friendly materials |
| 5 | Waste Separation and Management |
| 6 | Re-use waste water, materials |
| 7 | Energy efficiency practices |
| 8 | Collaboration and Coordination to implement CE, including clustering |
| 9 | economical impact |

In general, the concept of the circular economy has been developed. However, the adoption and use of these concepts in industrial SMEs are still in the inductive/inception phase, and more effort is needed. (Jirakraisiri et al. 2021; De Marchi et al. 2013). While the green and circular economy adoption can positively boost economic performance, besides the reduction of environmentally adverse events, (Jirakraisiri et al. 2021; De Marchi et al. 2013).

Finally, several attempts were made to integrate the circular economy and sustainability theories into the well-established institutional theory. However, most of the circular economy literature draws on the resource-based view and its extension to natural resources, stakeholder theory, institutional theory, and other main theories for circular economy and other green practices.

**2.6 Organizational Resilience**

(Meyer 1982) I defined organizational resilience as the ability to respond to turbulence and restore its previous order. According to previous studies, complex and related factors affect organizational resilience abilities, (Wang et al. 2024) These three levels affect organizational resilience: learning and development, redundancy, and adaptation. (1) Individual: personal abilities like learning, training, and knowledge; (2) organizational level: organizational relationship with stakeholders, knowledge transfer; (3) environmental level: mainly the external pressure, (Wang et al. 2024).

Most of the previous literature referred to resilience as the ability to withstand and recover from disruptions, adapt to change, and continue operations in the face of crises. It emphasizes preparedness, risk management, and the capacity to bounce back after adverse events. (Lopez et al. 2024; Meyer 1982; Wang et al. 2024).

Furthermore, there is no agreement in the literature on organizational resilience models. (Rahi, 2019) proposed a two-dimensional model for organizational resilience: awareness and adaptive resilience. Duchek (2020) proposed a three-dimensional model for organizational resilience. His model stands on anticipation, coping, and adaptation. Other scholars claim that organizational resilience is interactive and progressive, which develops over time, (Amaral and Da Rocha 2023).

(Browder, Dwyer, and Koch 2024)Interest in organizational resilience has increased recently, with several related publications rising sharply over the last decade; the figure below shows organizational resilience publications over the previous two decades in the Scopus database, using organizational resilience as the search keyword (search protocol).

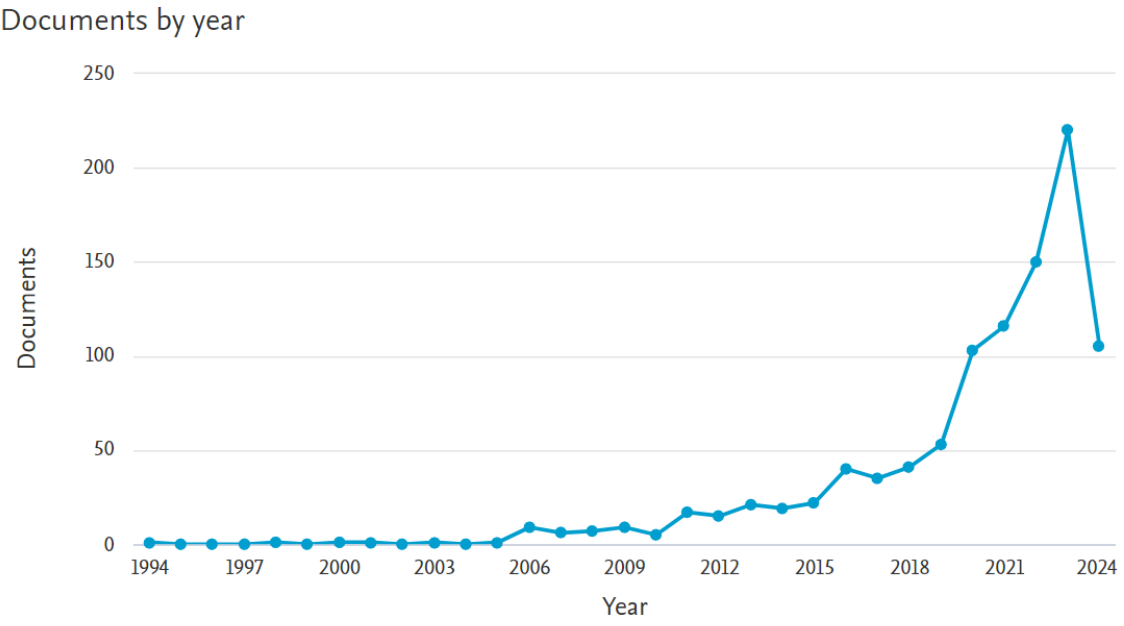


Figure (2.19): Number of publications on organizational resilience in general, based on the Scopus electronic database.

The most recent literature addressed and focused on organizational resilience as a process. Unfortunately, most of these studies described the process outcome rather than the process black box. Moreover, many scholars linked process resilience with crises and risk management, (Browder et al. 2024). Linking resilience to crises and risk management enables organizations to resist future crises and/or unexpected events. (Browder et al. 2024; Pal, Torstensson, and Mattila 2014).

Linking organizational resilience with dynamic capabilities was not well addressed in the literature. The vast majority of the previous literature examined the impact of dynamic capabilities on organizational resilience (You et al., 2023; Ahmić., 2022; Prayag et al., 2024; Radic et al., 2022; D. Wang & Zhao, 2024). Nevertheless, a misunderstanding and

mixing between organizational resilience and organizational agility can be seen in the literature.

(You et al. 2023) Proved that there is an indirect relationship between organizational resources, organizational dynamic capabilities, and organizational resilience. Organizational resilience was based on three dimensions (recovery, readiness, and response). While (Akpan, Johnny, and Sylva 2022) Link the relationship between dynamic capabilities and organizational resilience to agility and adaptability.

(Manfield and Newey 2018) This raised the question of whether resilience is static or a process. (Manfield and Newey 2018) Indirectly referred to resilience as a dynamic concept and recommended conducting more future research in this field to point out and figure out the resilience concept (whether it is static or process).

Thus, integrating dynamic capabilities theory with resilience would enhance organizational resilience to cope with an ever-changing business environment and unexpected future crises and risks.

The following figure represents the number of related articles in the PRISMA systematic literature review.

Table (2.6): Organizational Resilience Literature Review.

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Organizational Resilience) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Ahmić 2022) | Quantitative | This article examined sustainability and resilience and revealed a positive relationship. Hence, the organizational resilience was measured as results | To study the industry 4.0 technologies, like artificial intelligence and digitalization, on resilience | x | x | X | | | | | | | |
| (Radic et al. 2022) | Literature review | Thirty-four articles were reviewed and analyzed; the authors proposed a general framework to enhance organizational resilience. The proposed model is based on three levels (organizational, individual, and environmental) | Empirical studies will be conducted to test the proposed model. | | | | | | | | | | |
| (Bouaziz and Smaoui Hachicha 2018) | Quantitative | This article studied strategic human resources and organizational resilience. Positive relationship between strategic HR practices and organizational resilience | | | | x | x | X | | | | | |
| (Fathi et al. 2021) | Quantitative | This article tried to shape the relationship between resilience and competitive advantage. However, the measured organizational resilience dimension was more closely related | | None, since resilience is more cultural resilience. | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Organizational Resilience) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | to cultural resilience than to process or organizational resilience. | | | | | | | | | | | |
| (Pal et al. 2014) | Quantitative | The study revealed that different integrated strategies can be followed to achieve SME resilience, mainly learning and leadership, dynamic competitiveness, and resourcefulness. | | x | x | x | x | x | x | X | | | |
| (Manfield and Newey 2018) | Concept | The author reviewed resilience across many research domains, including psychology, business, and engineering. He revealed two types of business resilience in entrepreneurship: routine resilience capabilities and heuristic capabilities. | It is recommended that research continue in the field of resilience and that we determine whether organizational resilience is static or a process. | | | | | | | | | | |
| (Lamprinakis 2019) | Concept | The author revealed that CSR activities, including business resilience, can contribute to good business results. | | None, since resilience is more cultural resilience. | | | | | | | | | |
| (Teixeira and Werther 2013) | Qualitative | Organizational resilience is organizational innovation that positively impacts organizational competitiveness. | | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Organizational Resilience) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| (Aming'a, Marwanga, and Annan 2024) | Quantitative | Green strategies and the circular economy in the supply chain and in the closed loop positively affect the resilience and sustainability of supply chains in Kenya. | It is recommended that further research be conducted in contexts beyond the manufacturing sector. | | | X | X | | | | X | X | |
| (Kennedy and Linnenluecke 2022) | Concept | This paper reviewed current research on the circular economy and resilience. The study proposed multi-layer research that combined circular economy and resilience, for example, (social-ecological resilience). | | | | | | | | | | | |
| (Lampel, Bhalla, and Jha 2014) | Quantitative | This research tried to illuminate the relationship between firm governance and firm resilience. It revealed that employee stock programs contributed to organizational resilience. However, other factors also needed to be addressed. | | | | | | | | | | | |
| (Sullivan-Taylor and | Quantitative | This study tested Weick and Sutcliffe's (resourcefulness, technical, organizational, and rapidity) model in UK SMEs. According to | Future research is recommended to help SMEs develop resilience capabilities. | | | | | | | | | | |

| Authors | Research Method | Results, Discussion, and Conclusion | Recommendation | Variables (Organizational Resilience) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Branicki 2011) | | SME managers, the rapidity domain dominates organizational resilience in SMEs. | | | | | | | | | | | |
| (Ciasullo, Chiarini, and Palumbo 2024) | Literature Review | The authors reviewed 51 related publications and concluded that resilience is a multi-layered, multidisciplinary concept that requires different organizational functions to act together. Page 1440 represents a proposed model that combines HR, strategic management, and the business environment with resilience. Hence, the central concern of this article is the eco-social concept (redundancy, responsiveness, and adaptability). | | | | | | | | | | | |
| (Perramon et al. 2024) | Quantitative | A positive relationship between the circular economy and organizational resilience. Circular economy practices, like green policies. | It is recommended that green strategies be promoted at the national level. | | | | | | | | | | |
| | | | | 2 | 2 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | |

| # | Variables |
|---|---|

| | |
|---|---|
| 01 | Anticipating |
| 02 | Coping |
| 03 | Adaptability |
| 04 | Agility and flexibility |
| 05 | Integrity |
| 06 | Redundancy |
| 07 | Networking |
| 08 | Robustness |
| 09 | Risk cultures |

The link between established theories and organizational resilience has recently received more attention. However, the number of publications is limited; the previous literature in the field of organizational resilience and dynamic capabilities can be summarized as follows;

While several studies have explored the relationship between dynamic capabilities and organizational resilience, none have directly tested Teece's dynamic capabilities framework. Most researchers have examined specific elements of the theory in connection with resilience. For instance, (García-Valenzuela et al. 2023) Analyzed the relationship between dynamic capabilities - such as innovation, knowledge, dynamic detection, and integration- and resilience. Similarly, (Akpan et al. 2022) Focused on particular dimensions like sensing and reconfiguration. Notably, (You et al. 2023) It appears to be the only study applying Teece's dynamic capabilities theory (sensing, seizing, and reconfiguring) to organizational resilience.

Other researchers have employed dynamic capabilities theory as a mediator or moderator to explain the relationship with organizational resilience. For example, (Wang and Zhao 2024) examined the relationship between resources and resilience, using dynamic capabilities as a mediating factor

Few studies have attempted to merge dynamic capabilities and organizational resilience. For instance, (Pertheban et al. 2023) Proposed and tested a theoretical framework, but it lacks strength in explaining the link between the two concepts as comprehensively as other published research. (Zighan et al. 2022) I proposed a simple model of dynamic organizational resilience through learning and the integration of entrepreneurs' capabilities in Jordan.

(Ma, Xiao, and Yin, 2018) They attempted to theoretically connect various aspects of resilience with organizational dynamism, although their focus was not specifically on organizational resilience. (Ishak and Williams, 2018) They focused on the resilience behaviors of highly reliable organizations (HROs), including Civil Defense and multinational organizations such as IBM. They proposed a resilience model based on two dimensions: the amount and type of resilience, suggesting that the greater the variety and extent of resilience, the more dynamic the organization.

In line with (Mhlanga 2024) Further research on the theorization of organizational resilience is recommended. Building on previous attempts, the following model is proposed based on dynamic capabilities theory and organizational resilience.

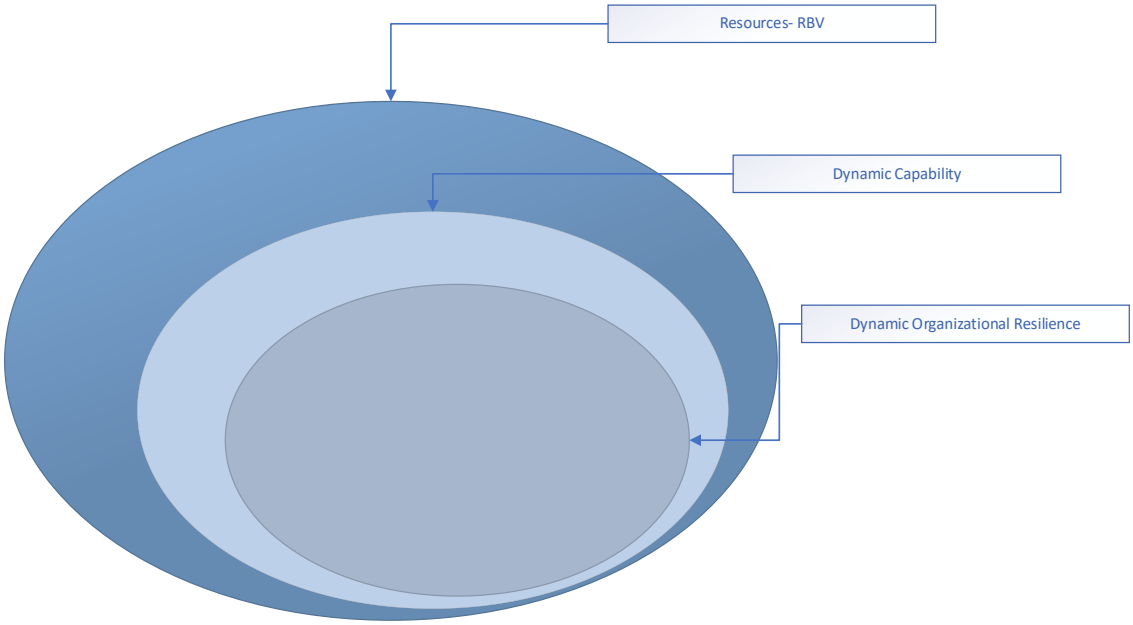


Figure (2.20): Theoretical relationship between RBV, DC, and organizational resilience

This model, illustrated in the figure below, is derived from the dynamic relationship between organizational resilience and Teece's dynamic capabilities framework, as well as key concepts explored by (Akpan et al. 2022; Ishak and Williams 2018; Lopez et al. 2024).

Moreover, previous research on organizational resilience has primarily focused on identifying its drivers, characteristics, and dimensions; none have integrated these elements into a comprehensive model. The proposed theoretical model (Figure 2.21) brings together these constructs across different levels of resilience, uniquely grounded in well-established theories such as dynamic capabilities theory.

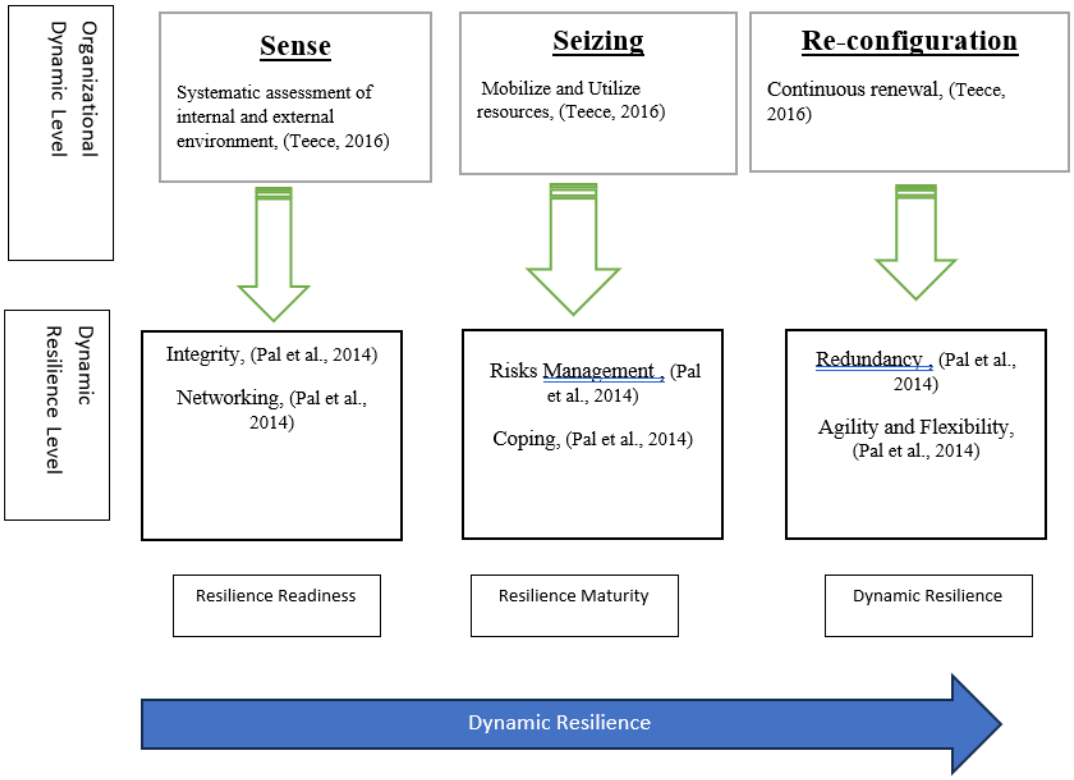


Figure (2.21): The organizational dynamic resilience model that the author developed.

## 2.7 Turbulent Environment

According to Mintzberg (2001), the environment is the external conditions that impact and influence organizational decisions, operations, and processes. The turbulent climate is characterized by continuous changes that are uncertain and unpredictable, (Rabelo et al. 2016).

A turbulent environment can take many forms, for example, the rapid changes in technologies and innovation processes. (Grant 2003; Rabelo et al. 2016), governmental hostile interventions, (Rabelo et al. 2016)disasters and closers like the COVID-19 global closer, (Dwikat et al. 2023).

Previous research does not address or explore the effects and implications of the turbulent environment on Small and Medium Enterprises (SMEs). Hence, SMEs continuously face ever-changing external conditions beyond their control (Bandeira de Mello and Marcon, 2005; Yapicioglu, 2023). Therefore, the rapidly changing environment affects instability

and uncertainty, innovation, competitiveness, SME performance, and overall economic performance (Dwikat et al., 2023).

SMEs operating in turbulent environments, such as the Palestinian context, need greater flexibility in their strategies and resource mobilization to adopt more dynamic capabilities and remain continually resilient. (Alberti, Ferrario, and Pizzurno 2018; Yapicioglu 2023)

Mainly, two levels of turbulent environment can be identified and measured: first, the global and national pressure level; second, the industry pressure level. (Ramírez and Selsky 2016) The national level includes the national unpredictable policies and regulations that regulate the business working environment, for example, the additional restrictions on ecology and environmental protection, and in the Palestinian case, it includes the Israeli occupation's additional restrictions (for example, the import and export restrictions, and the long dual-use material list). While technological innovations and changes in the industry can characterize the second level, (Dwikat et al. 2023; Ramírez and Selsky 2016).

Accordingly, under the two categories lie the following constructs with rigorous reference.

Table (2.7): Turbulent Environment Constructs.

| Item | Reference |
|---|---|
| **National Level** | |
| Occupation Policies “Special in Palestinian Case” | (Dwikat et al. 2023) |
| Legal regulations framework | (Bandeira de Mello and Marcon 2005; Rabelo et al. 2016; Yapicioglu 2023) |
| Globalization and Ease of Global Trade and Transportation | (Antony, McDermott, et al. 2022; Wright, Suh, and Leggett 2009) |
| **Industrial level** | |
| Competition (domestically and globally). | (Bandeira de Mello and Marcon 2005; Dwikat et al. 2023) |
| Technological changes | (Dwikat et al. 2023; Grant 2003; Rabelo et al. 2016; Ramírez and Selsky 2016; Yapicioglu 2023) |

Finally, firms' size can positively contribute to or moderate the relationship between strategies and performance or sustainability in turbulent environments. Thus, it is important to consider firms' size along with a turbulent environment.

## 2.8 Sustainability Performance, Organizational Performance, and Competitive Advantage

**Sustainability** is defined as meeting current needs without depleting resources for future generations. (Abdullahi et al. 2023; Abukari, Musah, and Assaidi 2023; Udayana et al. 2024).

Globalization, industrialization, and economic development significantly affect the environment, depleting natural resources and well-being. (H. Liu et al. 2023). Thus, environmental and social aspects, as well as the financial and non-financial performance, are essential to be evaluated and measured, (Dwikat et al. 2023; García-Valenzuela et al. 2023; Hamsal, Ichsan, and Wicaksono 2023).

Accordingly, firms must include environmental, human (social), and economic indicators. The triple bottom line of sustainability, which consists of social, ecological, and economic, has been proven in the literature to capture the sustainability performance. (Abdullahi et al. 2023).

Previous studies have shown that maximizing economic, social, and environmental performance and protecting natural resources can yield positive outcomes. (Abdullahi et al. 2023; Abukari et al. 2023; Bandeira de Mello and Marcon 2005).

Economic performance can be characterized as short-term, medium-term, and long-term financial performance. (Cohen, Smith, and Mitchell 2008). Additionally, economic performance was explicitly linked to the rapid response to changing market conditions through the leveraging of dynamic capabilities (Abukari et al., 2023; Sanusi & Johl, 2022). Furthermore, the more economic stability and growth, the more market stability and market performance, the more quality of life increases (Dwikat et al., 2023; Zahari et al., 2023)

The environmental performance can be characterized by firms' activities toward more eco-friendly products/services (green products) and eco-friendly processes and policies. (Asif 2023; Fraj et al. 2011; Pattinson et al. 2023; Rajapakse et al. 2022; Saether et al. 2021; Song et al. 2024; Yugai et al. 2023)Hence, the environmental aspect received more attention from governmental and private institutions. The United Nations has issued sustainable development goals (16 goals) for the environment, gender, development, and carbon reduction. (Dwikat et al., 2023; Salvador et al., 2023; Zahari et al., 2023).

