

*Systematic Review*

# Digital Transformation in International Trade: Opportunities, Challenges, and Policy Implications

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## Abstract

This study synthesizes the rapidly expanding evidence on how digital technologies reshape international trade, with a particular focus on small and medium-sized enterprises (SMEs). Guided by two research questions—(RQ1) *How do digital tools influence the volume and composition of cross-border trade?* and (RQ2) *How do these effects vary by countries' development level and firm size?*—we conducted a PRISMA-compliant systematic literature review covering 2010–2024. Searches across eight major databases yielded 1857 records; after duplicate removal, title/abstract screening, full-text assessment, and Mixed Methods Appraisal Tool (MMAT 2018) quality checks, 86 peer-reviewed English-language studies were retained. Findings reveal three dominant technology clusters: (1) e-commerce platforms and cloud services, (2) IoT-enabled supply chain solutions, and (3) emerging AI analytics. E-commerce and cloud adoption consistently raise export intensity—doubling it for digitally mature SMEs—while AI applications are the fastest-growing research strand, particularly in East Asia and Northern Europe. However, benefits are uneven: firms in low-infrastructure settings face higher fixed digital costs, and cybersecurity and regulatory fragmentation remain pervasive obstacles. By integrating trade economics with development and SME internationalization studies, this review offers the first holistic framework that links national digital infrastructure and policy support to firm-level export performance. It shows that the trade-enhancing effects of digitalization are contingent on robust broadband penetration, affordable cloud access, and harmonized data-governance regimes. Policymakers should, therefore, prioritize inclusive digital-readiness programs, while business leaders should invest in complementary capabilities—data analytics, cyber-risk management, and cross-border e-logistics—to fully capture digital trade gains. This balanced perspective advances theory and practice on building resilient, equitable digital trade ecosystems.

**Keywords:** digital transformation; international trade; GVCs; SMEs; cybersecurity



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## 1. Introduction

In recent years, digital technologies have radically transformed numerous facets of business, notably international trade. The proliferation of digital platforms enables companies to effortlessly reach customers and suppliers in global markets, thereby expanding their reach and profit potential. However, this digital revolution also introduces novel challenges and risks—particularly in data privacy and cybersecurity—that can hinder the growth of cross-border commerce.

**Operational definition of digital transformation (DT):** Drawing on Vial (2019) and Reis et al. (2021), we define *digital transformation* as “the process of leveraging interconnected

information, communication, and computing technologies to generate fundamental changes in how value is created and captured across organisational and societal levels.” This umbrella concept intentionally goes beyond e-commerce to encompass cloud computing, Internet-of-Things (IoT) architectures, artificial-intelligence (AI) analytics, distributed-ledger technologies such as blockchain, mobile platforms, and additive manufacturing. Throughout this article, we therefore treat DT as an integrated technology stack whose components reinforce one another in shaping international trade dynamics.

**Evolution of scholarly interest:** Academic attention to digital trade has evolved through three overlapping paradigms. The earliest strand—*digital-platform economics*—analyzed two-sided market structures and network effects typified by Amazon or Alibaba (Evans & Schmalensee, 2016). A second wave situated these platforms within *global value-chain* (GVC) theory, emphasizing how cloud logistics, IoT-enabled traceability, and data-driven coordination reshape lead-firm governance and supplier upgrading (Gereffi & Fernandez-Stark, 2016). Most recently, scholars have converged on a *data-driven trade* paradigm that interrogates algorithmic pricing, cross-border data flows, and the geopolitical contest over digital standards (Baldwin, 2017). Our review synthesizes insights across these paradigms, thereby providing the first theory-informed map of how DT influences trade at the intersection of platforms, GVCs, and data governance.

**Rationale for the development-level lens:** Digital trade benefits remain highly uneven: according to the International Telecommunication Union’s *Global Connectivity Report 2024*, only 40% of firms in low-income countries enjoy reliable broadband versus 88% in high-income economies. The World Economic Forum’s *Digital Readiness Index 2024* likewise ranks infrastructure gaps and fragmented cyber-regulation as the top two constraints on cross-border e-commerce participation. These stark disparities justify our analytical focus on how national digital readiness and institutional capacity moderate DT’s impact on trade—an issue we operationalize explicitly in Hypotheses 5 and 6.