The last aspect of sustainability is the social pillar, and social performance can be characterized by the social impact of firms' activities. Unlike economic and environmental performance, which have received more attention in the literature, the social aspect, as the third pillar of the triple bottom line of sustainability, does not receive the same attention. (Almagharbeh 2024; Ciasullo et al. 2024; Dwikat et al. 2023) Furthermore, globalization and technological advancements have drastically affected society. Hence, the social aspect is measured by its impact on stakeholders, including the community, customers, and employees. (Amer 2023b).

Although organizational performance and sustainable competitive advantage have been well addressed in the literature, they have not been well studied in the Palestinian context or in the industrial/manufacturing sectors. Fewer researchers and studies have examined these aspects. (Amer 2022, 2023a).

**Organizational** performance was well addressed in the literature. However, there is no standard agreement on organizational performance measurements; some scholars used the published financial data to represent organizational performance, (Abukari et al. 2023)Others used financial performance and non-financial performance based on questionnaire collected data, (Amer 2022, 2023a; Dwikat et al. 2023; Zahari et al. 2023).

Regarding the Palestinian context, only 7 published articles were found (Alfoqahaa, 2018; Dwikat et al., 2023; Zahari et al., 2023), and measured the organizational performance and sustainability using questionnaires with items related to financial and non-financial performance. Likewise, (Amer 2022, 2023a; Hussain, Shahzad, and Hassan 2020; Sultan, van Dijk, and Omran 2020) used Likert-scale questions to measure financial, operational,

and marketing performance. Meanwhile, Shihadeh (2021) used the published Return on Investment as an organizational performance indicator for public banks in Palestine.

As most of the Palestinian manufacturing sectors are characterized as small and medium enterprises and family businesses,(Amer 2022; Dwikat et al. 2023; Sultan et al. 2020). Thus, publishing financial and non-financial performance data is not obligatory for SMEs. Therefore, questionnaire surveys to measure performance are an acceptable, valid, and verified method. (Amer 2022, 2023a).

Finally, two schools of thought were considered concerning the firms' sustainable competitive advantages and performance. First, the resource-based view of Jay Barney, which summarizes the sustainable competitive advantages of the degree or level of a firm's ability to sustain its rare and valuable resources (Barny Jay 1991)Accordingly, Barney proposed the VRIO (Valuable, Rare, Non-imitable, and Organized) framework to measure competitive advantage.

The second school of thought is the industrial-based view (Porter, 1985), which holds that marketing strategies create sustainable competitive advantage. Porter discussed the strategy that achieved a sustainable competitive advantage and offered two main general strategies (Cost leadership and differentiation). Hence, Porter's market-oriented approach meant that a firm's position within its industry can be determined through its approach to dealing with its external five forces (customers, buyers, competitors, substitute products, and new entrants), (Sharp 1991)

A debate in the literature about which view can better characterize the sustainable competitive advantages, (Gellweiler 2018)One of the famous debates regarding these two thoughts is the debate between Jay Barney and Richard Prim. Accordingly, a literature review and empirical research examined both views (resources and industry views).

(Newbert 2007) Reviewed 55 articles contained 549 individual tests of RBV theory elements (independent and dependent variables) as presented by (Barney, 1991), in which 292 (53%) of those tests support the RBV direction as given by (Barney, 1991); these results also support (Warnier, Weppe, and Lecocq 2013) The conclusion that RBV needs to be extended, it is evident that in the remaining 47% of empirical tests that do not support

the RBV direction, the firms might not be interested in utilizing those resources to achieve competitive advantages, or it might be utilized to maintain the level of competitive but not completing the competitive advantage, (Newbert, 2007).

To close the gap in empirical testing of RBV theory, the relationship between VRIN resources and competitive advantage, (Newbert 2008) Conducted an empirical testing study and found that the more valuable and rare resources firms have and utilize, the more likely they are to attain competitive advantages. (Newbert 2008). Other scholars also supported these results. In a study conducted in the Croatian context, a sample of 265 companies across industries found that rare and valuable resources were positively correlated with achieving high performance and competitive advantage. (Talaja, 2012).

In conclusion, an integration model that merges two views can describe sustainable competitive advantages based on empirical findings. (Gellweiler 2018; Newbert 2007). Noting that Jay Barney proposed to test his theory in other than developed country contexts, and Porter also agreed that his market-oriented view needs to be extended toward rare resources, (Gellweiler 2018).

### 2.9 Resources-Based Theory (RBV) and its extension

According to Jay Barney, two main issues in achieving sustainable competitive advantages are rare and valuable sources; the more rare and valuable sources firms had, the more sustainable their competitive advantage capabilities were (Barney, 1991; J. B. Barney, 2001).

Accordingly, the resource-based view Theory urged firms to adopt unique value-creation strategies that competitors did not. The sustainability of competitive advantage is measured by a firm's ability to sustain rare and valuable resources (Barney, 1991).

RBV theory was extended to dynamic markets, where dynamic capabilities theory emerged because RBV was unable to explain how and why firms achieve competitive advantage in situations of rapid, unpredictable change. .(Eisenhardt & Martin, 2000)

Another extension of RBV theory is the Natural Resources View; it extends the concept of RBV to include environmental elements, awareness, and the ecological system as integral parts in achieving sustainable competitive advantage. (Johan et al. 2023).

Finally, this research contributes to RBV and its extension theories by empirically testing their applicability in the Palestinian turbulent environment.

### 2.10 Stakeholder Theory

Stakeholder theory holds that strategic management approaches, particularly the management of stakeholder relationships, are key success factors in achieving desired organizational goals. Hence, an organization that meets its stakeholders' requirements and hopes can be regarded as effective under stakeholder theory. (Johan et al. 2023).

### 2.11 Triple Bottom Line Theory (TPL) and Technology, Organization, and Environment TOE Model

According to this theory, effective organizations focus on environmental, social, and economic performance. TPL was first introduced by John Elkington (Business Development Advisor) in 1990. The TPL theory can contribute to this research by informing the results section of the proposed model.

However, the TOE model contributed to the Enabler part of the model, as the TOE can influence technology and innovation decisions. Moreover, the TOE model balances internal and external sustainable factors/enablers to achieve the organization's intended results with an ecological flavor (DiPietro et al., 1990; Mamer c, 2023).

### 2.12 Institutional Theory

Douglass Cecil introduced the institutional-based theory, which states that institutional factors and behaviors affect economic and social outcomes.(Hu 2023).

## 2.13 Chapter Two Conclusion

In conclusion, this thesis's topic is relatively new in the literature. It holistically addresses the relationship between new concepts that merged business enablers and environmental initiatives, and their impact on performance.

The circular economy, green strategies, sustainability, resilience, and supply chain are new topics in the literature with limited publications. Hence, this chapter addressed the sub-variables and dimensions of these variables/topics.

As for quality 4.0 and industry 4.0, despite the relatively large number of publications in the field of Total Quality Management, the number of publications in the sub-field of quality 4.0 is relatively low, as quality 4.0 is closely linked to the industry 4.0 concept, introduced to the literature in late 2011. Moreover, the related Industry 4.0 and Quality 4.0 dimensions.

Finally, this chapter summarizes related theories, providing the theoretical background for the study's variables. Hence, a linkage between theories and hypotheses was developed in Chapter Three.

# Chapter Three: Methodology

## 3.1 Introduction

This chapter discusses the hypothetical model, the constructions involved, the design of the data collection tool, and the validity testing of both the model and the tool. The hypothetical model summarizes the relationships between dependent, independent, and mediating variables, the corresponding hypotheses, and their coding. A total of 33 hypotheses are presented, covering the theoretical model derived from several well-established business and strategic theories, such as the Resource-Based View (RBV), Porter's Five Forces, Institutional Theory, and Upper Echelon Theory.

In addition, the chapter clarifies the types of validity tests conducted, including a collinearity test. It also outlines the technique used for hypothesis testing, which involves bootstrapping within Partial Least Squares Structural Equation Modeling (PLS-SEM).

## 3.2 Hypothesis and theoretical background:

Based on the abovementioned initial results, the following enabler and results-based framework is proposed for the current study:

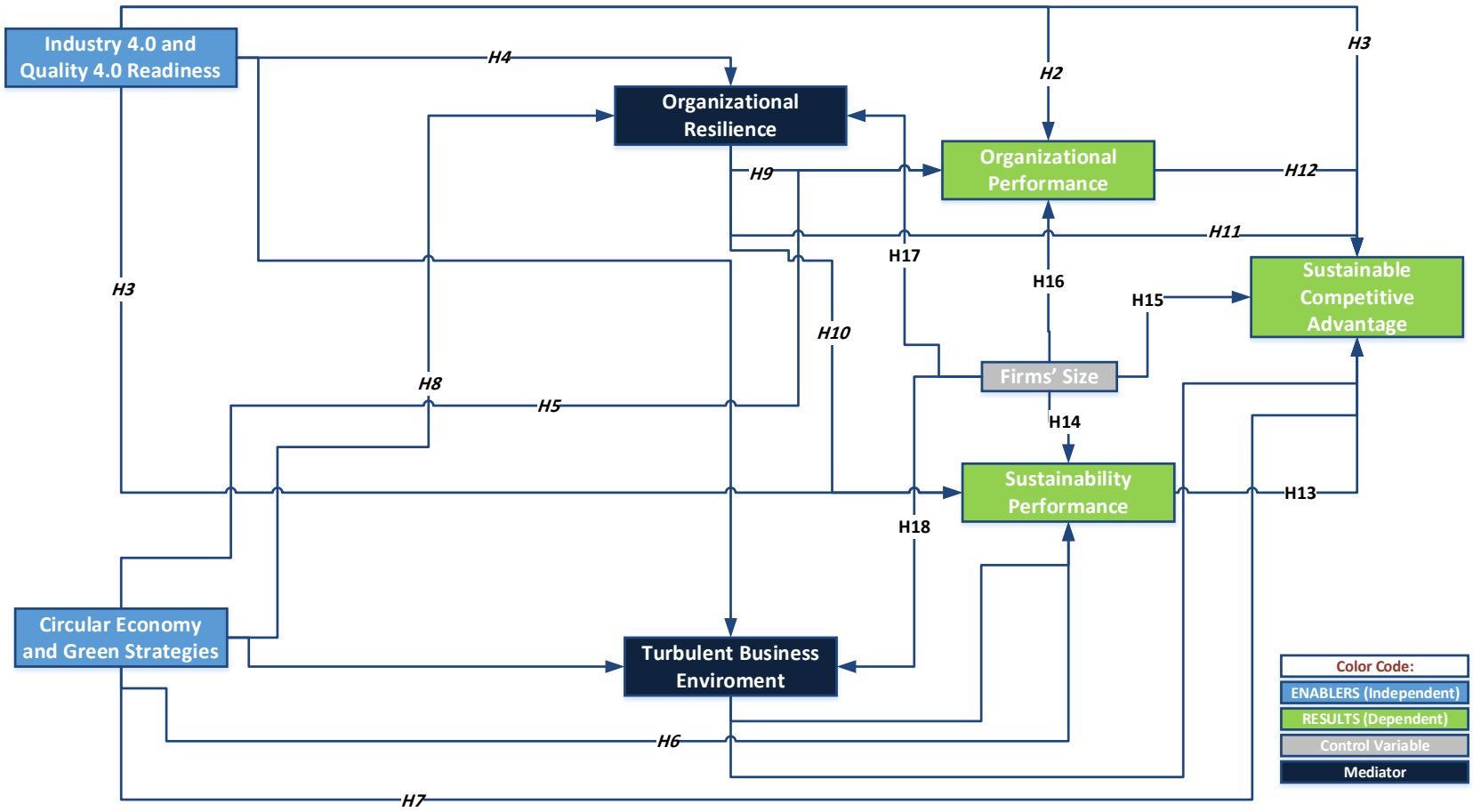


Figure (3.1): Study framework.

### 3.3 Hypothesis:

#### 3.3.1 Industry 4.0 and Quality 4.0 Readiness Group:

*H1: Industry 4.0 and Quality 4.0 Readiness positively impact the Organizational Performance.*

*H2: Industry 4.0 and Quality 4.0 Readiness positively impact the Sustainability.*

*H3 Industry 4.0 and Quality 4.0 Readiness positively impact the sustainable competitive advantage.*

*H4: Industry 4.0 and Quality 4.0 Readiness positively impact the Organizational Resilience.*

Starting from Jay Barney's Resource-Based View (RBV) theory, TEO: Technology, Environment and Organizational model; Quality 4.0 and Industry 4.0 technologies, along with organizational readiness and maturity levels, are considered both tangible and intangible organizational resources that enhance competitive advantages and performance (Barney, 1991), in which these resources are utilized referring to institutional theory to derive the intended outcomes like sustainability, sustainable competitive advantage and organizational performance (financial, marketing and operational). Moreover, quality 4.0 and industry 4.0 are considered institutional factors that affect economic performance, according to institutional theory.

An ambiguity in the literature regarding sustainability, sustainable competitive advantage, and organizational performance emerged amid Industry 4.0 and Quality 4.0. The literature revealed a positive relationship. (Pop et al. 2023; Swarnakar et al. 2023b). While others revealed a negative relationship between quality 4.0 and industry 4.0 with different performance matrices, (Gupta et al. 2022; Tripathi and Gupta 2023).

The vast majority of border literature on total quality management indicated a positive relationship between TQM practices and organizational, supply chain, and financial performance. (Amer 2022, 2023b, 2023a)

Fewer researchers have tried to identify the drivers of competitive advantage in the era of Industry 4.0/quality 4.0 (Kukharuk & Gavrysh, 2019). Similarly, limited researchers tried

to examine the relationship between Industry 4.0 and organizational resilience (Chari et al., 2022; Hattinger & Stylidis, 2023; Marcucci et al., 2022)

Therefore, testing and studying the relationships between quality 4.0 and industry 4.0, on the one hand, performance (sustainability, sustainable competitive advantage, and organizational performance) and organizational resilience, on the other hand.

### 3.3.2 Circular Economy and Green Strategies Group:

*H5: Green and Circular Economy Strategies positively impact Organizational Performance.*
*H6: Green and Circular Economy Strategies positively impact sustainability.*
*H7: Green and Circular Economy Strategies Positively Impact the Sustainable Competitive Advantage.*
*H8: Green and Circular Economy Strategies Positively Impact Organizational Resilience.*

Green strategies, green supply chains, and circular economy strategies and practices are new concepts recently introduced to the literature, for which more related research is needed to develop the circular economy theory or to build a concrete extension of one or more well-established theories and perspectives. (Mhatre et al. 2021; Pieroni, McAloone, and Pigosso 2020; Prieto-Sandoval et al. 2021). Therefore, more deductive and inductive research is required before the introduction of a specific model or theory, (Hu 2023; Sunarya et al. 2023).

A few publications tested the green strategies and their impact on performance, (Hu 2023; Sunarya et al. 2023) Revealed a positive relationship. Likewise, the circular economy publication revealed a positive relationship with business performance, (Filho et al. 2022b), and supply chain performance (Piyathanavong et al. 2022).

Resource-based view theory and its extension, the natural resources-based view, dynamic capabilities, and the TEO model are well-established theories that best describe the circular economy and green strategies. However, they should be taken holistically, as RBV can describe sustainable competitive advantage, TOE, and dynamic capability, which can partially cover environmental performance, organization, and resilience. Hence, the TOE

model and institutional theory can partially cover green strategies, the circular economy, and sustainability components.

The limited literature in the field of organizational resilience revealed a positive relationship between resilience and performance, (Hasayotin 2023). In which only one article shaped the relationship between circular economy and organizational resilience, and found it positive, (Lopes de Sousa Jabbour et al. 2023).

The relationship between organizational resilience and dynamic capabilities is discussed and clarified in the literature review chapter, where a few researchers have sought to link the two theories. (Akpan et al. 2022; Ma et al. 2018).

Finally, testing the impact of circular economy and green strategies on performance, sustainability, sustainable competitive advantage, and organizational resilience.

### 3.3.3 Organizational Resilience Group:

*H9: Organizational Resilience Positively impacts organizational performance.*
*H10:Organizational Resilience Positively Impacts Sustainability.*
*H11:Organizational Resilience Positively Impacts Sustainable Competitive Advantage.*
There is a strong connection between the Resource-Based View (RBV) theory and dynamic capability theory when considering organizational resilience. Tecce's dynamic capability theory provides the theoretical foundation for understanding organizational resilience, as discussed in the literature review. The concept of "dynamic resilience" is a relatively new term in the literature, with only a few published articles exploring it. In the turbulent and occupied Palestinian economy, dynamic resilience capabilities have taken on significant importance, (Hou et al. 2024; Ma et al. 2018).

Although few studies have examined the relationship between organizational resilience and dynamic capabilities to define dynamic resilience, this study's objective is to introduce this emerging concept into the literature. Moreover, limited research on the link between resilience and performance (Sinniah et al., 2022) revealed a positive relationship between organizational resilience and business performance.

The majority of empirical publications in the field of organizational resilience treated it as an outcome, using a dependent variable approach. (Bouaziz and Smaoui Hachicha 2018; Mitsakis 2022) tested the relationship between human resources management and organizational resilience; (Lopes de Sousa Jabbour et al. 2023) tested the relationship between circular business practices and organizational resilience; (Hou et al. 2024) tested the supply chain and its impact on resilience; (Lamprinakis 2019) Proved that good CSR practices positively contribute to achieving organizational resilience; (Akpan et al. 2022) Tested the dynamic capabilities and their impact on resilience in the Nigerian context.

However, fewer studies have examined organizational resilience as a capability that drives and fosters performance. (Lopez et al. 2024) studied the impact of organizational resilience on innovation; (Weber 2023) revealed a positive relationship between organizational resilience and sustainability; (Ciasullo et al. 2024) systematically reviewed the literature on resilience and its impact on sustainability; (Pertheban et al. 2023; Wang and Zhao 2024) Revealed a positive relationship between organizational resilience and performance.

One article examined the relationship between organizational resilience and competitive advantage and revealed a positive relationship. However, the competitive advantage was a mediator between organizational resilience and firm performance, (Fathi et al. 2021).

Therefore, testing the relationship between organizational resilience and performance matrices (organizational performance, sustainability, and sustainable competitive advantage) is important.

### 3.3.4 Dependent Variables Related Hypothesis

*H12: Organizational performance positively impacts the sustainable competitive advantage*

*H13: Sustainability Positively Impacts Sustainable Competitive Advantage.*

The Resource-Based View (RBV), Sustainability Theory, and Institutional Theory provide the theoretical foundation for this hypothesis. According to the RBV's VRIO framework, strong organizational performance can act as a catalyst for sustaining a firm's competitive advantage, (Barney 1991)

While a few studies have explored the links between organizational performance, sustainability, and competitive advantage in developed countries (SubbaNarasimha 2001; Timotius 2023; Ullah et al. 2022). Such a relationship has not been examined in the context of developing countries, especially in the Arab world.

Testing this relationship in the Palestinian context could contribute valuable insights to the literature by either confirming or challenging existing findings.

### 3.3.5 Firm Size "the control variable" related Hypothesis:

*H14: Firm size significantly influences sustainability performance.*

*H15: Firm size significantly influences the sustainable competitive advantage performance*

*H16: Firms' size significantly influences organizational performance.*

*H17: Firms' size significantly influences organizational resilience.*

*H18: Firm size significantly influences the turbulent environment*

Previous studies in the field of quality 4.0, industry 4.0, and circular economy used the firms' size as a controlled variable, like (Fathi et al. 2021; Khin and Hung Kee 2022) Both revealed a positive correlation between company size, sustainable competitive advantage, and business performance.

(Sullivan-Taylor and Branicki 2011)Revealed that organizational resilience is affected by the firm size. While, (Ahmić 2022) Found that organizational size can mediate the effect between sustainability and resilience.

Accordingly, measuring the impact of firm size on sustainability, sustainable competitive advantage, resilience, organizational performance, and turbulent environment would enrich the literature.

### 3.3.6The Mediating Effect Hypothesis Group

### *3.3.7 The mediating roles of Quality and Industry 4.0 in the relationships between the Circular economy and performance matrices, and in organizational resilience (group of hypotheses).*

*H19: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Organizational Performance.*

*H20: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Organizational Resilience.*

*H21: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Sustainability Performance.*

*H22: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Turbulent Business Environment*

(Tapia-Andino and Barcellos-Paula 2023) Tested the mediating effect of Industry 4.0 between job involvement and job performance and revealed mixed results according to sex (men and women). (Torrent-Sellens, Ficapal-Cusí, and Enache-Zegheru 2023) The study tested Industry 4.0's mediating role in environmental assets and social performance and confirmed a positive relationship.

Therefore, testing the mediating role of industry and quality 4.0 between a circular economy with performance and organizational resilience would enrich the literature, as only two articles used industry 4.0 as a mediating factor.

### *3.3.8 The mediating role of Turbulent Business Environments*

*H23: Turbulent Business Environment Mediates the Effect between Circular Economy and Green Strategies with Organizational Performance.*

*H24: Turbulent Business Environment Mediates the Effect between Circular Economy and Green Strategies with Sustainability Performance.*

*H25: Turbulent Business Environment mediates the effect between Industry and Quality 4.0 with Organizational Performance.*

*H26: Turbulent Business Environment mediates the effect between Circular Economy and Green Strategies with sustainable competitive advantage.*

*H27: Turbulent Business Environment mediates the effect between Industry and Quality 4.0 with Sustainability Performance.*

(Dwikat et al. 2023) Tested the turbulent environment as a mediator between human capital and sustainability and revealed a positive relationship. similarly, (Rehman, Hamdan, and Sindhu 2024) Revealed a positive relationship between a turbulent environment and performance.

Therefore, testing the mediating role of a turbulent environment in the relationships between quality 4.0 and the circular economy, and between the circular economy and performance, from the other side would enrich the literature.

### *3.3.9 The mediating role of Organizational Resilience Related Hypothesis*

*H28: Organizational Resilience mediates the effect between Circular Economy and Green Strategies with organizational performance.*
*H29: Organizational Resilience mediates the effect between Circular Economy and Green Strategies with sustainability performance.*
*H30: Organizational Resilience mediates the effect of Industry 4.0 and Quality 4.0 on organizational performance.*
*H31: Organizational Resilience mediates the effect between Circular Economy and Green Strategies with sustainable competitive advantage.*
*H32: Organizational Resilience mediates the effect between Industry and Quality 4.0 with sustainability performance*
*H33: Organizational Resilience mediates the effect between Industry and Quality 4.0 with sustainable competitive advantage performance*

The limited literature used organizational resilience to mediate between Industry 4.0, the circular economy, and performance metrics. For instance,

No previous publications examined the role of mediating organizational resilience in Industry 4.0 and the circular economy. However, the broader field of organizational resilience includes few publications. for instance, (Channa, Shah, and Ghumro 2019) Tested the mediating role of organizational resilience between human development and crisis management.

Thus, testing the mediating role of organizational resilience between quality 4.0 and circular economy with performance matrices, as indicated in the hypotheses, would enrich the literature.

### 3.4 Research Design

The research design involves transferring objectives and questions into actionable research projects. (Ramakrishan 2019). This study utilized a mixed-methods research design that combined elements of both qualitative and quantitative approaches, which have become increasingly prevalent in the social and behavioral sciences. The mixed-method research design is deemed appropriate for this study for the following reasons:

- **Addressing Research Questions:** The mixed-method approach effectively addresses the "how" of the research question. Specifically, this study examines how industrial and manufacturing firms in Palestine use dynamic strategies to achieve desired performance outcomes and sustainable competitiveness.
- **Data Collection:** The first research question aims to assess the level of Industry 4.0 readiness among Palestinian industrial and manufacturing firms. Surveys, through questionnaires, are suitable for gathering large amounts of data. Jonathan (2001) demonstrated that surveys and questionnaires are particularly effective compared to other methods, such as interviews.
- **Strategic Enablers:** Subsequent research questions focus on identifying strategic enabler practices and their impact on various performance aspects. The study employs quantitative (questionnaire survey) and qualitative (systematic literature

review using PRISMA methodology) methods. Data sources include primary (published and unpublished materials, such as articles, journals, and books) and secondary sources.

The secondary data analysis has facilitated a better understanding of the study and the development of the data collection tool (the questionnaire). This research follows a cross-sectional design due to time constraints and the established validity of cross-sectional studies in behavioral and social sciences, including organizational behavior and management (Mamer, 2023).

A critical review of over 150 articles in Chapter Two revealed that only four studies employed a longitudinal design. This suggests that cross-sectional research designs are more commonly used in empirical quantitative research, validating its use in this study.

Data analysis used Partial Least Squares Structural Equation Modeling (PLS-SEM). Data were collected through questionnaires, followed by follow-up phone calls and personal interviews with selected companies to ensure the inclusion of large firms in the sample.

**3.5 Target Population:**

The target population for this study consists of a group that is relevant, reachable, and accessible, as defined by (Sekaran and Bougie 2010). (Hoffman 2012) Defines a population as a set of events, people, or items with shared attributes.

This study identifies the Palestinian industrial and manufacturing sector as a cohesive group with shared interests and characteristics. According to the Ministry of Industries, there are 1,005[3] Registered manufacturing firms in Palestine. These firms represent the population for this research.

The manufacturing sector includes a range of industries, as classified by the Palestinian Federation of Industries and its specialized associations. This includes sectors such as food

[3] This number excluding bakery small firms, which considered as industrial/manufacturing firms, source: ministry of national economy registry records (note: registry is continuously updated).

production, marble and stone, construction, leather and footwear, textiles, paper, and precious metals.

### 3.6 Sampling frame and sample size

Sample size and sampling technique are regarded as critical aspects of the research. Many techniques are used in the literature to determine the sample size depending on an acceptable margin of error, population size, and acceptance level. This research concerned production companies and referred to the Ministry of National Economy register of the number of industrial licenses per capita.

Using the acceptance level (alpha) of 5%, margin of error of 5%, and sample proportion of 20%, and by applying the below formula, the sample for this study is 306 total elements (production companies),

The Sample Size equation,

**source:**https://www.calculator.net/sample-size-calculator.html?type=1&cl=95&ci=5&pp=50&ps=1500&x=Calculate

Sample size (n) = N*X / (X + N – 1) ,

where X = Zα/22 *p*(1-p) / MOE, and Zα/2 is the critical value of the Normal distribution at α/2 (e.g., for a confidence level of 95%, α is 0.05, and the critical value (Z value) is 1.96).

MOE is the margin of error,
p is the sample proportion,
Moreover, N is the population size.

Convenience ordinary sampling procedures were utilized due to the complexity of obtaining correct and easy information on the total populations of the study, and since many Palestinian industrial factories in Gaza were demolished by Israel's war on the Gaza Strip. Moreover, applying this equation yields a sample size of 296.

### 3.7 Unit of Analysis

(Dwikat et al. 2023; Komkowski et al. 2023; Mat, Mohamed@jaafar, and Mohamad 2022; Zahari et al. 2023) They have used middle and top management as the unit of analysis in their studies. This provides a strong justification for using middle management as the unit of analysis in the current research.

Using middle management as the unit of analysis will contribute to the literature on the middle management perspective; this study used middle management as the unit of analysis. The middle management is responsible for the implementation of initiatives like circular economy, resource efficiency, waste management, technology advancement, industry 4.0, etc

### 3.8 Research Strategy:

(Ramakrishan 2019) Identifies several methods for collecting empirical data, including interviews, questionnaires, case studies, action research, and archival research. According to (Hoffman 2012)Experimental strategies are akin to natural sciences, as they establish close relationships between independent and dependent variables.

Surveys, such as questionnaires, are commonly used in descriptive and exploratory research designs. In contrast, case studies often involve multiple cases and sources to conduct empirical investigations.

A survey (questionnaire) is the most appropriate method for the current study. Since the research questions are primarily "how" and "what" questions, they are best addressed using questionnaires.

### 3.9 Operationalization

To operationalize the study variables shown in Figure 3.1, the literature review identified many dimensions (sub-variables) for these variables; the following table summarizes the sub-variables.

Table (3.1): Variables Operationalization.

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| **Industry and Quality 4.0 Readiness Drivers** | | | | | |
| 01 | Innovative Operations and Smart Factories | It is the use of technologies in industrial operations through ICT infrastructure, such as cloud systems, operational automation, and ERP systems. | Process Automation | German-generated IMPLUS methodology; IMPLUS has been proven practically and theoretically in the context of developed countries. | (Fauskanger and Fatemi 2014) |
| | | | ICT Infrastructure, like the Claud System | | (Fauskanger and Fatemi 2014; Shqair and Altarazi 2022b) |
| | | | Data Protection and Information Security | | (Ashtankar et al. 2023; Fauskanger and Fatemi 2014; Lan and Jeenanunta 2023; Salimbeni et al. 2023; Shqair and Altarazi 2022b) |
| 03 | Smart Products and Product Innovation | Data usage in products. Smart products drive product innovation by integrating | Use of Advanced Technologies in Production, like AI, Data Analysis, etc | | (Fauskanger and Fatemi 2014; Shqair and Altarazi 2022b) |

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| | | advanced technologies like IoT, AI, and data analytics to enhance functionality, adaptability, and user experience. | | | |
| 04 | Data-Driven Services | Data sharing internationally and externally | Data Sharing services methods | | |
| 05 | Employee Focus | Employee and human resources | Employee skills | | |
| 06 | Strategy and Organization | Adoption of new technologies like Industry 4.0 needs strategic directions | strategy | | |
| | | | Process Automation and digitalization | | |
| 07 | Quality Management Practices in the Era of Industry 4.0 | Characterized by a focus on the achievement of customer requirements, | Customer focus | The customer is the central focus of a firm's operations. | (Zulfiqar et al. 2023b) |
| 08 | Top Management Support for quality 4.0 and industry 4.0 transfer | | Top Management Commitment | The commitment of top management ensures good adherence to | (Zulfiqar et al. 2023b) |

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| | | | | quality systems. | |
| **Circular Economy and Green Strategy** | | | | | |
| 01 | Eco-Strategy | Environmental and green strategy consists of planning, leadership, and systems. | Environmental leadership | (environment, social, and governance) in firms and SME's | (Olayeni et al. 2021) |
| | | | Green System and Procedures | | |
| | | | Green Planning | | |
| | Environmental Assessment and Monitoring | Continuous monitoring of the environmental aspect | Environment Aspect Monitoring | | |
| | Eco Marketing | Eco-marketing includes environmental and sustainability in marketing activities. | Use Green Product as Brand "Eco-Branding" | | |
| | Governance | Are ethical behaviors toward environments and stakeholders | Code of Conduct | | |
| 01 | Reduce | The circular economy is a strategy and practice involving | Resources Efficiency | Efficiency in input and processes | (Andersen et al. 2022; Ghaithan et al. 2023c; Schöggl et |
| | | | Usage of eco-friendly materials | | |

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| | | reducing, reusing, and recycling. | Energy Efficiency | | al. 2023, 2024) |
| 02 | Re-use | | Reuse of water | Recycling and reusing efficiency | |
| | | | Reuse of materials | | |
| 03 | Re-cycle ` | | Recycle waste | | |
| **Organizational Resilience** | | | | | |
| 01 | (Sensing) Resilience Readiness | According to Tecee's dynamic capability model and theory, sensing is directly connected with resilience readiness. | Integrity | The linkage between Resilience and Tecee's dynamic capabilities. | (Ma et al. 2018; Pertheban et al. 2023; Teece and Pisano 1994) |
| | | | Networking | | |
| 02 | (Seizing) Resilience Maturity | Resilience maturity is achieved when an organization has robust risk management and can adapt to new issues. | Risks Management | | |
| | | | Coping | | |
| 03 | (Reconfiguration) Dynamic Resilience | A dynamic level is achieved when an organization is | Redundancy | | |
| | | | Flexibility and Agility | | |

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| | | flexible and adaptable. | Adaptability | | |
| **Turbulent Business Environment** | | | | | |
| 01 | Occupation Policies and Procedures | Israeli Occupation policies impede the economic growth of Palestine | Israeli Restrictions | Israeli occupation policies and Palestinian government policies affect the business-enabling environment. | (Dwikat et al. 2023) |
| 02 | National Level | National-level regulation and restriction | Legal business environment | | (Alberti et al. 2018; Bandeira de Mello and Marcon 2005; Dwikat et al. 2023; Grant 2003; Rabelo et al. 2016; Ramírez and Selsky 2016; Yapicioglu 2023) |
| 03 | Industrial Level | In free-market economies, industrial competition, along with policies and strategies, puts greater pressure on firms to become more competitive. | **Porter Five Forces** (Competition) | Competition at national and global levels affects business performance, **Porter Five Forces Model** | |
| | | | Technological Changes | | |
| **Sustainable Competitive Advantage Performance (Results)** | | | | | |
| 01 | Value Added and Non-imitable Products/Services | Value Added Products, including after-sales services | Value Added Product | VIRO model of Jay Barney, **Resources-** | Warnier et al., 2013, Barny, 1991, |

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| 02 | Rare Products and or Services | Rare Products/Services, including after-sales services | Rare Products or Services | **Based View Theory** | Newbert, 2008 |
| 04 | Well-organized system | Including indicators for resource management, benchmarking, etc | Effectiveness of operational performance indicators | Performance indicators ensure the rare, non-imitable, and valuable products and services | |
| **Sustainability** | | | | | |
| 01 | Environmental Results | Environmental results include industrial results and the impact on the environment and the ecological system. | Reduction of adverse events, including gas emissions | Environmental performance | (Asif 2023; Fraj et al. 2011; Pattinson et al. 2023; Rajapakse et al. 2022; Saether et al. 2021; Song et al. 2024; Yugai et al. 2023) |
| 02 | Social and Economic | Direct and indirect labor | Direct and Indirect Labor | Social Performance | |
| | | Degree of energy, water, and materials consumption reduction | Reduction | Economic performance | |
| **Organizational Performance** | | | | | |
| 01 | Organizational Performance | Regular business and organizational | Financial performance | Organizational Performance | Amer, 2022, |

| # | Item | Description | Sub variables | Rational | References |
|---|---|---|---|---|---|
| | | results and performance (financial, operational, marketing, and innovation) | Marketing performance | | 2023a; Dwikat et al., 2023; Zahari et al., 2023 |
| | | | Operational performance | | |
| | | | Innovation Performance | | |

The following figure shows the outer and inner models of the designed questionnaire, constructed using PLS 4.0.

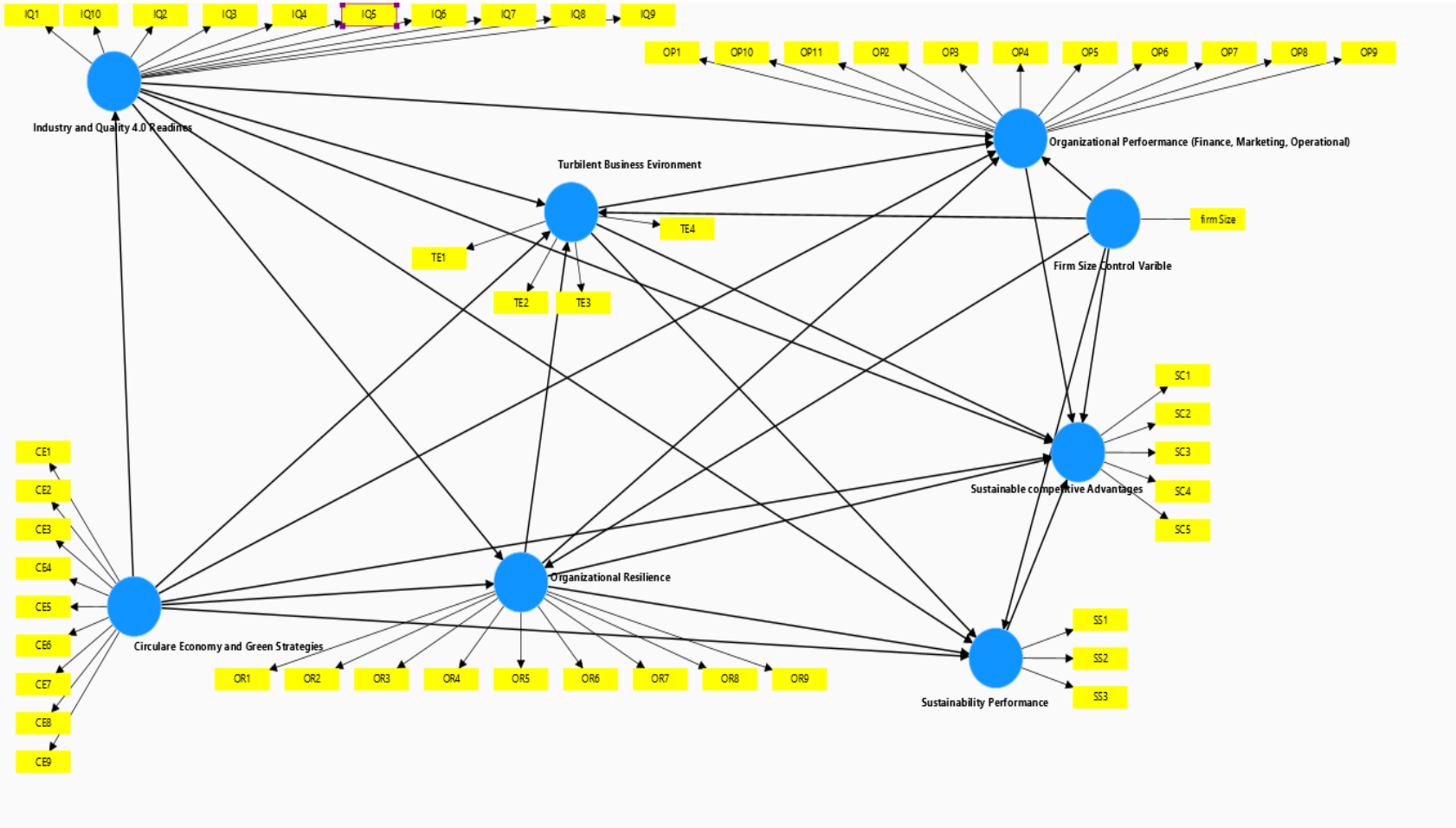


Figure (3.2): Operationalized Model, Questionnaire Questions, and Constructs. “Outer and inner model”

The key items of the questionnaire are outlined in the table below for reference.

Table (3.2): Data Collection Tool Constructs and Factors.

| No | Code | Questions |
|---|---|---|
| **Industry and Quality 4.0** | | |
| 01 | IQ1 | Good Degree of Process Automation |
| 02 | IQ2 | Good and utilized ICT infrastructure, including, for instance, the Claud System. |
| 03 | IQ3 | Good Data Protection and Information Security in Place |
| 04 | IQ4 | Good Level of Product and Services Development |
| 05 | IQ5 | Good Usage of Advanced Technologies in Production, like AI tools, Data Analysis, digital control and monitoring, etc |
| 06 | IQ6 | Good Data Sharing System in Place, Data shared with stakeholders |
| 07 | IQ7 | Our Employees are skillful and can adopt new technologies |
| 08 | IQ8 | Our customer requirements are well organized and used in product and process development. |
| 9 | IQ9 | Our Top Management Committed to Technology Advancement |
| 10 | IQ10 | Our System, Process, and ICT are suitable for the introduction of Industry 4.0 Technologies. |
| **Circular Economy and Green Strategies** | | |
| 11 | CE1 | Our Management is Committed to Environmental Protection |
| 12 | CE2 | An environmental management system and plan are in place |
| 13 | CE3 | Environmental factors are continuously monitored and controlled. |
| 14 | CE4 | Green Product, Environmental Protection Process used as Sales and Marketing arm “Eco-branding.” |
| 15 | CE5 | Good ethical behaviors and a Code of Conduct are in place |
| 16 | CE6 | Good resource efficiencies in place, like reducing non-product inputs |
| 17 | CE7 | Re-use of materials like water and other resources |
| 18 | CE8 | Recycle materials, water, and waste to produce bi-products or new products. |

| No | Code | Questions |
|---|---|---|
| 19 | CE9 | Good Energy Efficiency programs and tools in place, like the use of LED for lighting |
| **Organizational Resilience** | | |
| 20 | OR1 | Our firm proactively monitors developments in the sector to gain early insight. |
| 21 | OR2 | Our firm understands how to actively connect with other firms in the exact location or industry to link (clustering). |
| 22 | OR3 | Our firm understands the impact of risks and crises |
| 23 | OR4 | Our firm has risks and crisis management plans in place |
| 24 | OR5 | Our firm has a good coping strategy to deal with changes |
| 25 | OR6 | Our firm shifts rapidly from regular business to crisis or risk modes. |
| 26 | OR7 | When a problem occurs in our organization, internal resources are more readily available at short notice, and there is less red tape than for routine problems. |
| 27 | OR8 | Our Firm quickly adopted the new changes with minimal effect on production and service delivery. |
| 28 | OR9 | Our firm's management is flexible and can adapt to any new conditions through scenario-based management. |
| **Turbulent Business Environment** | | |
| 29 | TE1 | Israeli Occupation Policies and Restrictions Affected Our Business |
| 30 | TE2 | Palestinian Legal Framework Affects Our Business |
| 31 | TE3 | The competitive environment affects our business |
| 32 | TE4 | The Technological Advancement Requirement Affects Our Business |
| **Sustainable Competitive Advantage Performance** | | |
| 33 | SC1 | Our Product Features are Non-immable features: “Logo, Product Contents, Packaging, etc.” |
| 34 | SC2 | Our Product is a Rare and highly demanded product |
| 35 | SC3 | Our Product is a highly Valued Product and includes High-Value Services |

| No | Code | Questions |
|---|---|---|
| 36 | SC4 | Our Organizational System is effective |
| 37 | SC5 | We have a List of Key Performance Indicators to control our operations and product features. |
| **Sustainability Performance** | | |
| 38 | SS1 | Reduction in all Adverse Environment Events/Factors like waste, Gas Emission, Dust, etc. |
| 39 | SS2 | Our Direct and Indirect Labor is more than our competitors |
| 40 | SS3 | Continuous Reduction in Energy Usage, waste, Byproducts, etc |
| **Organizational Performance** | | |
| 41 | OP1 | Our Financial Position and Performance are good and improved |
| 42 | OP2 | Our Revenues and net income are good |
| 43 | OP3 | Increased Sales Volume |
| 44 | OP4 | Increased Customer Trust in Our Products and Services |
| 45 | OP5 | Increased Number of customers |
| 46 | OP6 | Increased Customer Loyalty and Satisfaction |
| 47 | OP7 | Good Product and Services Quality Control |
| 48 | OP8 | Good Production Utilization and Efficiency |
| 49 | OP9 | Sound Production System and Procedures covering material handling, manufacturing, packaging, and after-sales services. |

### 3.10 Research Data Collection Tool (Questionnaire)

To cover all subjects in the aforementioned table (3-01), a questionnaire was designed, peer-reviewed, tested, and verified on a sample of five firms (testing conducted by face-to-face interviews of the firm's executives). Figure 3-02) below represents the questionnaire questions linked with the theoretical model.

### 3.11 Validation and Verification

The PLS-SEM (Partial Least Squares Structural Equation Modeling) analysis used in this study is advantageous due to its flexibility with sample sizes and its lack of stringent assumptions about data normality ((Hair et al. 2014)). This ensures secure measurement quality without assuming data normality (Hair et al., 2014). Additionally, PLS-SEM includes internal consistency validity tests, which are crucial for assessing reliability and validity.

Two primary tests of reliability and validity in PLS-SEM are composite reliability and discriminant validity.

1. **Composite Reliability:** This measures the variance in the model due to the original data, including respondent misunderstandings. It includes three tests:
    - **Cronbach's Alpha (CA):** Assesses internal consistency with a threshold value of (0.7 – 0.95). A CA of (0.7- 0.95) is generally acceptable, indicating reliable indicators of the construct, (Arof, Ismail, and Saleh 2018; Mikalef et al. 2020)
    - **Composite Reliability (CR):** An advanced measure of internal consistency, providing a more accurate estimate of reliability, especially with distinct factors within a composite. A CR value of 0.7 or higher is considered satisfactory, with CR superior to CA. (Canatay et al. 2022; Hair et al. 2014; Rasoolimanesh 2022)
    - **Average Variance Extracted (AVE):** This measure measures convergent validity by assessing how healthy indicators represent the construct. AVE is calculated by dividing the squares of factor loadings by the number of indicators for each construct. A value of 0.5 or above indicates a good explanation of the construct and its indicators (Canatay et al., 2022).
2. **Discriminant Validity:** Ensures that each latent construct is unique and not excessively correlated with other constructs in the model, confirming that constructs represent different concepts (Rasoolimanesh, 2022). It includes:

- **Fornell-Larcker Criterion:** Measures if the square root of AVE for a construct is more significant than its correlations with other constructs. A higher value indicates more distinctiveness between constructs (Hair et al., 2014; Rasoolimanesh, 2022).
- **Heterotrait-Monotrait Ratio (HTMT):** A more recent and rigorous method to assess discriminant validity. HTMT compares between-construct correlations to within-construct correlations. A threshold value of 0.9 or above indicates distinct constructs with good discriminant validity.