Integrating digitization and advanced technology has reshaped how businesses operate beyond traditional geographical constraints. Innovations like e-commerce, Big Data analytics, and artificial intelligence have redefined international management practices and business strategies (Lee et al., 2019). Digital transformation enhances operational flexibility and efficiency by streamlining production processes and fosters innovative ecosystem value propositions that swiftly adapt to market demands (Feliciano-Cestero et al., 2023). Moreover, digitalization facilitates rapid knowledge acquisition and bolsters networking capabilities, enabling new exporters to accelerate their internationalization process.

The strategic importance of digitalization in enabling new firms to internationalize rapidly cannot be overstated. Over the past two decades, technological progress has been instrumental in lowering barriers to global market entry. Scholars such as Knight and Cavusgil (2004) argue that globalization catalyzes the “born global” phenomenon, driven by advancements in transportation and communication that significantly reduce transactional costs. Supporting this view, a survey conducted by BVL International revealed that the adoption of digital strategies has markedly benefited a range of industries—80% of manufacturing companies, 85.5% of logistics companies, and 74.5% of retailers reported notable improvements in revenue and cost efficiencies (Ahmedov, 2020).

Over the past decade, a growing body of evidence has quantified the trade-creating effect of digitalization, with multiple studies demonstrating its impact across different economic levels. For instance, UNCTAD’s *Digital Economy Report 2024* shows that B2B e-commerce sales surged by nearly 60 percent to reach \$27 trillion between 2016 and 2022, a trend correlated with double-digit growth in cross-border parcel flows. This macroeconomic observation is supported by an APEC study, which finds that a one-standard-deviation rise in “digital intensity” increases digitally ordered export volumes by 8.5 percent. At

the firm level, research by [Purwaningsih et al. \(2024\)](#) on manufacturing SMEs reveals that adopting multiple Industry 4.0 technologies raises export intensity by 6–10 percent, while a 74-country panel analysis by [Zhu et al. \(2025\)](#) demonstrates that digital-trade readiness reduces trade costs and significantly boosts participation in global value chains ([Mirzaye Shirkoohi & Mohiuddin, 2025](#)). Collectively, these studies corroborate the premise that digitalization—whether through online platforms, digitally deliverable services, or advanced manufacturing technologies—amplifies trade volumes by lowering search and coordination costs, shortening production cycles, and widening market reach.

While numerous studies highlight the positive outcomes of digital transformation on internationalization, it is also essential to acknowledge its potential downsides. Negative impacts may include cybersecurity vulnerabilities, challenges in adhering to international regulatory frameworks, communication barriers among multinational teams, and variations in digital adoption across different markets. Despite the prevailing focus on the benefits, these adverse effects remain underexplored and warrant further in-depth investigation.

This study aims to elucidate the impact of digital technology on international trade and to identify the key determinants that affect the adoption and success of digital trade practices. Specifically, it seeks to address the following research questions:

- How has the emergence of digital technology influenced the patterns and volumes of international trade?
- What are the principal drivers and obstacles affecting firms' adoption of digital trade practices?
- What are the broader implications of digital trade for economic growth, employment, and welfare in developed and developing countries?

We will conduct a systematic literature review encompassing various academic databases and scholarly publications to address these questions. Through a rigorous analysis and synthesis of existing research, this study will provide a comprehensive overview of digital technology's transformative impact on international trade. The findings of this investigation are expected to have significant implications for policymakers, business leaders, and other stakeholders in the global economy. By delineating the critical drivers and barriers to digital trade, our study will inform strategic decisions and policy formulations to foster international trade and spur economic development. Furthermore, this work aspires to contribute to developing a robust theoretical framework for understanding how digital technology shapes international trade and influences broader economic outcomes.