3. **Multicollinearity:** Assessed using the Variance Inflation Factor (VIF), which measures multicollinearity among independent variables. VIF is calculated as the inverse of (1 - $R^2$), where $R^2$ is the coefficient of determination. A VIF value below 4 indicates no significant collinearity among independent variables (Hair et al., 2014, 2019).

### 3.14 Hypothesis Testing

Hypothesis testing in PLS-SEM is conducted via bootstrapping, with t-tests used to evaluate the hypotheses. Typically, a hypothesis is accepted if the p-value is less than 5%, indicating a significant relationship between the variables.

PLS-SEM (PLS4) software is used for this analysis, following the bootstrapping procedures outlined by Hair et al. (2014). Hypothesis testing results are presented in separate sections and tables. Specifically, the indirect relationships and potential mediating effects are detailed in distinct tables, as described by (Streukens and Leroi-Werelds 2016)

These tables provide all the necessary information to accept or reject the hypotheses, including p-values and R-squared values (Streukens & Leroi-Werelds, 2016).

### 3.14 Chapter Conclusion

This chapter presented the methodological framework adopted to empirically examine the proposed research model. It introduced the hypothetical framework grounded in key theories, including the Resource-Based View (RBV), Institutional Theory, Dynamic Capability Theory, Porter's Five Forces, and the Technology–Organization–Environment (TOE) model. Based on these foundations, an integrated conceptual model was developed incorporating Industry 4.0 and Quality 4.0 readiness, Circular Economy and Green Strategies, Organizational Resilience, Turbulent Business Environment, and organizational performance outcomes.

A total of thirty-three hypotheses were formulated to examine direct, mediating, and control-variable relationships among the study constructs. The hypotheses explore how technological readiness and sustainability-oriented strategies influence performance, sustainability, and sustainable competitive advantage, while emphasizing organizational resilience as a strategic capability within turbulent environments.

The study employed a mixed-methods, cross-sectional research design combining quantitative survey data with insights derived from systematic literature review procedures. The Palestinian industrial and manufacturing sector was defined as the target population, with middle and top management selected as the unit of analysis due to their involvement in strategic and technological implementation. The questionnaire was developed through systematic operationalization of constructs grounded in prior literature.

Reliability and validity were assessed using Partial Least Squares Structural Equation Modeling (PLS-SEM), including tests of internal consistency, convergent validity, discriminant validity, and multicollinearity. Hypotheses were tested using bootstrapping techniques to evaluate relationships within the structural model.

Overall, the methodological design provides a robust empirical foundation for examining the relationships among Industry 4.0, Quality 4.0, Circular Economy strategies, organizational resilience, and performance outcomes. The next chapter presents the empirical analysis and hypothesis testing results.

# Chapter Four Results and Findings

## 4.1 Introduction:

This chapter reports the detailed results and findings of empirical analysis regarding industrial and quality 4.0 readiness based on the well-known IMPLUS model, the impact of Quality 4.0 on Performance, the Impact of the Circular Economy on Performance, the mediating Role of Organizational Resilience and Turbulent Environment, and finally, the impact of firm size.

This chapter includes the hypothetical testing based on the study framework figure (03-01) and the results of reliability and validity testing using the PLS-SEM. (Hair et al. 2019a, 2019b; Rasoolimanesh 2022) and detailed statistical analysis, starting with validity tests using the PLS 4 software, (Hair et al. 2019b).

## 4.2 Data Sample and Response Rate

The survey data for this study were collected from large, medium, and small enterprises operating in the West Bank, Palestine. A total of **217 questionnaires** were successfully gathered. Of these, **46 questionnaires** were obtained via Google Forms, while the remaining were collected through direct contact and distribution. This effort was conducted in collaboration with several key organizations, including the **Palestinian Federation of Industries, the Construction Industries Union, the Food Industry Union, the Marble and Stone Industrial Association, and the Palestine Trade Center**. Additionally, the researcher conducted structured meetings and interviews with representatives of middle management from industrial firms to ensure comprehensive data collection.[4].

The achieved sample represents approximately **a 71% response rate, which exceeds the commonly accepted minimum threshold of 50% for survey-based research. After collection, the questionnaires were systematically organized into a specially designed Excel database. Subsequently, this database was** uploaded into PLS 4.0 to assess the validity of the responses and to perform further data analysis.

[4] The researcher attended workshop with industrial federation of industries “workshop

### 4.3 Validity Tests

PLS-SEM was used in this study because it is not sensitive to sample size and does not require the assumption of multivariate normality. (Al-Swidi et al. 2023; Hair et al. 2019a). Accordingly, measurement quality can be assessed without the normality assumption; PLS-SEM analysis includes internal consistency, reliability, and validity measures. (Hair et al. 2014, 2019b, 2019a). The newest version of PLS, "PLS 4.0," was built on. (Hair et al. 2019a) Updated the PLS-SEM measurement published article.

### 4.4 PLS-SEM Validity Analysis

Following (Hair et al. 2014, 2019a) Method: The internal consistency, including the composite reliability (CR) and convergent validity, was assessed using the "Average Variance Extracted AVE." PLS 4.0 software was used to calculate these measures. Moreover, PLS 4.0 reports the regular Cronbach's alpha (CA) as one of the internal consistency measures for the constructs. Accordingly, Table (4.1) below represents the results of CA, CR, and AVE.

Table (4.1): CA, CR, and AVE measures values.

| ***Constructs*** | ***CA*** | ***CR*** | ***(AVE)*** |
|---|---|---|---|
| *Circular Economy and Green Strategies* | 0.915 | 0.929 | 0.595 |
| *Industry and Quality 4.0 Readiness* | 0.908 | 0.923 | 0.546 |
| *Organizational Performance (Finance, Marketing, & Operations)* | 0.938 | 0.947 | 0.620 |
| *Organizational Resilience* | 0.939 | 0.949 | 0.676 |
| *Sustainability Performance* | 0.807 | 0.886 | 0.722 |
| *Sustainable Competitive Advantages* | 0.872 | 0.907 | 0.662 |
| *Turbulent Business Environment* | 0.850 | 0.899 | 0.690 |

**The CR test** was conducted by (Hair et al. 2014, 2019a).The threshold for CR values is 0.7. Hence, values of CR for constructs shall be more than 0.7; from the Table (4.1) above-mentioned, the CR values were from 0.899 to 0.95, and Cronbach alpha values ranged from 0.807 to 0.939. CA values above 0.9 and below 0.95 indicate high reliability; above 0.8,

good reliability; and above 0.7, an acceptable level. Thus, a high level of validity was achieved.

AVE threshold value is 0.5, and AVE values greater than 0.5; as for the AVE in specific, it indicated significant convergent validity, and more than half of the construct is explained by its indicators(Hair et al. 2019a). Table 4.1 indicates that AVE values exceed 0.5.

Similarly, a **factor loading analysis** was conducted using **PLS 4.0** to evaluate the extent to which each indicator is associated with its corresponding construct. The study revealed that all indicators were appropriately loaded onto their respective constructs, demonstrating strong relationships between the observed variables and the underlying latent constructs.

A factor loading of 0.7 or higher between a factor and its constructs is considered well-loaded, indicating good reliability and validity of the model and measurement (Hair et al., 2014, 2019a; Sarstedt et al., 2020).

The factor loadings in Table 4.2 and Figure 4.1 were derived from PLS 4.0, which confirmed that all indicators/factors met or exceeded the 0.7 threshold.

Table (4.2): Factor Loading.

| | Circular Economy and Green Strategies | Firm Size Control Variable | Industry and Quality 4.0 Readiness | Organizational Performance (Finance, Marketing, Operations) | Organizational Resilience | Sustainability Performance | Sustainable Competitive Advantages | Turbulent Business Environment |
|---|---|---|---|---|---|---|---|---|
| **CE1** | 0.816 | | | | | | | |
| **CE2** | 0.779 | | | | | | | |
| **CE3** | 0.763 | | | | | | | |
| **CE4** | 0.736 | | | | | | | |
| **CE5** | 0.756 | | | | | | | |
| **CE6** | 0.786 | | | | | | | |
| **CE7** | 0.773 | | | | | | | |
| **CE8** | 0.701 | | | | | | | |
| **CE9** | 0.823 | | | | | | | |

| | Circular Economy and Green Strategies | Firm Size Control Variable | Industry and Quality 4.0 Readiness | Organizational Performance (Finance, Marketing, Operations) | Organizational Resilience | Sustainability Performance | Sustainable Competitive Advantages | Turbulent Business Environment |
|---|---|---|---|---|---|---|---|---|
| **IQ1** | | | 0.732 | | | | | |
| **IQ2** | | | 0.702 | | | | | |
| **IQ3** | | | 0.723 | | | | | |
| **IQ4** | | | 0.788 | | | | | |
| **IQ5** | | | 0.723 | | | | | |
| **IQ6** | | | 0.718 | | | | | |
| **IQ7** | | | 0.817 | | | | | |
| **IQ8** | | | 0.725 | | | | | |
| **IQ9** | | | 0.718 | | | | | |
| **IQ10** | | | 0.739 | | | | | |
| **OP1** | | | | 0.760 | | | | |
| **OP10** | | | | 0.789 | | | | |
| **OP11** | | | | 0.817 | | | | |
| **OP2** | | | | 0.719 | | | | |
| **OP3** | | | | 0.724 | | | | |
| **OP4** | | | | 0.756 | | | | |
| **OP5** | | | | 0.834 | | | | |
| **OP6** | | | | 0.807 | | | | |
| **OP7** | | | | 0.867 | | | | |
| **OP8** | | | | 0.790 | | | | |
| **OP9** | | | | 0.787 | | | | |
| **OR1** | | | | | 0.734 | | | |
| **OR2** | | | | | 0.771 | | | |

| | Circular Economy and Green Strategies | Firm Size Control Variable | Industry and Quality 4.0 Readiness | Organizational Performance (Finance, Marketing, Operations) | Organizational Resilience | Sustainability Performance | Sustainable Competitive Advantages | Turbulent Business Environment |
|---|---|---|---|---|---|---|---|---|
| **OR3** | | | | | 0.876 | | | |
| **OR4** | | | | | 0.763 | | | |
| **OR5** | | | | | 0.919 | | | |
| **OR6** | | | | | 0.887 | | | |
| **OR7** | | | | | 0.867 | | | |
| **OR8** | | | | | 0.796 | | | |
| **OR9** | | | | | 0.765 | | | |
| **SC1** | | | | | | | 0.811 | |
| **SC2** | | | | | | | 0.827 | |
| **SC3** | | | | | | | 0.769 | |
| **SC4** | | | | | | | 0.835 | |
| **SC5** | | | | | | | 0.824 | |
| **SS1** | | | | | | 0.807 | | |
| **SS2** | | | | | | 0.870 | | |
| **SS3** | | | | | | 0.871 | | |
| **TE1** | | | | | | | | 0.861 |
| **TE2** | | | | | | | | 0.826 |
| **TE3** | | | | | | | | 0.811 |
| **TE4** | | | | | | | | 0.823 |
| **firm Size** | | 1.000 | | | | | | |

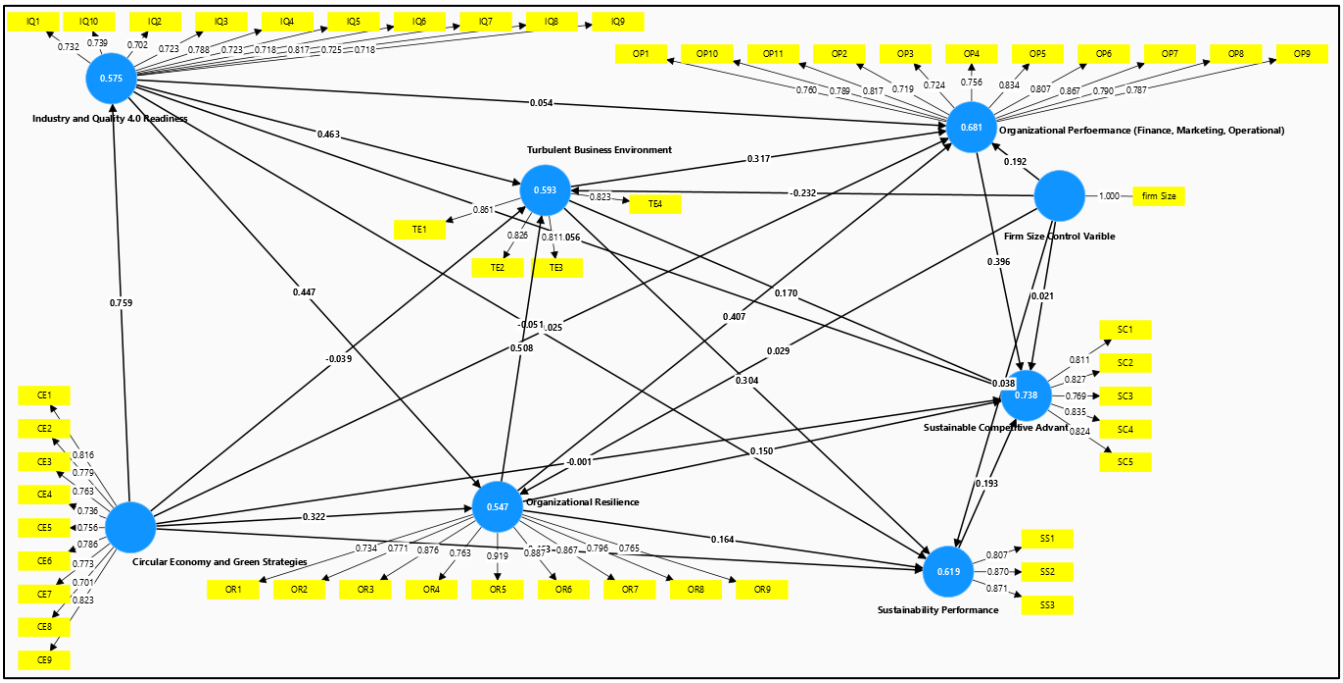


Figure (4.1): Factor Loading.

To test the discernment validity, two tests were conducted as per the research methodology, Fornell-Larcker and the heterotrait-monotrait ratio (HTMT); Table 4.3 and Table 4.4 below represent these values, respectively.

Table (4.3): Fornell–Larcker Measure Values.

| Constructs | Circular Economy and Green Strategies | Industry and Quality 4.0 Readiness | Organizational Performance (Finance, Marketing, Operations) | Organizational Resilience | Sustainability Performance | Sustainable Competitive Advantages | Turbulent Business Environment |
|---|---|---|---|---|---|---|---|
| Circular Economy and Green Strategies | 0.771 | | | | | | |
| Industry and Quality 4.0 Readiness | 0.758 | 0.739 | | | | | |
| Organizational Performance (Finance, | 0.609 | 0.678 | 0.787 | | | | |

| Constructs | Circular Economy and Green Strategies | Industry and Quality 4.0 Readiness | Organizational Performance (Finance, Marketing, Operations) | Organizational Resilience | Sustainability Performance | Sustainable Competitive Advantages | Turbulent Business Environment |
|---|---|---|---|---|---|---|---|
| Marketing, Operations) | | | | | | | |
| Organizational Resilience | 0.677 | 0.706 | 0.772 | 0.822 | | | |
| Sustainability Performance | 0.717 | 0.639 | 0.673 | 0.673 | 0.850 | | |
| Sustainable Competitive Advantages | 0.624 | 0.677 | 0.807 | 0.753 | 0.712 | 0.813 | |
| Turbulent Business Environment | 0.539 | 0.665 | 0.698 | 0.707 | 0.643 | 0.718 | 0.831 |

Table (4.4): HTMT Test Results.

| Constructs | Circular Economy and Green Strategies | Firm Size Control Variable | Industry and Quality 4.0 Readiness | Organizational Performance (Finance, Marketing, Operations) | Organizational Resilience | Sustainability Performance | Sustainable Competitive Advantages |
|---|---|---|---|---|---|---|---|
| Firm Size Control Variable | 0.529 | | | | | | |
| Industry and Quality 4.0 Readiness | 0.805 | 0.577 | | | | | |
| Organizational Performance (Finance, Marketing, Operations) | 0.635 | 0.505 | 0.728 | | | | |
| Organizational Resilience | 0.702 | 0.456 | 0.762 | 0.816 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sustainability Performance | 0.819 | 0.427 | 0.745 | 0.771 | 0.764 | | |
| Sustainable Competitive Advantages | 0.679 | 0.459 | 0.751 | 0.884 | 0.823 | 0.847 | |
| Turbulent Business Environment | 0.574 | 0.243 | 0.750 | 0.774 | 0.786 | 0.771 | 0.815 |

Table 4.4 indicates that all HTMT (**Heterotrait-Monotrait Ratio)** test results are less than 0.9, indicating that the constructs are distinct and there is no overlap between them. (Streukens and Leroi-Werelds 2016)

Table 4.3 indicates that Fornell-Larcker's "square root of AVE" is greater than the correlated value of other constructs. For instance, the square root of the **Circular Economy and Green Strategies** is 0.771, "representing the overlapping of the construct with itself." It is more significant than any other related circular economy value, "representing the overlap between the construct and others."

Therefore, the model is valid, and the constructs are sufficiently distinct. Since both the Fornell-Larcker and the HTMT meet their discriminant validity test threshold requirement

The Variance Inflation Factor (VIF) was used to assess multicollinearity in the model. According to (Hair et al. 2014, 2019a; Sarstedt, Ringle, and Hair 2020) VIF values should **not exceed 4** to consider no collinearity in the model. Table (04-05) presents the VIF test results, which indicate no multicollinearity problems within the model.

Table (4.5): VIF Values.

| | **Industry and Quality 4.0 Readiness** | **Organizational Performance (Finance, Marketing, Operations)** | **Organizational Resilience** | **Sustainability Performance** | **Sustainable Competitive Advantages** | **Turbulent Business Environment** |
|---|---|---|---|---|---|---|
| **Circular Economy and** | 1.000 | 2.651 | 1.34, 5 | 2.651 | 3.219 | 2.413 |

| | | | | | |
|---|---|---|---|---|---|
| **Green Strategies** | | | | | |
| **Firm Size Control Variable** | 1.615 | 1.345 | 1.615 | 1.730 | 1.480 |
| **Industry and Quality 4.0 Readiness** | 3.552 | | 3.552 | 3.571 | 2.588 |
| **Organizational Performance (Finance, Marketing, Operations)** | | | | 3.268 | |
| **Organizational Resilience** | 2.836 | | 2.836 | 3.382 | |
| **Sustainability Performance** | | | | 2.734 | |
| **Turbulent Business Environment** | 2.460 | | 2.460 | 2.923 | |

The coefficient of determination **($R^2$)** measures the effect of exogenous contracts on endogenous contracts. Hair Jr et al. (2014) indicated that **$R^2$** values of 0.25, 0.5, and 0.75 are weak, moderate, and substantial predictive accuracy, respectively. The coefficient of determination for this study Table 4.6 summarizes these values, revealing moderate to substantial predictive accuracy. All these results were obtained using the bootstrapping process in PLS 4.0.

Table (4.6): R-squared values of model constructs.

| **Constructs** | **R-square** | **R-square adjusted** |
|---|---|---|
| **Industry and Quality 4.0 Readiness** | 0.575 | 0.571 |
| **Organizational Performance (Finance, Marketing, Operations)** | 0.681 | 0.663 |
| **Organizational Resilience** | 0.547 | 0.533 |
| **Sustainability Performance** | 0.619 | 0.598 |
| **Sustainable Competitive Advantages** | 0.738 | 0.717 |
| **Turbulent Business Environment** | 0.593 | 0.576 |

## 4.5 General Statistical Results and Findings

The firm size in terms of the number of employees is represented in the figure 4.2 below, which indicates that large, medium, and small firms are well represented in the sample, according to the national definition of SME "Small and Medium Enterprises."[5]

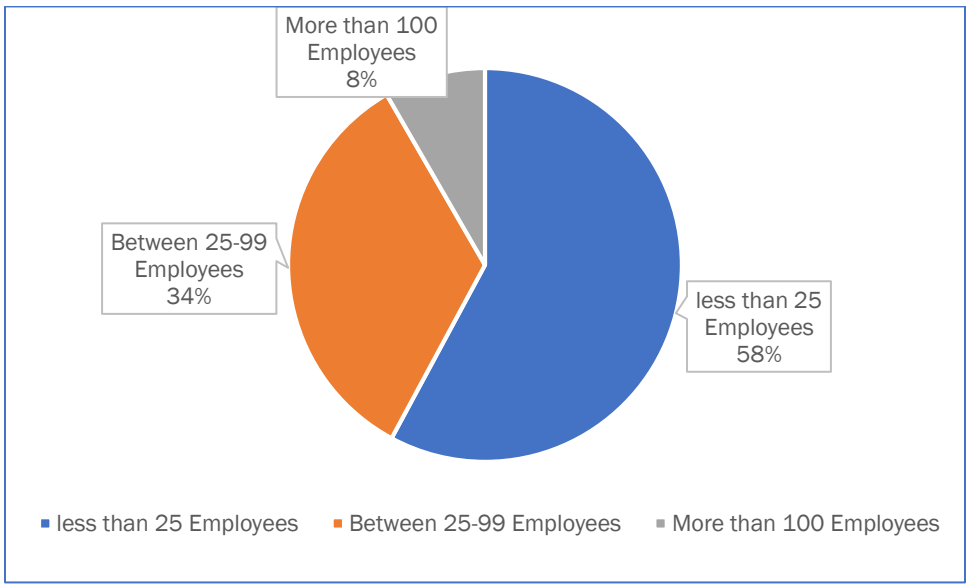


Figure (4.2): Sample Distribution According to Firm Size "Number of Employees."

The assessment of **Industry 4.0** and **Quality 4.0 readiness** within the Palestinian industrial sector indicates a **moderate level of preparedness (Average of 3.7 out of 5)**. Based on the criteria established by the **IMPULS Readiness Model**, this level of readiness classifies the sector as being at the **"beginner" stage**. This designation suggests that while foundational elements of Industry 4.0 and Quality 4.0 have been introduced, the sector is still in the early phases of adopting and integrating advanced digital technologies and quality management practices associated with these paradigms. Enhancing awareness, infrastructure, and workforce capabilities will be critical for progressing to higher readiness levels; Figure 4.3 represent quality 4.0 and industry 4.0.

[5] Firms with number of employees less than 10 are regarded as small, firms with number of employees less than 20 are considered medium, and those with more than 20 are considered large firms, "Source: Palestinian Central Bureau of Statistics."

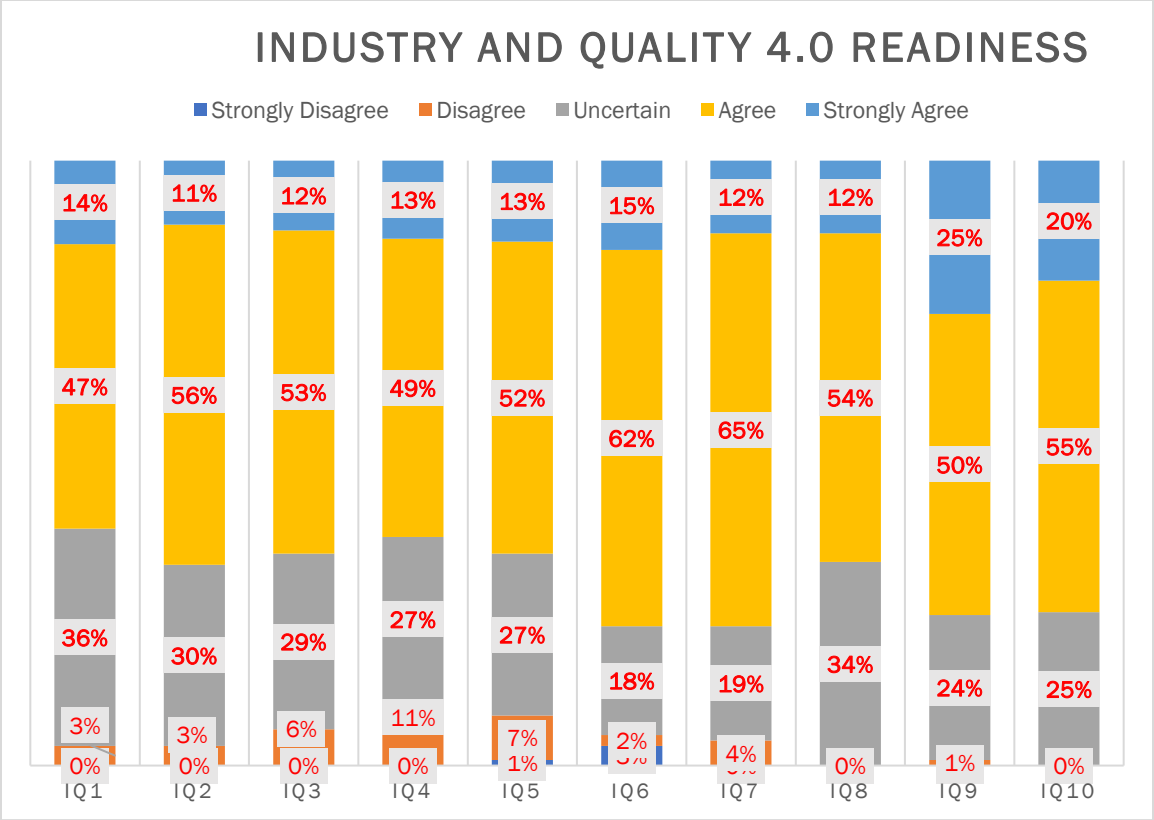


Figure (4.3): Results of Industry 4.0 and Quality 4.0 Readiness as perceived by respondents.

Similarly, Green and Circular Economy Strategies and practices in the Palestinian industrial firm are moderate, as the average of all responses does not exceed 3.6 on a scale of five points. Figure 4.5 below represents percentages of these responses.

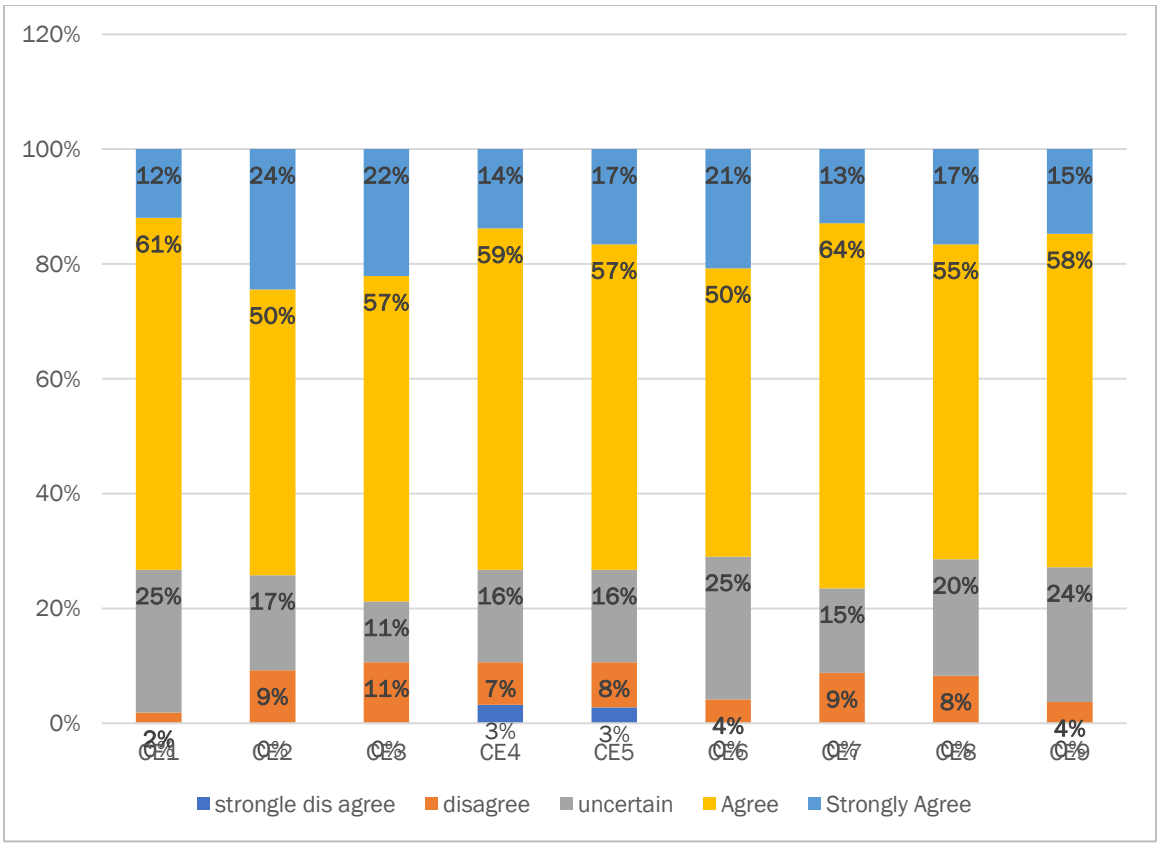


Figure (4.4): Circular and Green Strategies Response Evaluations.

Similarly, the survey responses revealed moderate to high **organizational resilience in** the Palestinian industrial sector, with an average score of **3.82 on a five-point scale**. This score reflects the sector's ability to adapt, recover, and maintain functionality amidst challenges and disruptions. **Figure 4.5** below illustrates the distribution of responses, highlighting the percentages related to various factors contributing to organizational resilience.

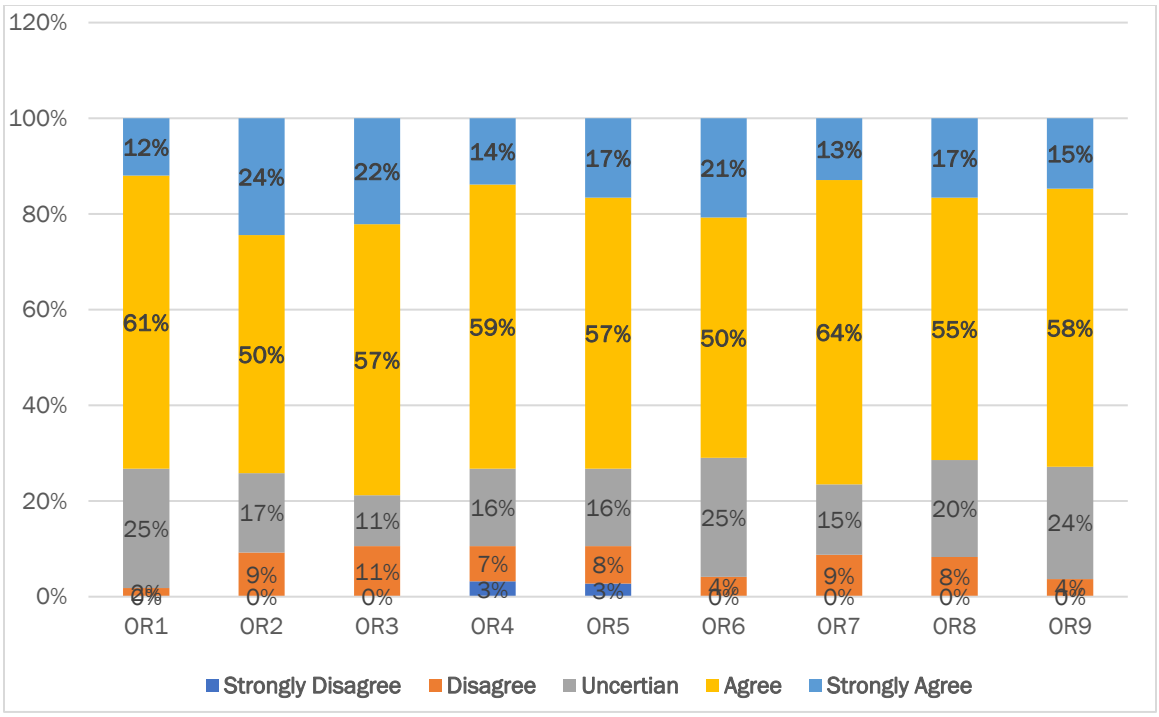


Figure (4.5): Response Results in Organizational Resilience.

Similarly, the analysis revealed that turbulent environments moderately to highly influenced Industry 4.0/Quality 4.0 readiness and Circular Economy practices, with response scores of 3.9 on a 5-point scale. Figure (04-06) graphically represents the categorized responses of respondents.

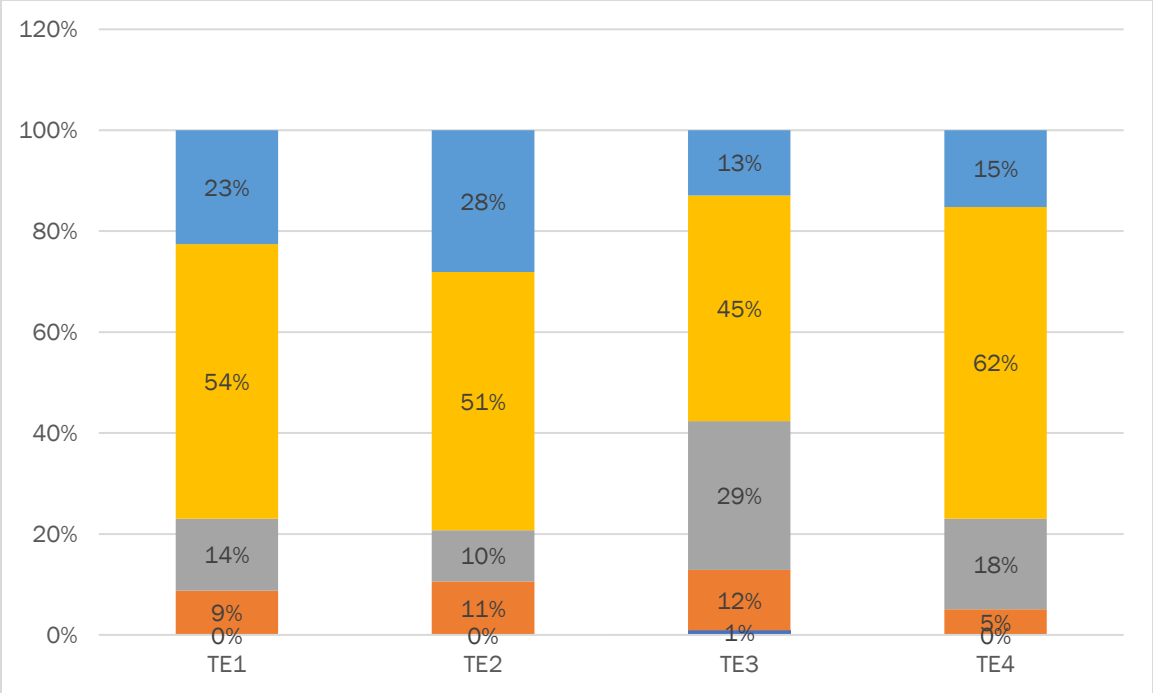


Figure (4.6): Percentage Responses related to Turbulent Environment.

The findings indicate **moderate to high responses** to factors related to sustainable competitive advantage, with an average of 3.7 on a five-point scale. Figure (4.7) below represents the percentages of responses based on the five-point scale.

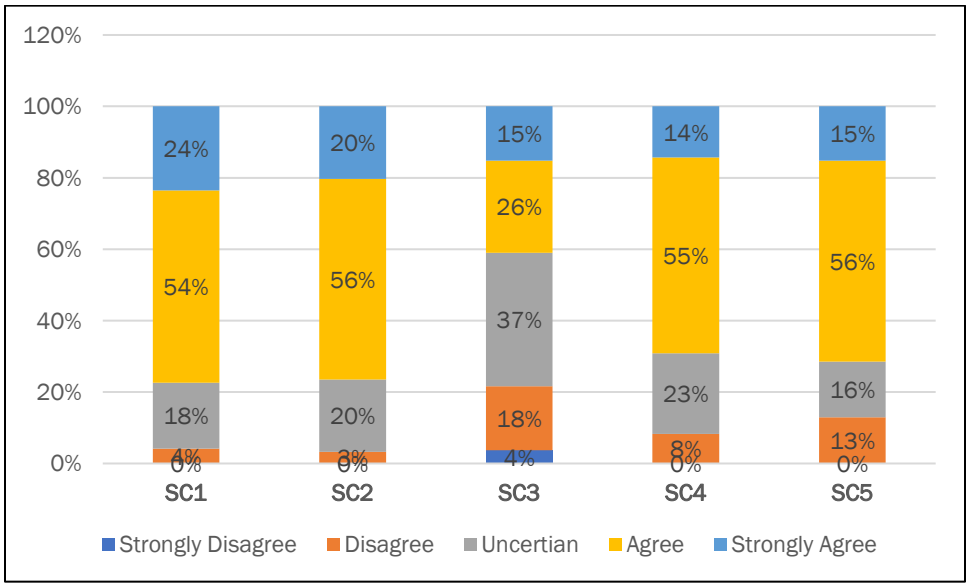


Figure (4.7): Percentage Responses related to Sustainable Competitive Advantages.

The results indicated moderate responses to sustainability-related factors, with an average sustainability rating of 3.49 on a scale of 5. This can be explained by the fact that sustainability and sustainability reporting remained emerging concepts in the region and the Palestinian context. Nevertheless, the Palestinian Capital Market Authority (PCMA) introduced a sustainability reporting requirement for all publicly traded firms to report on their sustainability by the following year (2025 and onward); Figure 4.8 below shows the percentage of responses.

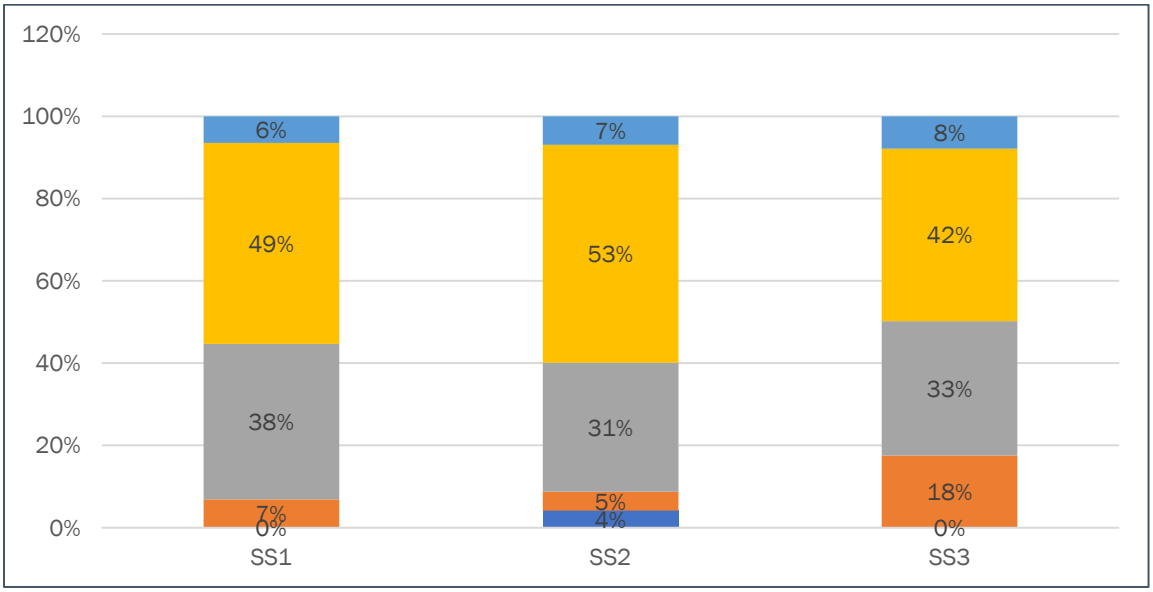


Figure (4.8): Percentage Responses Related to Sustainability.

Finally, a moderate response was also reported regarding organizational performance, with an average score of 3.7 on a scale of 5, indicating that Palestinian firms have the potential to improve their performance. Figure 4.9 represents the response percentage.

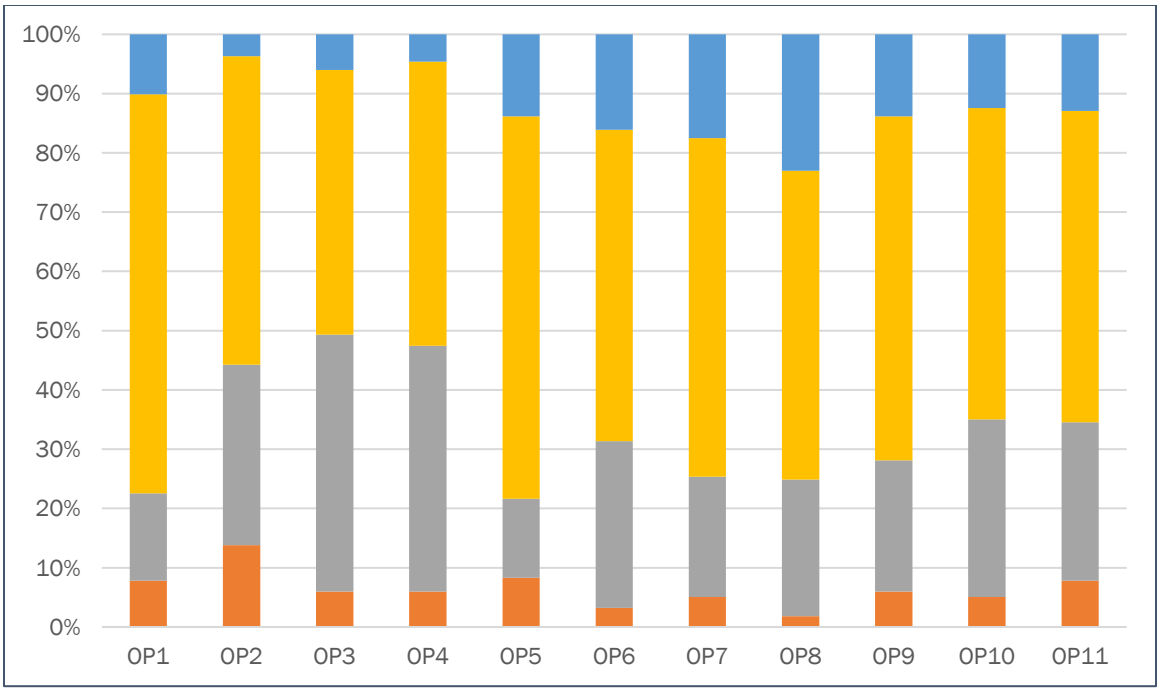


Figure (4.9): Percentage Responses related to Organizational Performance.

## 4.6 Hypothesis Testing

Building on the results of the previous section, the "validity and reliability" of the study model, the next step is to test the hypothesis. According to (Hair et al., 2014; Sarstedt et al., 2020; Streukens & Leroi-Werelds, 2016) Hypothesis testing is conducted using the bootstrapping function within the PLS-SEM software. The bootstrapping tests the direct relationship ("direct hypothesis"), the indirect relationships ("mediating hypothesis"), and the control effect of control variables, using two-tailed or one-tailed T-tests and P-values to accept or reject hypotheses. Figure (04-09) graphically represents the bootstrapping results of the model.

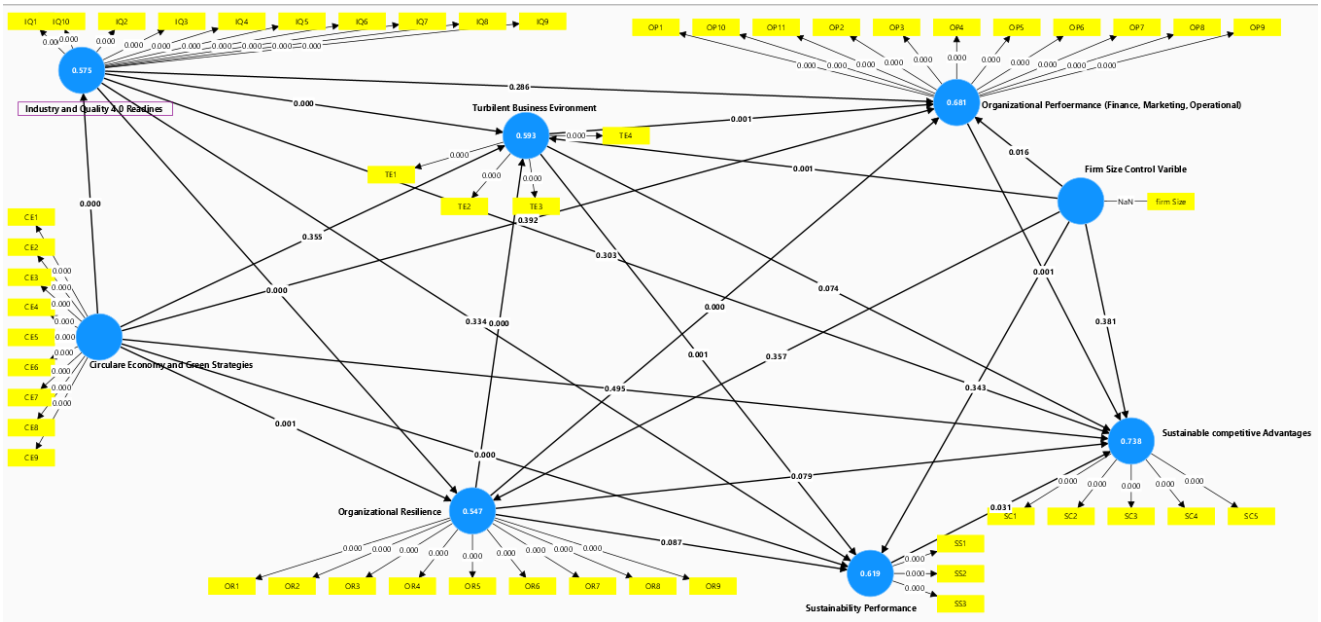


Figure (4.10): Bootstrapping results.