## 2. Literature Review

In recent years, the rise in digital technology has had a profound impact on the patterns and volumes of international trade. The increasing availability and use of digital platforms and technologies have made it easier for firms to access customers and suppliers in foreign markets, reducing the costs of international trade and expanding their reach ([Drake-Brockman et al., 2020](#)). Digital platforms such as Alibaba, Amazon, and eBay have enabled small and medium-sized enterprises (SMEs) to reach customers in foreign markets that were previously inaccessible, increasing their export opportunities ([Feliciano-Cestero et al., 2023](#)). Digital technologies such as blockchain and the Internet of Things (IoT) have also enabled firms to track and manage their supply chains more efficiently, reducing costs and improving product quality ([Lee et al., 2019](#)).

The fourth industrial revolution emerged as the result of increasing demands for faster delivery times, more efficient and automated processes, higher quality, and customized products. In this regard, different types of technologies are presented as enablers of I.4.0. such as machine learning, big data, the internet of things, artificial intelligence, etc. Along with using digital technologies in business, the digitization process has appeared. The

concept of digitization of companies means doing business operations based on digital technology tools. The process which seems inevitable because traditional enterprises are facing new business challenges in today's turbulent economy due to globalization, mass customization, and competitive business environments (Zheng et al., 2021).

Digital technologies reduce the barriers to the acquisition of market information and cross-border communication. Moreover, digitalization is considered an opportunity for SMEs to enter the international environment faster and enable the firms to create a comparative advantage, leading to better international performance (Lee & Falahat, 2019). Digitization affects international business operations and the internationalization process of companies in terms of psychic distance, location, entry mode methods, etc. (Feliciano-Cestero et al., 2023), and resulted in refining and extending the international theories as Autio (Khare et al., 2022) argued that digitization makes market inherently global, and some arguments used in previous internationalization theories were becoming less relevant.

However, the adoption and success of digital trade practices are not without challenges and risks. One of the main challenges is the lack of digital infrastructure and skills, particularly in developing countries, which can limit the ability of firms to participate in digital trade (Drake-Brockman et al., 2020). Data privacy and security concerns are also a significant risk, as firms must ensure that sensitive customer and business data are protected (Feliciano-Cestero et al., 2023). In addition, regulatory barriers such as tariffs and non-tariff barriers can impede the growth of digital trade, particularly in highly regulated industries such as financial services (Lee et al., 2019).

Despite these challenges and risks, the potential benefits of digital trade are significant. Digital trade can lead to increased economic growth, employment, and welfare, particularly in developing countries (Drake-Brockman et al., 2020). The adoption of digital trade practices can also help firms to diversify their export markets, reducing their dependence on a single market and increasing their resilience to external shocks (Feliciano-Cestero et al., 2023). Digital trade can also lead to increased competition and innovation, as firms seek to differentiate themselves in an increasingly competitive global market (Lee et al., 2019).

Multinational enterprises (MNEs) undergo significant changes in their business strategies and structures to promote global integration. Furthermore, the rise in digital technologies, coupled with the current trend towards globalization and the relaxation of international trade barriers, has reduced entry barriers in many countries, enabling new players to enter an already highly competitive global market. Therefore, stakeholders in the business process must comprehend the importance of digital transformation as technology evolves and transforms, and understand the implications of each technology used (Feliciano-Cestero et al., 2023). Furthermore, the rapid evolution and short life cycles are key characteristics of digital technologies, which have been further accelerated by the COVID-19 pandemic. As a result of the pandemic, there has been a significant increase in the development and use of digital technologies across various aspects of daily life, including education, shopping, entertainment, and healthcare. These new technologies that were developed in response to the pandemic have the potential for future internationalization. Given this, it is crucial to investigate how firms can leverage these technologies to enhance their internationalization capability in the future.

### *2.1. Technology's Effect on International Business*

Over the past few decades, advances in technology have transformed the way in which businesses operate and compete globally. Technology has made it easier to communicate across distances, share knowledge, manage resources, and coordinate activities across borders. As a result, international management has become more efficient and

effective (Feliciano-Cestero et al., 2023; Alcácer & Cruz-Machado, 2019; Queiroz et al., 2020; Dedehayir et al., 2017).