### 4.6.1 Industry 4.0 and Quality 4.0 Related Hypothesis Test Results:

*H1: Industry 4.0 and Quality 4.0 Readiness positively impact the Organizational Performance.*

*H2: Industry 4.0 and Quality 4.0 Readiness positively impact the Sustainability.*

*Industry 4.0 and Quality 4.0 Readiness positively impact the sustainable competitive advantage.*

*H4: Industry 4.0 and Quality 4.0 Readiness positively impact the Organizational Resilience.*

The hypothesis testing for Industry and Quality 4.0 revealed mixed results. Hypotheses H2, H3, and H5 were rejected, while H4 was supported, as shown in Table 4.7 below.

Table (4.7): Hypothesis Test Results Related to Industry and Quality 4.0 Related Hypothesis Group.

| Hypo | Path | T-test | P values | Decision |
|---|---|---|---|---|
| H1 | Industry and Quality 4.0 Readiness -> Organizational Performance (Finance, Marketing, Operational) | 0.565 | 0.286 | Not Supported/ Not Accepted |
| H2 | Industry and Quality 4.0 Readiness -> Sustainability Performance | 0.429 | 0.334 | Not Supported/Accepted |
| H3 | Industry and Quality 4.0 Readiness -> Sustainable Competitive Advantages | 0.516 | 0.303 | Not Supported/Accepted |
| H4 | Industry and Quality 4.0 Readiness -> Organizational Resilience | 4.266 | 0.000 | Supported/Accepted |

These findings align with (Müller, Kiel, and Voigt 2018), who argue that the short-term effects of Industry 4.0 readiness on traditional performance metrics may be hindered by various challenges, such as resource allocation and skill shortages, which prevent the full utilization of Industry 4.0 concepts and techniques. Moreover, achieving tangible financial, operational, and marketing performance improvements through Industry 4.0 and Quality 4.0 requires a longer time horizon, particularly in emerging and developing economies like Palestine. (Zulqarnain et al. 2022a). This indicates that while these advanced technologies and practices hold promise, their immediate impact is constrained by contextual and structural barriers in less mature markets.

Similarly, the analysis found no significant relationships between Industry 4.0 and Quality 4.0 readiness, sustainability, or sustainable competitive advantage. This aligns with Gupta et al. (2022), who suggest that integrating sustainability with Quality 4.0 requires additional strategic alignment and sustained effort. Industry 4.0's limited immediate impact on

sustainability outcomes reflects the emerging nature of the sustainability concept in the Palestinian context, underscoring the maturity gap between developed and developing nations in sustainability practices. (Kvasničková Stanislavská et al. 2023). Furthermore, achieving sustainable competitive advantage demands a multidimensional approach that integrates marketing, innovation, sustainable practices, and industrial and technological advancements (Bocken et al., 2014; Colli et al., 2018). These findings emphasize the need for integrated strategies to maximize the benefits of Industry 4.0 and Quality 4.0 on broader organizational goals.

In contrast, hypothesis H4 was supported, demonstrating a positive and significant relationship between Industry 4.0 and Quality 4.0 readiness, as well as between Industry 4.0 and organizational resilience. This outcome is consistent with prior research indicating that Industry 4.0 technologies enhance organizational flexibility, adaptability, and resilience. By adopting these advanced tools and practices, organizations can build long-term resilience and maintain operational stability in uncertain and turbulent business environments. (Marcucci et al. 2022)These results highlight the potential of Industry 4.0 and Quality 4.0 to enable resilience and sustainability in challenging conditions.

### 4.6.2 Green and Circular Economy Strategies 4.0 Related Hypothesis Tests Results:

*H5: Green and Circular Economy Strategies positively impact Organizational Performance.*
*H6: Green and Circular Economy Strategies positively impact sustainability.*
*H7: Green and Circular Economy Strategies Positively Impact the Sustainable Competitive Advantage.*
*H8:Green and Circular Economy Strategies Positively Impact Organizational Resilience.*

The circular economy and green strategies test yielded mixed results regarding sustainability, organizational performance, sustainable competitive advantage, and organizational resilience, as shown in Table 04-07 below. H5 and H7 were rejected, while H6 and H8 were significantly supported.

Table (4.8): Hypothesis Test Results Related to Green and Circular Economy Strategies.

| Hypo | Path/Direction | T statistics | P values | Decision |
|---|---|---|---|---|
| **H5** | **Circular Economy and Green Strategies -> Organizational Performance (Finance, Marketing, Operational)** | 0.275 | 0.392 | No Supported |
| **H6** | **Circular Economy and Green Strategies -> Sustainability Performance** | 4.323 | 0.000 | Supported |
| **H7** | **Circular Economy and Green Strategies -> Sustainable Competitive Advantages** | 0.014 | 0.495 | Not Supported |
| **H8** | **Circular Economy and Green Strategies -> Organizational Resilience** | 3.094 | 0.001 | Supported |

The above table indicates relationships between the circular economy, green strategies, and sustainability (H6: Accepted), and organizational resilience (H8: Accepted). These findings support the related literature, which suggests that the Circular Economy and green strategies and practices strengthen SMEs' ability to adapt and cope with potential challenges. Hence, the current study results agreed with most green and resilient literature. (Ahmić 2022; Akpan et al. 2022; Castro-Lopez et al. 2023; Lopes de Sousa Jabbour et al. 2023; Patyal et al. 2022). Likewise, positive relations and impacts were found between the Circular Economy and Green Strategies, as the two concepts are closely related. Thus, a positive relationship was established and is consistent with most related literature. Since the Circular Economy and Green Strategies involve several sustainability initiatives and practices, those practices touch the Environmental, Social, and Governance (ESG) performance within SME outcomes ((Awan and Sroufe 2022; Ghaithan et al. 2023b; Toni 2023; Turner et al. 2022)). Firms implementing Green and circular economy practices are more likely to achieve sustainable performance than other firms.

In contrast, circular economy and green strategies did not support organizational performance and sustainable competitive advantage (H5 and H7 are rejected). These

findings are consistent with those of Rodríguez-González et al. (2022), who argued that CE practices can yield long-term benefits rather than immediate impacts on traditional performance matrices. Furthermore, CE and green practices might require additional investments (Skalli et al., 2024)

Likewise, the results further indicated no significant direct relationship between CE and Green Strategies and Sustainable Competitive Advantages, which is inconsistent with the majority of the related literature.(Bocken et al. 2014)Such an effect could be contingent upon market orientation, innovative practices, and the business environment. Repeatedly, the lack of financial resources, resource utilization, knowledge gaps, differences between large and small firms, and differences between industrial clusters might hinder the effect of CE. (Stark and Chin 2022; Yaqub and Alsabban 2023).

### 4.6.3 Organizational Resilience-Related Hypotheses:

*H9: Organizational Resilience Positively impacts organizational performance.*
*H10:Organizational Resilience Positively Impacts Sustainability.*
*H11:Organizational Resilience Positively Impacts Sustainable Competitive Advantage.*

The bootstrapping process and hypothesis testing revealed that H9 is accepted. However, H10 and H11 are rejected, as shown in Table 4.9 below.

Table (4.9): Organizational Resilience-Related Hypothesis Bootstrapping Test Results

| Hypo | Path | T statistics | P values | Direction |
|---|---|---|---|---|
| **H9** | **Organizational Resilience -> Organizational Performance (Finance, Marketing, Operational)** | 3.503 | 0.000 | Supported |
| **H10** | **Organizational Resilience -> Sustainability Performance** | 1.357 | 0.087 | Not Supported |
| **H11** | **Organizational Resilience -> Sustainable Competitive Advantages** | 1.414 | 0.079 | Not Supported |

Table 4.9 revealed a strong relationship between organizational resilience and organizational performance, with more resilient firms more likely to achieve good performance because they are more flexible, better able to cope with potential challenges, and better equipped to navigate disruption and adapt to the dynamic business environment. The current finding aligns with the majority of the literature, which shows that organizational and supply chain resilience improve SMEs' ability to maintain good operational performance and achieve objectives despite external shocks. (Hou et al. 2024; Ismail et al. 2024; Pertheban et al. 2023).

In contrast, the relationships between organizational resilience and sustainability and between organizational resilience and sustainable competitive advantage were not supported (the related Hypotheses were rejected). This suggests that while organizational resilience positively contributed to organizational flexibility, it might not directly improve sustainability performance and outcomes. A recent study of (Aming'a et al. 2024) Revealed that achieving sustainability often requires dedicated strategies that include organizational resilience. Accordingly, organizational resilience alone might not affect sustainability without the support of additional factors.

Likewise, according to Jay Barney's resource-based view, organizations need to enhance their rare, valuable, and non-imitable resources to achieve sustainable competitive advantage. Hence, organizational resilience indirectly affects the utilization of organizational resources.

### 4.6.4 Dependent Variables Related Hypotheses

*H12: Organizational performance positively impacts the sustainable competitive advantage*

*H13: Sustainability Positively Impacts Sustainable Competitive Advantage.*

Both hypotheses regarding the dependent variable were accepted, as shown in the Table 4.10 below, which was generated using PLS 4.0 bootstrapping techniques for hypothesis testing.

Table (4.10): Dependent Variable Related Hypotheses.

| Hypo | Path/Direction | T statistics | P values | Decision |
|---|---|---|---|---|
| H12 | Organizational Performance (Finance, Marketing, Operations) -> Sustainable Competitive Advantages | 3.065 | 0.001 | Supported |
| H13 | Sustainability Performance -> Sustainable Competitive Advantages | 1.860 | 0.031 | Supported |

The hypothesis results demonstrate significant findings regarding the impact of organizational performance on sustainable competitive advantage. Good performance would support organizational capabilities and abilities to achieve sustainable competitive advantage. This finding supported the previous related literature emphasizing the key role of organizational performance in creating long-term sustainable competitive advantage, (Bocken et al. 2014; Colli et al. 2018; Mikalef et al. 2020).

Similarly, H13 highlights a significant positive relationship between sustainability performance and sustainable competitive advantage, aligning with previous related literature. Hence, previous literature suggested that the effective implementation and performance of sustainability would positively contribute to achieving a good level of sustainable competitive advantage and could also contribute to building a long-term competitive edge for SMEs (Gupta et al. 2022; Tolmachev et al. 2023; Yuldashev et al. 2023). Furthermore, (Corral-Marfil et al. 2021) Recycling strategies as part of sustainability practices positively affect SMEs' sustainable competitive advantages.

### 4.6.4 Firm Size “Control Variable” Related Hypotheses

*H14:firm size significantly influences sustainability performance.*
*H15: Firm size significantly influences the sustainable competitive advantage performance*
*H16: Firms' size significantly influences organizational performance.*

*H17: Firms' size significantly influences organizational resilience.*
*H18: Firm size significantly influences the turbulent environment*

By performing hypothesis testing using the bootstrapping function in PLS 4, the results shown in the table below 4.11 were obtained, and H14 and H18 were accepted. while H15, H16 and H17 rejected.

Table (4.11): Firm Size Related "Control Variable" Hypotheses

| Hypo | Path | T statistics | P values | Direction |
|---|---|---|---|---|
| **H14** | **Firm Size Control Variable -> Organizational Performance (Finance, Marketing, Operational)** | 2.146 | 0.016 | Supported |
| **H15** | **Firm Size Control Variable -> Organizational Resilience** | 0.367 | 0.357 | Not Supported |
| **H16** | **Firm Size Control Variable -> Sustainability Performance** | 0.404 | 0.343 | Not Supported |
| **H17** | **Firm Size Control Variable -> Sustainable Competitive Advantages** | 0.302 | 0.381 | Not Supported |
| **H18** | **Firm Size Control Variable -> Turbulent Business Environment** | 2.970 | 0.001 | Supported |

The hypothesis-testing results for the relationship between the control variable, Firm Size, and various organizational outcomes are mixed. Specific firm size significantly influences the turbulent business environment. The firm's size determines the firm's ability to respond to challenges in this environment. Larger firms might have more diversified resources to withstand turbulence. This conclusion is supported by Jay Barney's well-established resource-based view theory.

Likewise, firm size significantly influences its ability to achieve good organizational performance as H14 is accepted -see table 04-10-. This finding aligns with previous

literature emphasizing the firm's size as a key driver of organizational capabilities and outcomes. Hence, the larger the firms are, the more able they are to utilize resources, foster and benefit from new technologies, and achieve greater financial resources and performance than smaller firms. Nevertheless, these resources provide firms, “especially the larger firms,” with a competitive edge, particularly in dynamic environmental contexts (Ahmić 2022; Ali and Johl 2023; Gupta et al. 2022; Hadjinicolaou, Kader, and Abdallah 2022; Jum’a et al. 2024; Tripathi and Gupta 2023).

Smaller firms faced greater challenges due to resource constraints and limited market presence, which might hinder their ability to achieve outcomes similar to those of larger firms. (Rodríguez-González et al. 2022).

Table (04-10) revealed that firm size does not influence sustainability (H16: rejected), sustainable competitive advantage (H17: rejected), or organizational resilience (H15: rejected). Despite having fewer resources than larger firms, SMEs can leverage their flexibility, innovation, and niche markets to achieve the same results.

### 4.6.5 The Mediating Hypotheses Group:

*H19: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Organizational Performance.*

*H20: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Organizational Resilience.*

*H21: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Sustainability Performance.*

*H22: Industry and Quality 4.0 mediate the effect between Circular Economy and Green Strategies with Turbulent Business Environment*

*H23: Turbulent Business Environment Mediates the Effect between Circular Economy and Green Strategies with Organizational Performance.*

*H24: Turbulent Business Environment Mediates the Effect between Circular Economy and Green Strategies with Sustainability Performance.*

*H25: Turbulent Business Environment mediates the effect between Industry and Quality 4.0 with Organizational Performance.*

*H26: Turbulent Business Environment mediates the effect between Circular Economy and Green Strategies with sustainable competitive advantage.*

*H27: Turbulent Business Environment mediates the effect between Industry and Quality 4.0 with Sustainability Performance.*

*H28: Organizational Resilience mediates the effect between Circular Economy and Green Strategies with organizational performance.*

*H29: Organizational Resilience mediates the effect between Circular Economy and Green Strategies with sustainability performance.*

*H30: Organizational Resilience mediates the effect of Industry 4.0 and Quality 4.0 on organizational performance.*

*H31: Organizational Resilience mediates the effect between Circular Economy and Green Strategies with sustainable competitive advantage.*

*H32: Organizational Resilience mediates the effect between Industry and Quality 4.0 with sustainability performance*

*H33: Organizational Resilience mediates the effect between Industry and Quality 4.0 with sustainable competitive advantage performance*

Using the bootstrapping technique, the specific indirect relations include all potential indirect relationships (including the research mediating effect hypotheses). Table 4.12 summarizes the nine mediating effect hypotheses.

Table (4.12): Mediating Effect Hypotheses Results.

| Hypo | Path/ Direction | T statistics | P values | Decision |
|---|---|---|---|---|
| **H19** | **Circular Economy and Green Strategies -> Industry and Quality 4.0 -> Organizational Performance** | 0.561 | 0.287 | Not Supported |
| **H20** | **Circular Economy and Green Strategies -> Industry and Quality 4.0 -> Organizational Resilience** | 4.217 | 0 | Supported |
| **H21** | **Circular Economy and Green Strategies -> Industry and Quality 4.0 -> Sustainability Performance** | 0.423 | 0.336 | Not Supported |
| **H22** | **Circular Economy and Green Strategies -> Industry and Quality 4.0 -> Turbulent Business Environment** | 3.637 | 0 | Supported |
| **H23** | **Circular Economy and Green Strategies ->Turbulent Business Environment -> Organizational Performance** | 0.356 | 0.361 | Not Supported |
| **H24** | **Circular Economy and Green Strategies ->Turbulent Business Environment -> Sustainability Performance** | 0.339 | 0.367 | Not Supported |
| **H25** | **Industry and Quality 4.0 -> Turbulent Business Environment -> Organizational Performance** | 2.328 | 0.01 | Supported |
| **H26** | **Circular Economy and Green Strategies ->Turbulent Business Environment -> Sustainable Competitive Advantages** | 0.303 | 0.381 | Not Supported |
| **H27** | **Industry and Quality 4.0 -> Turbulent Business Environment -> Sustainability Performance** | 2.446 | 0.007 | Supported |
| **H28** | **Circular Economy and Green Strategies -> Organizational Resilience -> Organizational Performance** | 2.208 | 0.014 | Supported |
| **H29** | **Circular Economy and Green Strategies -> Organizational Resilience -> Sustainability Performance** | 2.535 | 0.006 | Supported |

| | | | | |
|---|---|---|---|---|
| **H30** | **Industry and Quality 4.0 -> Organizational Resilience -> Organizational Performance** | 2.63 | 0.004 | Supported |
| **H31** | **Circular Economy and Green Strategies -> Organizational Resilience - >Sustainable Competitive Advantages** | 1.152 | 0.125 | Not Supported |
| **H32** | **Industry and Quality 4.0 -> Organizational Resilience -> Sustainability Performance** | 1.223 | 0.111 | Not Supported |
| **H32** | **Industry and Quality 4.0 -> Organizational Resilience -> Sustainable Competitive Advantages** | 1.31 | 0.095 | Not Supported |

### *4.6.6 The mediating role of Industry and Quality 4.0 related hypothesis (H19-H22)*

The mediating roles of Industry 4.0 and quality 4.0 between circular economy, green strategies, and performance (Sustainability and Sustainable Competitive Advantage) are not supported, as H19 and H21 are rejected. These results are consistent with the main hypothesis of this study, as previously discussed. Fostering the Circular Economy and Industry 4.0 requires long-term attention and, at times, investment to achieve the intended results in terms of sustainability and sustainable competitive advantage. (Rodríguez-González et al. 2022).

In contrast, the mediating effect of industry and quality 4.0 between circular economy and green strategies and organizational resilience is accepted (H20: Accepted) and with a Turbulent environment (H22: Accepted), which reveals an organization's ability to utilize industry 4.0 and the circular economy to adapt and cope with a challenge with more flexibility and dynamic capabilities by strengthening dynamic capabilities.

Nevertheless, the results highlighted the importance of an integrated model that merges circular economy, sustainability, and quality 4.0, aligning CE principles with Industry 4.0 techniques to enhance flexibility and dynamics and achieve sustainable performance (Luu, Chromjaková, and Nguyen 2023b; Rodríguez-González et al. 2022). (Luu et al. 2023b) circular economy and industry 4. The proposed model can be further developed to

incorporate dynamic resilience, yielding a robust model that integrates Industry 4.0, the circular economy, resilience, and dynamic capabilities.

**The mediating role of Turbulent Business Environment Related hypothesis (H23-H27)**

On one hand, the analysis showed no significant mediating role of Turbulent Business Environment between Circular Economy and Green Strategies and organizational performance (H23: Rejected), Sustainability Performance (H24: Rejected), and Sustainable Competitive Advantage (H26: Rejected). These findings supported the literature's previous findings in that a turbulent environment can weaken the direct and immediate impact of the circular economy on different performance matrices, especially when SMEs face resource constraints.(Stark and Chin 2022) .

On the other hand, a significant mediating relationship exists between industry and quality 4.0 and organizational performance (H25: Accepted), sustainability (H27: Accepted),(Lopes de Sousa Jabbour et al. 2023) . Again, these results highlighted the importance of having an integrated model to strengthen performance, (Hizam-Hanafiah et al. 2020; Lopes de Sousa Jabbour et al. 2023; Luu et al. 2023b; Nenadál 2020).

**4.6.7 The mediating role of Organizational Resilience Related hypothesis (H28-H33)**

Organizational resilience perfectly mediates the relationships between circular economy and green strategies and organizational performance (H28: accepted) and sustainability (H29: accepted); this supports the few studies that consider organizational resilience as a mediating factor in achieving sustainability (Ahmić, 2022). However, the mediating role of sustainable competitive advantage was not supported (H31: rejected), highlighting the importance of considering another aspect in an integral way with organizational resilience to achieve sustainable competitive advantage. Hence, organizational resilience, along with another component, could be considered a valuable resource according to the resource-based view of Jay Barney. (Barney, 1991).

Similarly, the mediating role of organizational resilience between industry and quality 4.0 with organizational performance is significant (H30: accepted), while it was not significant with sustainability (H32: rejected), sustainable competitive advantage (H33: rejected)

These findings highlight the importance of developing an integrated model that combines Industry 4.0, the Circular Economy, and Sustainability to address the complex, interconnected challenges faced by modern organizations. An integrated approach leverages technological advancements alongside sustainability principles and resilient practices, leading to holistic, long-term benefits (Gupta et al., 2022). Such synergies are crucial to achieving a competitive edge and sustainability, and to fostering traditional SME performance without underscoring the challenges that might arise from such an integrated model, from both practical and theoretical perspectives. (Bocken et al. 2014; Yaqub and Alsabban 2023)

## 4.7 Discussion

### 4.7.1 The readiness level of Industry 4.0 and Quality 4.0

The readiness of the Palestinian industry to adopt Industry 4.0 and Quality 4.0 technologies and techniques was assessed by the answers of middle management in section one of the questionnaire. Which gauge most closely reflects Palestinian firms' readiness to adopt quality 4.0 technologies and principles? The findings were in line with the limited previous literature in the arab and Middle East context, which was moderately evaluated. This means Palestinian industry is still in the introductory phase. (Shqair and Altarazi 2022b; Skalli et al. 2024).

Such findings underscore the broader challenges faced by developing economies, including limited resources, skill shortages, and infrastructure gaps that hinder the seamless adoption of Industry 4.0 technologies. Addressing these challenges requires a holistic approach and integrated model, combining technological, strategic, and human capital investments and enhancing industries in Palestine and other Arab countries to benefit from the opportunities presented by the promises within Industry 4.0 and Quality 4.0 (Patyal et al., 2022)

### 4.7.2 The readiness level of Industry 4.0 and Quality 4.0:its impact on Performance

The results of Industry 4.0 and Quality 4.0 readiness, and their impact on performance, were positively correlated with organizational performance. However, it was not significantly correlated with sustainability or sustainable competitive advantage; these findings support the literature suggesting that Industry 4.0 techniques require longer-term investment and the dedication of resources, technologies, infrastructure, and organizational capabilities (Müller et al., 2018; Zulqarnain et al., 2022). The limited immediate effects on sustainability and competitive advantage further emphasize the importance of integrating strategic alignment with sustainability goals and adopting a holistic, multidimensional model or approach, as discussed by Gupta et al. (2022) and Bocken et al. (2014). These results reflect the maturity gap between developed and developing economies, particularly in adopting advanced technologies and sustainable practices, highlighting the need for targeted efforts to bridge it.

Conversely, the study demonstrated a significant positive relationship between Industry 4.0 and Quality 4.0 readiness, as well as between Industry 4.0 and organizational resilience. This finding supports prior research (Marcucci et al., 2022) and reveals that these technologies enhance an organization's ability to adapt to disruptions and maintain continuity in turbulent environments. By fostering flexibility and robust operational frameworks, Industry 4.0 and Quality 4.0 readiness can be critical enablers of resilience, positioning organizations to navigate complex challenges effectively.

### 4.7.3 Circular Economy and Green Strategies: Its Impact on Performance

The hypothesis testing for Circular Economy (CE) and Green Strategies revealed mixed impacts on various organizational outcomes, as shown in Table 04-07. The results revealed a positive relationship between sustainability and organizational resilience. However, they did not support the relationship between organizational performance and sustainable competitive advantage. These results highlight the nature of CE and Green Strategies, emphasizing their potential to strengthen sustainability and resilience, while also noting their limitations in directly driving performance and competitive advantage in the short term. (Awan and Sroufe 2022).

The positive relationship between CE and Green Strategies and sustainability (H6) aligns with prior research in terms of limited effects on the short-term horizon, as these approaches need a longer time of investment of resources, capabilities, and skills to gain the short-term outcomes (Awan & Sroufe, 2022; Ghaithan et al., 2023). Similarly, the significant relationship with organizational resilience supported the limited prior literature, suggesting that the Circular economy and its potential could enhance organizational flexibility and dynamism in coping with business shocks (Ahmić, 2022; Akpan et al., 2022).

Conversely, the lack of significant impact on organizational performance (H5) and sustainable competitive advantage (H7) pointed out the challenges faced by SMEs in adopting these practices and differences between large, medium, and small firms in adoption and ability to implement these practices, as there were significant relations between Firm Size and Circular Economy and Green Strategies.

Moreover, these findings are consistent with Rodríguez-González et al. (2022), who highlight that while CE practices offer long-term benefits, their immediate impact on financial, operational, and marketing metrics is often constrained by the need for substantial investments and structural adjustments. Additionally, achieving sustainable competitive advantage through CE and Green Strategies requires complementary factors, such as innovation, market orientation, and new technologies, such as Industry 4.0 (Bocken et al., 2014; Stark & Chin, 2022). The disparities between large and small firms, coupled with resource limitations and knowledge gaps in industrial clusters, further hinder the short-term effectiveness of these practices (Yaqub & Alsabban, 2023).

Finally, this finding highlighted the importance of a holistic, integrated model that combines circular economy practices with other technological approaches, such as Industry 4.0, to enable SMEs to benefit in the short and long term. (Filho et al. 2022a; Ghaithan et al. 2023c; Toni 2023; Turner et al. 2022)

### 4.7.4 Organizational Resilience as Mediator

The findings emphasize the critical role of organizational resilience as a mediator in achieving organizational performance and sustainability. As the circular economy and Industry 4.0 support the resource-based view (Barney, 1991), resilience can be considered a valuable resource for navigating complexity. While the lack of mediation with competitive advantages and “industry and quality 4.0 and sustainability " sheds the importance of having an integrated approach that synergizes between different aspects to gain long-term results, such a model can combine organizational resilience, industry 4.0, and circular economy (Gupta et al., 2022). While this approach holds promise for SMEs' performance and resilience, practical and theoretical challenges, like the turbulent environment, must be considered to optimize outcomes (Bocken et al., 2014; Yaqub & Alsabban, 2023).

### 4.7.5 Industry 4.0 and Quality 4.0 as Mediators

The findings reveal that the mediating role of Industry and Quality 4.0 between Circular Economy and Green Strategies with performance outcomes such as sustainability and sustainable competitive advantage is not supported. This aligns with discussions in previous sections, highlighting that fostering the Circular Economy and Industry 4.0 requires long-term commitment and significant investments to achieve sustainability impacts and competitive advantage (Rodríguez-González et al., 2022). However, the mediating role of Industry and Quality 4.0 between Circular Economy and Green Strategies, and between organizational resilience and turbulent business environments, would also underscore the need for an integrated model to enhance organizational sustainable competitive edge.

Such an integrated model should include circular economy practices and Industry 4.0 technologies, supported by sustainability and resilience, to strengthen the organization's dynamics (Luu et al., 2023; Rodríguez-González et al., 2022).

### 4.7.6 Theoretical Discussion

RBV, DC, institutional, TBL, and TOE models or theories explain how Industry 4.0 and CE practices operate in turbulent environments. On the one hand, RBV and DC emphasize the strategic and adaptive use of internal resources, while the Institutional Theory and the TOE model focus on external pressures and systemic factors influencing adoption.

Integrating these frameworks reveals that achieving resilience and sustainable performance in dynamic conditions requires a multidimensional approach aligning organizational capabilities, technological advancements, and environmental factors. This underscores the need for integrated models that leverage synergies among CE, Industry 4.0, and sustainability to address the complex challenges of today's volatile, turbulent business environment. Recent literature has tried to offer a new "Circular economy theory." The development of CE theory is an ongoing process, with much of its evolution driven by practical applications and by interdisciplinary borrowing from other theories. However, the circular economy theory could provide a new research arena. The RBV, DC, and institutional theories can still offer avenues for adopting CE and Industry 4.0 integration.

Extending existing theories is often more impactful and practical than creating an entirely new one, especially in fields like CE and Industry 4.0, which are still evolving. Building on established frameworks ensures your work is grounded in proven concepts while adding value through specific CE and industry 4.0-focused insights. The following table summarizes proposed extensions regarding these theories to cover CE and Industry 4.0 principles.

Table (4.13) Proposed Theoretical Extensions.

| Theoretical Framework | Current Application in the Study | Key Role in Explaining Findings | Proposed Extension | Theoretical Contribution |
|---|---|---|---|---|
| **Resource-Based View (RBV)** | Firms achieve competitive advantage through valuable, rare, inimitable, and non-substitutable (VRIN) resources. Industry 4.0 technologies and Circular Economy practices are treated as strategic resources. | Industry 4.0 and the Circular Economy positively influence resilience and sustainability; however, achieving direct performance gains requires integrating capabilities. | Extend RBV toward **circular-digital resource integration**, where IoT, AI, and CE practices create hybrid strategic assets that enhance resilience and sustainability in turbulent environments. | Shifts RBV from static resource possession to **integrated digital-circular capabilities** as higher-order strategic assets. |
| **Dynamic Capabilities Theory** | Focuses on sensing, seizing, and reconfiguring resources in dynamic environments. Organizational resilience is | Resilience mediates the relationships among Industry 4.0, the Circular Economy, and organizational performance. | Integrate Industry 4.0 tools (predictive analytics, digital twins) as **digital enablers of sensing and reconfiguratio** | Position resilience as an **operational dynamic capability** enhanced through digital transformation. |

| | | | | |
|---|---|---|---|---|
| | conceptualized as a dynamic capability. | | **n**, strengthening adaptive capacity. | |
| **Institutional Theory** | Firms respond to regulatory, normative, and cultural-cognitive pressures. Environmental and regulatory factors influence the adoption of Industry 4.0 and CE practices. | Institutional pressures shape the adoption level of digital and circular initiatives. | Extend the theory to analyze how sustainability policies and digital regulations accelerate the integration of Industry 4.0 into circular supply chains. | Connects institutional pressure with **digital sustainability transformatio n**, especially in emerging economies. |
| **Technology-Organizatio n-Environmen t Framework (TOE)** | Technology adoption depends on technological readiness, organizational capabilities, and environmental pressures. | Adoption of Industry 4.0 and CE practices is influenced by readiness, internal capabilities, and market/regulato ry context. | Expand TOE by positioning Industry 4.0 as a **technological enabler of Circular Economy implementatio n**, linking digital readiness with sustainability outcomes. | Integrates digital and circular transformation within a unified adoption framework. |

| | | | | |
|---|---|---|---|---|
| **Triple Bottom Line (TBL)** | Organizational performance is evaluated across economic, environmental, and social dimensions. Sustainability is treated as a multidimensional outcome. | Industry 4.0 and Circular Economy practices contribute to environmental performance and long-term economic sustainability, mediated by resilience. | Extend TBL by incorporating **digital transformation and resilience as drivers of balanced sustainability performance**, particularly under turbulent conditions. | Links digital and circular capabilities to **simultaneous economic, environmental, and social value creation**, strengthening sustainable competitive advantage. |

### 4.8 Chapter Conclusion

The hypothesis results moderately support the need for an integrated model combining sustainability, Industry 4.0, Circular Economy (CE), and dynamic resilience to address the interconnected challenges organizations face in today's turbulent environments. While Circular Economy practices foster environmental sustainability and operational efficiency, their immediate financial and strategic benefits often remain limited when implemented in isolation. Similarly, Industry 4.0 technologies enhance flexibility and operational performance but require alignment with sustainability and circular principles to achieve holistic and lasting impacts.

The findings highlight that organizational resilience is a crucial enabler, helping organizations navigate disruptions and leverage advanced technologies and sustainable practices effectively. Together, these elements must function as a cohesive system to unlock long-term sustainable competitive advantages, (Barney 1991).

This integrated approach aligns with several theoretical frameworks. The Resource-Based View (RBV) emphasizes leveraging unique resources, such as advanced technologies and

sustainable practices, to gain a competitive advantage. At the same time, the Dynamic Capabilities Theory highlights the need to adapt and reconfigure these resources to respond to evolving challenges. Other theories that can inform the model include institutional, stakeholder, and middle management perspectives, as well as TEO models. However, some extensions to these theories are needed to cover the circular economy and sustainability perspectives.

Finally, it is proven that sustainability performance and traditional performance matrices can leverage the organizational sustainable competitive advantage. (Corral-Marfil et al. 2021; Wang, Han, and Liu 2018). Hence, integration is crucial for organizations to achieve the expected outcomes in turbulent business environments.

# Chapter Five: Conclusions

## 5.1 Introduction:

The overarching aim of this thesis is to fill a literature gap on Industry 4.0 and the circular economy in the developing Arab context. This chapter summarizes the conclusion regarding Industry 4.0 and circular economy aspects. It sheds light on practical and theoretical recommendations to foster Industry 4.0 and circular economy concepts in the Arab regions.

## 5.2 Conclusion:

Six research questions were raised in this study, which tried to shed light on the different relationships between the Circular economy, Industry 4.0, and performance metrics in the turbulent environment; these questions are summarized below:

(1) What is the level of Industry 4.0 Readiness in the Palestinian Industrial Sector?
    a. What is the readiness and maturity level based on the IMPLUS framework?
    b. What is the readiness level of Quality 4.0 in the Palestinian industrial sector?
(2) Are quality 4.0 and industry 4.0 positively influencing sustainable performance, Business Performance, and Organizational Resilience?
(3) Do green strategies and the circular economy positively influence business and organizational performance, sustainable performance, and organizational resilience?
(4) Does Organizational Resilience Mediate the effect between (Quality 4.0, Circular Economy) and Performance (Sustainable Performance, Organizational Performance)?
(5) Does Quality 4.0 Mediate the Effect of Circular Economy and Performance (Sustainable Performance and Organizational Performance)?
(6) Are RBV and dynamic capabilities theories applicable in the Palestinian context of "manufacturing SMEs"

To answer these questions using a questionnaire survey design, a quantitative cross-sectional research methodology was employed. The data were analyzed using PLS-SEM.

### 5.2.1 Response to Question Number One

Based on the empirical analysis of the questionnaire, particularly the first section, it can be concluded that the Palestinian industrial sector has strong potential to benefit from Industry 4.0 and Quality 4.0, as the findings on these questions indicate that Palestinian firms are moderately ready to adopt them.

As previously discussed, these findings align with the existing literature, emphasizing the importance of assessing readiness and understanding the unique characteristics of the industrial context. This approach provides deeper insights into the challenges associated with Industry 4.0 and Quality 4.0, particularly within the Middle Eastern context. (Alsharah 2020; Qushtom 2020; Shqair and Altarazi 2022b).

Finally, the more profound analysis of responses highlighted differences in the abilities and readiness of larger and smaller firms for Industry 4.0. As larger firms have more access to more resources and can utilize these resources better than small firms with limited resources and capabilities, (Mittal et al. 2018a; Sullivan-Taylor and Branicki 2011).

### 5.2.2 Response to Question Number Two

The relationship between industry and quality 4.0 shows no positive association with performance matrices (sustainability, sustainable competitive advantage, and organizational performance) or resilience. Hence, firm size played a key role in shaping this relationship, (Mittal et al. 2018a; Sullivan-Taylor and Branicki 2011).

The findings under this question suggest that quality 4.0 and industry 4.0 practices and technologies offer a promising avenue for Palestinian industrial firms to strengthen their flexibility and resilience and achieve the required outcomes in the extended horizon. While achieving short-term impact and outcomes, Industry 4.0, if combined with other approaches such as the circular economy, might offer a short-term positive impact.(Ashtankar et al. 2023; Mittal et al. 2018b; Patyal et al. 2022).

**Response to Question Number Three**

Similarly, the relationship between the circular economy and green strategies, as measured by different performance matrices and resilience, was also mixed. Considering the natural relationship between the circular economy and sustainability, which was supported.

It can also be concluded that a circular economy and green strategies could offer Palestinian firms an avenue to cope with turbulent business environments and achieve the required resilience capabilities. (Todorovic et al. 2020)As such, the study concluded that a holistic, integrated model that combined Industry 4.0 and circular economy dynamic capabilities could foster Palestinian firms' short—and long-term performance, considering the potential effect of firm size. (Awan and Sroufe 2022; Ghaithan et al. 2023b, 2023c; Patyal et al. 2022; Toni 2023; Turner et al. 2022).

**Response to Question Number Four**

In conclusion, the findings highlight the pivotal role of organizational resilience as a mediator in achieving organizational performance and sustainability, particularly within the resource-based view.

Furthermore, the findings underscore the direct relationship with sustainable competitive advantages. However, sustainability and organizational performance lead to sustainable competitive advantages. This view and relationship strengthen the conclusion that a holistic, integrated model that considers Industry 4.0, the circular economy, and resilience capabilities is needed to achieve the intended results.

Finally, organizational resilience capabilities can be pivotal in achieving sustainability and sustainable competitive advantages. Nevertheless, the outcomes will be significantly enhanced if Industry 4.0 and a circular economy are further strengthened.(Cherrafi et al. 2022; Ghaithan et al. 2023c; Howard, Böhm, and Eatherley 2022)

**Response to Question Number Five**

The findings revealed that quality and Industry 4.0 could mediate the impact of the circular economy on organizational performance and organizational resilience. However, they did not support the relationship between sustainability and sustainable competitive advantages.

It can be concluded that Industry 4.0 can partially cover circular economy practices, as it includes measures to enhance operational efficiency, and that automation can offer significant operational efficiencies. However, its ability to cover sustainability issues is limited. Thus, an integrated model combining the circular economy and Industry 4.0 is required to achieve the intended outcomes of sustainable competitive advantage. (Howard et al. 2022; Patyal et al. 2022).

**Response to Question Number Six:**

Industry 4.0, quality 4.0, and circular economy concepts are still new in the literature, so developing related theories is not advised. Alternatively, using well-established theories in the strategy field can be a good option until the concept matures in the literature through additional empirical and non-empirical analyses and results.

RBV, DC, institutional theory, TOE, and triple bottom line theories together could offer promising avenues for establishing an integrated model that combines organizational resilience, circular economy, and Industry 4.0 in a turbulent environment. (Gellweiler 2018; Krmela and Šimberová 2023; Wang, Chen, and Zhang 2022)

## 5.3 Recommendations:

The recommendation section of Chapter Five summarizes actionable recommendations based on the findings and results presented in Chapter Four. The analysis revealed critical insights into Palestinian industrial firms' readiness for Industry 4.0 and Quality 4.0, the impact of Circular Economy (CE) and Green Strategies, the role of organizational resilience, and the influence of turbulent business environments.

These findings highlight the need for an integrated approach to enhance organizational performance, sustainability, and competitive advantage. The recommendations are structured to address key stakeholders, including policymakers, industry leaders, and academic researchers, to foster sustainable development and resilience in the Palestinian industrial sector; Figure 5.1 summarizes the main stakeholders covered in the recommendations.

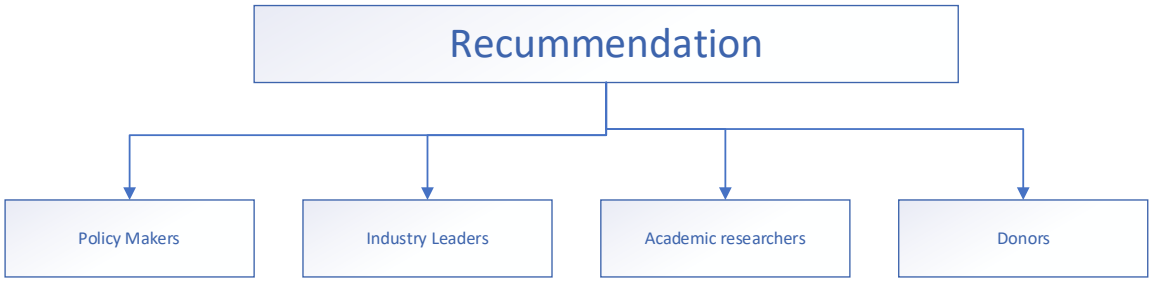


**Figure (5.1): Stakeholders Covered in the Recommendations.**

### 5.3.1 Recommendations for Policymakers

#### 5.3.1.2 Promote Industry 4.0 and Quality 4.0 Adoption

Develop national strategies and policies to accelerate the adoption of Industry 4.0 and Quality 4.0 technologies among the industrial sector to enhance the competitive advantage; this includes providing financial incentives, tax breaks, and subsidies for firms investing in advanced technologies and investment promotions, Establish training programs and partnerships with educational institutions to build a skilled workforce capable of implementing and managing Industry 4.0 technologies through collaboration with academic and technical institutions and encourage academic institutions to adopt new related academic and technical programs.

#### 5.3.1.2 Support Circular Economy Initiatives

Introduce regulatory frameworks and incentives to encourage firms to adopt Circular Economy practices, such as waste reduction, recycling, and resource efficiency. (Awan and Sroufe 2022)

Facilitate public-private partnerships to create industrial ecosystems that promote circularity, such as green industrial clusters, industrial parks designed for resource sharing and waste management, (Wang and Zhao 2024). For instance, industrial waste from the stone and marble industries can be recycled and used in other industries.

#### 5.3.1.3 Enhance Sustainability Reporting

Promote sustainability reporting among industrial firms, especially those with higher pollution impacts. Provide the needed guidelines and tools to help firms effectively measure and report their sustainability performance. The United Nations Global Compact (UNGC) and other guidance can serve as general policy guidelines. Hence, the UNGC is a well-known global ESG practice adopted by the United Nations, (Fasoulis 2022; Gilbert and Behnam 2013).

#### 5.3.1.4 Strengthen Institutional Support:

Establish dedicated government agencies or task forces to oversee the implementation of Industry 4.0, Quality 4.0, and Circular Economy initiatives. (Aria and Cuccurullo 2017; Patyal et al. 2022). Hence, the Palestinian Federation of Industries and the Chamber of Industries can be suitable places to host the Industry 4.0 hub.

Collaborate with international organizations and donors to secure funding and technical assistance for sustainable industrial development, focusing on Industry 4.0 and the circular economy. (Patyal et al. 2022)

### 5.3.2 Recommendation To Industry Leaders

#### 5.3.2.1 Invest in Industry 4.0 and Quality 4.0 Technologies

Prioritize and evaluate the impact of investments in digital technologies, such as IoT, AI, and big data analytics, to improve performance and efficiency. Develop a phase implementation plan that leverages the new concepts of Industry 4.0 and Quality 4.0 to enhance current quality management and business practices.

#### 5.3.2.2 Adopt Circular Economy Practices

The circular economy model focuses on (reducing, reusing, and recycling) and implementing circular business models that focus on reducing waste, reusing materials, and recycling resources. Collaborate with suppliers and customers to create closed-loop supply chains that minimize environmental impact.

#### 5.3.2.3 Build Organizational Resilience/ dynamic organizational resilience

Develop contingency plans and risk management strategies to evaluate turbulent business environments, which include flexibility in production and manufacturing processes (Kennedy & Linnenluecke, 2022; Teixeira & Werther, 2013; Wang et al., 2024). A linkage between training and capacity-building for resilience-building skills would enhance outcomes. (Mitsakis 2022)

#### 5.3.2.4 Enhance Sustainability Performance

Integrate sustainability into core business strategies by setting clear ESG goals with key performance indicators to facilitate follow-up and engage with stakeholders, including employees, customers, and communities, in sustainability initiatives.

### 5.3.3 Recommendations for Academic Researchers (Future Research)

#### 5.3.3.1 Conduct Further Research on Integrated Models

Explore the development of an integrated model that combines Industry 4.0, Circular Economy, and organizational resilience to address the complex challenges faced by industrial firms.

Study the role of dynamic capabilities in enabling firms to adapt to turbulent environments and achieve sustainable competitive advantage. (Alkaraan et al. 2024; Subramaniam, Salamzadeh, and Mujtaba 2023; Wang and Zhao 2024). Moreover, studying the mediating role of dynamic capabilities in the relationship between the circular economy and resilience would enrich future literature.

#### 5.3.3.2 Study the Impact of Firm Size:

Study how firm size influences the adoption and implementation of Industry 4.0, Circular Economy, and sustainability practices, using empirical or case-study evidence, preferably comparing practices across large, medium, and small firms. , (Ahmić 2022; Ali and Johl 2023; Jum'a et al. 2024)

#### 5.3.3.3 Explore Regional and Cultural Contexts

To conduct comparative studies to understand how regional and cultural factors influence the adoption of Industry 4.0, Circular Economy, and sustainability practices. Moreover, the current study methodology can be applied to other contexts to evaluate the differences. (Patyal et al., 2022).