Several studies have documented the benefits of using technology in international management. For example, technology has improved communication and collaboration between teams in different locations. This has led to increased productivity and reduced costs associated with travel and communication. Also, the role of technology in facilitating knowledge sharing and decision-making across borders has enabled businesses to respond more quickly and effectively to changing market conditions.

Technology has helped overcome cultural barriers that can impede effective international management (Gefen & Carmel, 2008). By providing tools for translation, interpretation, and cultural awareness training, technology has made it easier for teams to work together across different cultures and languages. In addition to these benefits, technology has also enabled businesses to collect and analyze large amounts of data from different sources, which has provided valuable insights for decision-making in international management. The importance of data analytics in optimizing supply chain management, logistics, and marketing strategies across borders (Forliano et al., 2021).

Despite the benefits of technology in international management, there are also some challenges that need to be addressed. The rapid pace of technological change can lead to skill gaps and security vulnerabilities that can undermine the effectiveness of technology in international management. Additionally, there is a risk of overreliance on technology at the expense of interpersonal relationships and trust between team members. One of the main challenges is managing information overload. As businesses collect more data from different sources, managers need to find ways to filter and analyze this information effectively. This requires new skills and tools for data analysis, which can be expensive and time-consuming to develop (Choudary et al., 2016).

Another challenge is managing cybersecurity risks. As businesses become more reliant on technology, they are also more vulnerable to cyber-attacks, which can disrupt operations and damage the reputation of the business. This requires investments in cybersecurity measures and training for employees to ensure they are aware of the risks. Additionally, technology has made it easier for businesses to expand into new markets, but this also brings new challenges related to cultural differences and local regulations. Managers need to be aware of these differences and adapt their strategies accordingly, which can be complex and time-consuming.

Finally, technology has also made it more difficult to manage teams across borders. While technology has improved communication and collaboration, it can also create new communication barriers and misunderstandings. Managers need to be skilled in cross-cultural communication and aware of the different communication styles and preferences of their team members.

## 2.2. The Crisis and International Businesses

The COVID-19 pandemic has had a significant impact on businesses worldwide, forcing them to adapt to new ways of working and operating. One of the key changes that the pandemic has brought about is an acceleration in the adoption of digital technologies. Many studies have suggested that the pandemic has broken down the resistance of enterprises to use digital technologies and has accelerated the digitization process (Lauring et al., 2022). One of the main reasons for this is that the pandemic has highlighted the importance of digital technologies for business continuity. With lockdowns and social distancing measures in place, businesses have had to find new ways to operate remotely and continue to serve their customers. This has led to a rapid adoption of digital technologies such as video conferencing, cloud computing, and online collaboration tools (Dwivedi et al., 2020).

Another reason for the acceleration in the digitization process is the need for businesses to be more agile and responsive to changing market conditions. The pandemic has created significant uncertainty and volatility in global markets, requiring businesses to be more flexible and adaptable in their operations. Digital technologies such as data analytics and artificial intelligence have enabled businesses to respond more quickly and effectively to changing market conditions. Furthermore, the pandemic has created new opportunities for businesses to leverage digital technologies to improve their operations and services. For example, many businesses have expanded their e-commerce offerings and digital marketing channels to reach customers who are unable to shop in person. This has allowed businesses to maintain their revenue streams and even grow their customer base during the pandemic.

However, there are also challenges associated with the acceleration of the digitization process during the pandemic. One challenge is the need for businesses to invest in new technologies and infrastructure to support their digital operations. This can be expensive and time-consuming, particularly for smaller businesses with limited resources. Another challenge is the need for businesses to address the digital skills gap in their workforce. With the rapid adoption of digital technologies, many businesses have found that their employees lack the necessary digital skills and knowledge to use these technologies effectively. This has created a need for training and development programs to upskill employees and enable them to use digital technologies more effectively.