Identify best practices and lessons learned from other developing economies that can be adapted to the context of developing and emerging markets. (Kvasničková Stanislavská et al. 2023; Zulqarnain, Wasif, and Iqbal 2022b)

#### 5.3.3.4 Investigate the Role of Stakeholders

Analyze the role of stakeholders, including governments, industry associations, and civil society, in promoting sustainable industrial development, taking into consideration the stakeholder theory and its applicability in developing and emerging market contexts.(Bıçakcıoğlu-Peynirci and Tanyeri 2022)

Develop frameworks for stakeholder engagement and collaboration to drive collective action toward sustainability and the Sustainable Development Goals.

**Future Studies using different research designs**

It is also recommended that longitudinal studies be conducted to examine practices and their impacts over a longer period. Panel studies can also be used to measure and evaluate long-term practices and impacts, rather than the cross-sectional research design currently used in this study.

## 5.5 Recommendations for International Organizations and Donors

### 5.5.1 Provide Financial and Technical Support

To offer grants, loans, and technical assistance to support the adoption of Industry 4.0, Quality 4.0, and Circular Economy among Palestinian industrial firms. Hence, the pilot project in the field of circular economy, managed by UNIDO and GIZ, has strong potential to enhance sustainable development and sustainability in the Palestinian industrial sector and to serve as a role model for circular economy practices.

Such practices should be linked with capacity-building programs to enhance the Palestinian local staff's skills in those emerging fields,(Gupta et al. 2022)

### *5.5.2 Facilitate Knowledge Exchange:*

Organize workshops, conferences, and study tours to share best practices and success stories from other regions. Moreover, regional and international benchmarking studies in related fields can be beneficial. For instance, the Chamber of Industry and Commerce in Ajman, United Arab Emirates, conducted an excellent Industry 4.0 maturity

assessment of 100 industrial firms and developed an industrial rehabilitation program. Nevertheless, learning about such experiences would enrich the knowledge of Industry 4.0 and the circular economy. (Gupta et al. 2022)

Create platforms for collaboration and knowledge exchange between Palestinian firms and international experts.

### 5.6 Chapter Conclusion

Table (5.1): Hypothesis, V.S Findings and Implications

| Strategic Construct | Overall Findings | Strategic Conclusion | Practical Implications | Theoretical Contribution |
|---|---|---|---|---|
| Industry 4.0 Technologies & Quality 4.0 Technologies Readiness | Limited direct effect on organizational performance and sustainable competitive advantage; strong and consistent influence on organizational resilience | Readiness for Industry 4.0 and Quality 4.0 technologies does not, in itself, guarantee superior performance; rather, it strengthens the firm's adaptive architecture and renewal capacity. | Organizations should treat Industry 4.0 and Quality 4.0 technologies as long-term strategic infrastructure investments that enhance sensing, responsiveness, and operational intelligence rather than short-term profitability tools. | Extends the Resource-Based View by framing technological readiness as a strategic capability that gains value when embedded within dynamic organizational processes; reinforces the Dynamic Capabilities theory |
| Circular Economy & Green Strategies | Strong positive influence on sustainability and organizational resilience; | Circular and green strategies constitute structural drivers of sustainability and resilience | Firms should institutionalize circular supply chains, eco-design, and resource- | Strengthens the Triple Bottom Line perspective and conceptualizes Circular Economy practices as rare |

| | | | | |
|---|---|---|---|---|
| | limited short-term financial impact | enhancers rather than immediate performance accelerators. | efficiency practices as part of strategic transformation rather than compliance-driven initiatives. | and inimitable strategic assets within RBV logic |
| Organizational Resilience | Strong mediating mechanism linking strategic enablers to performance outcomes | Organizational resilience emerges as the pivotal transformation capability that converts Industry 4.0, Quality 4.0, and Circular Economy technologies into sustainable performance outcomes. | Firms must embed agility, adaptive leadership, crisis preparedness, and structural flexibility into governance systems to secure long-term viability. | Advances resilience scholarship by repositioning it as a higher-order dynamic capability through the adoption of Dynamic Resilience, central to sustained competitive advantage |
| Turbulent Business Environment | Context-sensitive mediating influence; amplifies the value of Industry 4.0 and Quality 4.0 technologies under volatility | Environmental turbulence functions as a strategic stress-test that reveals the value of adaptive technological readiness; its influence on circular | Organizations operating in volatile markets should align Industry 4.0 technologies with predictive analytics, scenario planning, and | Integrates Contingency Theory with RBV and Dynamic Capabilities by demonstrating that capability value is environmentally conditioned |

| | | | | |
|---|---|---|---|---|
| | | strategies is comparatively long-term | strategic foresight mechanisms. | |
| Integrated Strategic Model | Indirect (mediated) effects are substantially stronger than direct effects. | Sustainable competitive advantage is achieved by orchestrating Industry 4.0, Quality 4.0, and Circular Economy technologies through organizational resilience in turbulent environments. | Strategic alignment and capability integration are essential; isolated adoption of technologies or sustainability initiatives is insufficient for long-term superiority. | Develops an integrated RBV–Dynamic Capabilities–TOE–TBL framework explaining how technological and sustainability enablers jointly shape resilient performance systems |

### 5.6.1 Practical Implication

**Adoption of Industry 4.0 and Quality 4.0**: The findings suggest that Palestinian industrial firms are beginning to adopt these technologies. Firms should prioritize investments in digital tools like IoT, AI, and big data analytics to improve operational efficiency and production.

**Circular Economy Practices: Firms should adopt circular business models focusing** on waste reduction, resource efficiency, and recycling. Including designing products for reuse or implementing product and production efficiency models can significantly reduce environmental impact (Bocken et al., 2014). More collaboration with suppliers and customers to create closed-loop supply chains to achieve circularity (Turner et al., 2022).
**Building Organizational Resilience:** To navigate turbulent environments, firms should develop contingency plans, diversify supply chains, and invest in flexible production

systems. Enhance knowledge and capacity in resilience-building skills, such as problem-solving and crisis management (Hou et al., 2024).

**Policy Support for Advanced Technologies**: Policymakers should develop national strategies to promote the adoption of Industry 4.0 and Quality 4.0 technologies. Financial incentives, such as tax breaks and subsidies, can encourage firms to invest in advanced technologies. **Regulatory Frameworks for the Circular Economy: Policymakers should introduce regulations and incentives to encourage firms to adopt Circular Economy practices, such as tax incentives for reducing** waste or penalties for excessive waste generation.

**Sustainability Reporting Mandates**: Industrial firms should implement mandatory sustainability reporting, particularly those in high-impact sectors or high-pollution industries. The Palestinian regulatory framework can benefit from the United Nations Global Compact's sustainability reporting framework, which promotes sustainability reporting among industrial and non-industrial firms.

### 5.6.2 Theoretical Implications

The study's findings contribute to the theoretical understanding of Industry 4.0, Circular Economy, and Organization.

Resilience by highlighting their interconnectedness and impact on organizational performance and sustainability. The following theoretical frameworks were used to explain the findings, and extensions are proposed to better align with the integration of these concepts.

#### 5.6.2.3 Resource-Based View (RBV):

**Current Application**: The RBV emphasizes that firms achieve competitive advantage by leveraging unique, valuable, and rare resources (Barney, 1991). In this study, Industry 4.0 technologies and Circular Economy practices are considered strategic resources that enhance organizational performance and sustainability.

**Proposed Extension**: The RBV can be extended to emphasize how integrating Industry 4.0 technologies (e.g., IoT, AI) with Circular Economy principles creates circular resources and competencies. These resources can enhance resilience and sustainability, enabling firms to thrive in turbulent environments. For example, firms can leverage real-time data from IoT devices to optimize resource use and reduce waste, creating a unique competitive advantage.

**5.6.2.4 Dynamic Capabilities Theory**:

**Current Application**: Dynamic Capabilities Theory focuses on a firm's ability to adapt, innovate, and reconfigure resources to respond to changing environments (Teece et al., 1997). In this study, organizational resilience is viewed as a dynamic capability that enables firms to navigate disruptions and maintain performance.

**Proposed Extension**: The Dynamic Capabilities perspective can be further extended by conceptualizing *dynamic resilience* as an advanced manifestation of sensing, seizing, and reconfiguring capabilities under conditions of turbulence. Industry 4.0 technologies (e.g., predictive analytics, digital twins, real-time monitoring systems) enhance these higher-order capabilities by enabling continuous environmental scanning, rapid strategic response, and structural reconfiguration. Through predictive analytics, firms can anticipate disruptions, recalibrate resource allocation, and redesign operational processes in real time, thereby strengthening not only adaptability but also dynamic resilience—the organization's capacity to absorb shocks, recover, and simultaneously transform toward more sustainable configurations. In this sense, dynamic resilience becomes an evolutionary capability that sustains competitive advantage while aligning technological advancement with long-term sustainability objectives.

**5.6.2.5 Institutional Theory**:

**Current Application**: Institutional Theory explains how firms are influenced by regulatory, normative, and cultural-cognitive pressures within their environments (DiMaggio & Powell, 1983). In this study, the adoption of Industry 4.0 and Circular Economy practices is shaped by institutional pressures, such as government regulations and industry norms.

**Proposed Extension**: The theory can be extended to examine how institutional norms and policies influence Industry 4.0 innovations (e.g., digital platforms for circular supply chains). For example, government incentives for sustainable practices can motivate firms to adopt Industry 4.0 technologies that support circularity.

#### 5.6.2.6 Technology-Organization-Environment (TOE) Framework

**Current Application**: The TOE framework explains technology adoption in terms of technological, organizational, and environmental factors (Tornatzky & Fleischer, 1990). In this study, technological readiness, organizational capabilities, and environmental pressures influence the adoption of Industry 4.0 and Circular Economy practices.

**Proposed Extension**: The TOE framework can include Industry 4.0 technologies as critical enablers of Circular Economy practices. For instance, integrating IoT and AI can enhance organizational flexibility and environmental performance, enabling firms to respond more effectively to regulatory and market pressures (Ghaithan et al., 2023).

#### 5.6.2.7 Triple Bottom Line Theory

**Current Application:** The Triple Bottom Line framework posits that organizational success should be evaluated based on three interrelated dimensions: economic performance, environmental stewardship, and social responsibility (Elkington, 1997). In this study, sustainability and sustainable competitive advantage are examined through the integration of Industry 4.0 technologies, Quality 4.0 technologies, and Circular Economy strategies, reflecting the simultaneous pursuit of profitability, environmental performance, and long-term societal value.

**Proposed Extension:** The TBL framework can be extended by positioning organizational resilience as a strategic capability that operationalizes and sustains the balance among economic, environmental, and social objectives under turbulent business conditions. By embedding Industry 4.0 technologies and Circular Economy practices within a resilience-oriented framework, firms can move beyond static sustainability reporting toward dynamic, adaptive value creation aligned with long-term sustainable development.

#### 5.6.2.8 The Integrated Model of Industry 4.0, Circular Economy, and Organizational Resilience

Although the study is primarily grounded in Industry 4.0 and Quality 4.0 technologies, the proposed integrated framework implicitly anticipates the evolution toward Industry 5.0 by embedding sustainability, organizational resilience, and long-term value creation at the core of technological transformation. Unlike purely efficiency-driven technological paradigms, the model advances a systemic perspective in which technological readiness is strategically aligned with environmental stewardship, adaptive capacity, and stakeholder-oriented performance. By positioning organizational resilience as a higher-order dynamic capability that orchestrates Industry 4.0 technologies and Circular Economy practices under turbulent conditions, the framework reflects the foundational pillars of Industry 5.0—human-centricity, sustainability, and resilience. Consequently, the study does not merely explain performance outcomes within the Industry 4.0 context; rather, it provides a forward-looking conceptual bridge toward an industrial paradigm in which technological advancement is harmonized with societal value, sustainable competitiveness, and long-term organizational viability.

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# Appendices

## Appendix

### Questionnaire

### Doctoral Program in Strategic Management

Dear Firms Representatives,

You are kindly requested to fill out this questionnaire as a part of Doctoral thesis in the field of strategic management at Arab American University, the thesis tried to capture different strategic enablers and its impact on sustainable competitive advantage and organizational performance, all provided information and data will strictly used for the purpose of scientific research only and will remain confidential.

Best Regards,

Mahmoud Amer

**First: General Section: Kindly fill in the following.**

**Organization: _____.**

**Number of Employee Less than 25 empl es, between -99, 100 or more**

**Industrial Sector:_____**

**Name:_____**

**Sex:_____**

**Third: Kindly put (X) in the suitable box>**

| No | Code | Questions | S. agree | Agree | Uncertain | Disagree | S.disagree |
|---|---|---|---|---|---|---|---|
| **Industry and Quality 4.0** | | | | | | | |
| 01 | IQ1 | Good Degree of Process Automation | | | | | |
| 02 | IQ2 | Good and utilized ICT infrastructure, including the usage of Claud System, for instance. | | | | | |
| 03 | IQ3 | Good Data Protection and Information Security in Place | | | | | |
| 04 | IQ4 | Good Level of Product and Services Development | | | | | |
| 05 | IQ5 | Good Usage of Advanced Technologies in Production like AI | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | tools, Data Analysis, digital control and monitoring, etc | | | | | |
| 06 | IQ6 | Good Data Sharing System in Place, Data shared with stakeholders | | | | | |
| 07 | IQ7 | Our Employees are skillful and can adopt new technologies | | | | | |
| 08 | IQ8 | Our Customer Requirements are well organized and used in our product and process development. | | | | | |
| 9 | IQ9 | Our Top Management Committed to Technology Advancement | | | | | |
| 10 | IQ10 | Our System, Process, and ICT are suitable for introducing Industry 4.0 Technologies | | | | | |
| **Circular Economy and Green Strategies** | | | | | | | |
| 11 | CE1 | Our Management is Committed and Support to Environmental Protection | | | | | |
| 12 | CE2 | An environmental management system and plan in place | | | | | |
| 13 | CE3 | The environmental aspects/factors are continuously monitored and controlled | | | | | |
| 14 | CE4 | Green Product, Environmental Protection Process used as Sales and Marketing arm “Eco-branding” | | | | | |
| 15 | CE5 | Good ethical behaviors and a Code of Conduct are in place | | | | | |
| 16 | CE6 | Good resource efficiencies in place like reducing non-product inputs | | | | | |
| 17 | CE7 | Re-use of materials like water and other resources | | | | | |
| 18 | CE8 | Re-cycle materials, water, and wastes to produce bi-products or new product | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | CE9 | Good Energy Efficiency programs and tools in place like the use of LED for lighting | | | | | |
| **Organizational Resilience** | | | | | | | |
| 20 | OR1 | Our firm proactively monitors what is happening in the sector to have an early emergence | | | | | |
| 21 | OR2 | Our firm understands how to connect with other firms in the same location or industry to actively link (clustering) | | | | | |
| 22 | OR3 | Our firm understands the impact of risks and crises | | | | | |
| 23 | OR4 | Our firm has risks and crisis management plans in place | | | | | |
| 24 | OR5 | Our firm has a good coping strategy to deal with changes | | | | | |
| 25 | OR6 | Our firm shift rapidly from business regular mode to crisis mode or risk mode | | | | | |
| 26 | OR7 | When a problem occurs in our organization, internal resources become more easily available at short notice, and there is less red tape to deal with than that of routine problem | | | | | |
| 27 | OR8 | Our Firm quickly adopted the new changes with minimal effect on production and service delivery | | | | | |
| 28 | OR9 | Our firm management is flexible and can adopt any new condition through different scenario management | | | | | |
| **Turbulent Business Environment** | | | | | | | |
| 29 | TE1 | Israeli Occupation Policies and Restrictions Affected our Business | | | | | |
| 30 | TE2 | Palestinian Legal Framework Affects Our Business | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 31 | TE3 | The competitive environment affects our business | | | | | |
| 32 | TE4 | The Technological Advancement Requirement Affect Our Business | | | | | |
| **Sustainable Competitive Advantage Performance** | | | | | | | |
| 33 | SC1 | Our Product Features are Non-Imitable features “Logo, Product Contents, Packaging, ... etc” | | | | | |
| 34 | SC2 | Our Product is a Rare and highly demanded product | | | | | |
| 35 | SC3 | Our Product is a highly Valued Product and includes High-Value Services | | | | | |
| 36 | SC4 | Our Organizational System is effective | | | | | |
| 37 | SC5 | We have a List of Key Performance Indicators to control our operations and product features | | | | | |
| **Sustainability Performance** | | | | | | | |
| 38 | SS1 | Reduction in all Adverse Environment Events/Factors like waste, Gas Emission, Dust, ... etc. | | | | | |
| 39 | SS2 | Our Direct and Indirect Labor is more than our competitors | | | | | |
| 40 | SS3 | Continuous Reduction in Energy Usage, waste, Byproducts, ... etc | | | | | |
| **Organizational Performance** | | | | | | | |
| 41 | OP1 | Our Financial Position and Performance is good and improved | | | | | |
| 42 | OP2 | Our Revenues and Net Income is Good | | | | | |
| 43 | OP3 | Increased Sales Volume | | | | | |
| 44 | OP4 | Increased Customer Trust in Our Products and Services | | | | | |
| 45 | OP5 | Increased Number of customers | | | | | |
| 46 | OP6 | Increased Customer Loyalty and Satisfaction | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 47 | OP7 | Good Product and Services Quality Control | | | | | |
| 48 | OP8 | Good Production Utilization and Efficiency | | | | | |
| 49 | OP9 | Good Production System and Procedures covering material handling, manufacturing, packaging, and after-sales services. | | | | | |

**<<<End>>>>**

# عوامل التمكين الاستراتيجية (الجودة 4.0، الاستراتيجيات الخضراء) وإثرها على الاداء (الميزة التنافسية المستدامة، أداء الاعمال والاستدامة)

**محمود عوض الله داود عامر**

**د.أمجد الغانم.**

**د. جون لبنسكي.**

**د.مادان باترا**

## الملخص

تناول هذه الأطروحة بالدراسة والتحليل الأثر التكاملي لممارسات الجودة 4.0، والصناعة 4.0، والاقتصاد الدائري في تعزيز الأداء التنظيمي وترسيخ الاستدامة وتحقيق الميزة التنافسية في القطاع الصناعي الفلسطيني. كما تستقصي الأدوار الوسيطة لكلٍّ من المرونة التنظيمية وتقلبات بيئة الأعمال في تشكيل طبيعة هذه العلاقات وتأثيراتها. وقد اعتمدت الدراسة منهجية بحثية مختلطة، جُمعت في إطارها البيانات من خلال استبيانات شملت (217) شركة صناعية فلسطينية، ثم خضعت للتحليل باستخدام أسلوب نمذجة المعادلات الهيكلية بالمربعات الصغرى الجزئية.(PLS-SEM)

وأظهرت النتائج أن جاهزية الشركات لتبنّي مفاهيم الصناعة 4.0 والجودة 4.0 تسهم إسهامًا إيجابيًا في تعزيز المرونة التنظيمية، غير أن أثرهما المباشر في الاستدامة والميزة التنافسية المستدامة ظل محدودًا. وعلى المنوال ذاته، تبيّن أن تطبيق ممارسات الاقتصاد الدائري والاستراتيجيات الخضراء يعزز الاستدامة ويرسّخ المرونة التنظيمية بدرجة معنوية، إلا أن انعكاس ذلك على تحسين الأداء التنظيمي أو تحقيق ميزة تنافسية مباشرة في الأجل القصير لم يكن ملموسًا. وقد برزت المرونة التنظيمية بوصفها متغيرًا وسيطًا محوريًا، إذ كان لها أثر إيجابي واضح في دعم الأداء التنظيمي والاستدامة، بينما بدا تأثيرها في الميزة التنافسية المستدامة أقل حدة وأضعف نسبيًا. على الرغم من أن تأثيره على الميزة التنافسية المستدامة أقل وضوحاً، فإن الدراسة، رغم ارتكازها على تقنيات الصناعة 4.0 وجودة 4.0، تتقدم بالإطار المتكامل مفهوميًا إلى ما بعد هذه النماذج من خلال مواءمته ضمنياً مع المبادئ الناشئة للصناعة 5.0 وجودة 5.0، مع دمج الاستدامة والمرونة التنظيمية في صميم التحول التكنولوجي.

وتؤكد الدراسة أهمية تبنّي نموذج تكاملي يجمع بين مرتكزات الصناعة 4.0 ومبادئ الاقتصاد الدائري وأبعاد المرونة التنظيمية، بوصفه مدخلًا استراتيجيًا لمواجهة التحديات المعقدة التي تعترض الشركات الصناعية في البيئات المتقلبة والمضطربة. كما تقدم جملة من التوصيات العملية الموجهة إلى صُنّاع القرار وقادة القطاع الصناعي والباحثين الأكاديميين، بهدف تعزيز مسارات التنمية المستدامة وبناء قدرات تنظيمية قادرة على التكيّف والصمود داخل القطاع الصناعي الفلسطيني.

وعلى الصعيد النظري، تسهم هذه الدراسة في توسيع وتطوير عدد من الأطر النظرية ذات الصلة، من بينها منظور الموارد(RBV) ، ونظرية القدرات الديناميكية، والنظرية المؤسسية، فضلًا عن إطار التكنولوجيا–المنظمة–البيئة (TOE: Technology–Organization–Environment Framework)الذي يُعنى بتحليل محددات تبنّي الابتكارات التقنية داخل المؤسسات، وكذلك نظرية المحصلة الثلاثية (Triple Bottom Line Theory) التي تؤكد التكامل بين الأبعاد الاقتصادية والبيئية والاجتماعية للاستدامة. ويأتي هذا التوسّع النظري بما ينسجم مع متطلبات التكامل بين الصناعة 4.0 والاقتصاد الدائري، ويوائم بين الأطر المفاهيمية والتحولات التكنولوجية والبيئية المعاصرة وتضيف هذه الدراسة إلى الأدبيات العلمية إسهامًا نوعيًا من خلال تقديم شواهد ميدانية رصينة مستمدة من سياق اقتصاد نامٍ ومتقلب (الحالة الفلسطينية) فضلًا عن طرح رؤى تطبيقية عملية قابلة للتفعيل، تسهم في الارتقاء بالأداء الصناعي وتعزيز الاستدامة عبر توظيف التقنيات المتقدمة في مجالات الجودة (الجودة الرابعة) والاقتصاد الدائري وتبنّي الممارسات المستدامة.

الكلمات المفتاحية: الجودة 4.0، الصمود المؤسسي، الاقتصاد الدائري، الاستدامة، الميزة التنافسية المستدامة.