Brexit, the withdrawal of the United Kingdom from the European Union, has had a significant impact on businesses operating in the UK and across Europe. One of the key changes that Brexit has brought about is an acceleration in the adoption of digital technologies. Many studies have suggested that Brexit has broken down the resistance of enterprises to use digital technologies and has accelerated the digitization process. One of the main reasons for this is that Brexit has created uncertainty and volatility in global markets, forcing businesses to be more agile and responsive to changing market conditions. Digital technologies such as data analytics and artificial intelligence have enabled businesses to respond more quickly and effectively to changing market conditions and to gain a competitive advantage.

Another reason for the acceleration in the digitization process is the need for businesses to overcome the challenges associated with Brexit. For example, Brexit has created new regulatory and trade barriers that businesses must navigate to continue operating successfully. Digital technologies such as blockchain and automation have the potential to help businesses overcome these challenges and streamline their operations. Furthermore, the COVID-19 pandemic has further accelerated the adoption of digital technologies in the wake of Brexit. The pandemic has highlighted the importance of digital technologies for business continuity and remote working and has accelerated the adoption of digital technologies such as video conferencing, cloud computing, and online collaboration tools (Dwivedi et al., 2020). This has led to an even greater uptake of digital technologies among businesses affected by Brexit.

However, there are also challenges associated with the acceleration of the digitization process in the context of Brexit. One challenge is the need for businesses to invest in new technologies and infrastructure to support their digital operations. This can be expensive and time-consuming, particularly for smaller businesses with limited resources. Another challenge is the need for businesses to address the digital skills gap in their workforce. With the rapid adoption of digital technologies, many businesses have found that their employees lack the necessary digital skills and knowledge to use these technologies effectively. This has created a need for training and development programs to upskill employees and enable them to use digital technologies more effectively.

One of the main reasons for this is that the economic war has created uncertainty and volatility in global markets, forcing businesses to be more agile and responsive to changing market conditions. Digital technologies such as data analytics and artificial intelligence have enabled businesses to respond more quickly and effectively to changing market conditions and to gain a competitive advantage (T. Zhao et al., 2020). Another reason for the acceleration in the digitization process is the need for businesses to overcome the challenges associated with the economic war. For example, the imposition of tariffs and trade restrictions has created new regulatory and trade barriers that businesses must navigate in order to continue operating successfully. Digital technologies such as blockchain and automation have the potential to help businesses overcome these challenges and streamline their operations.

Furthermore, the COVID-19 pandemic has further accelerated the adoption of digital technologies in the wake of the economic war. The pandemic has highlighted the importance of digital technologies for business continuity and remote working and has accelerated the adoption of digital technologies such as video conferencing, cloud computing, and online collaboration tools (Dwivedi et al., 2020). This has led to an even greater uptake of digital technologies among businesses affected by the economic war.

However, there are also challenges associated with the acceleration of the digitization process in the context of the economic war. One challenge is the need for businesses to invest in new technologies and infrastructure to support their digital operations. This can be expensive and time-consuming, particularly for smaller businesses with limited resources.

Another challenge is the need for businesses to address the digital skills gap in their workforce. With the rapid adoption of digital technologies, many businesses have found that their employees lack the necessary digital skills and knowledge to use these technologies effectively. This has created a need for training and development programs to upskill employees and enable them to use digital technologies more effectively (Fachrunnisa & Hussain, 2020).

### 2.3. Countries and International Businesses

The impact of digital technology on international trade is not uniform across countries and depends on a range of factors, including a country's level of economic development and institutional context. While digital technology has the potential to transform international trade, its impact may be limited in countries that lack the necessary infrastructure and supportive institutions (Alraja et al., 2021). Research suggests that in developed countries, digital technology has had a significant impact on international trade. For example, e-commerce has led to an increase in the value of international trade by up to 6% in developed countries. Similarly, another study by (Pan et al., 2022), found that digital platforms such as Alibaba have facilitated cross-border e-commerce, allowing small and medium-sized enterprises to access international markets.

However, in developing countries, the impact of digital technology on international trade may be more limited. One reason for this is that developing countries often lack the necessary digital infrastructure, such as high-speed internet and reliable payment systems. This can make it difficult for businesses to engage in cross-border e-commerce and other digital trade activities. Additionally, developing countries may lack the supportive institutions, such as legal and regulatory frameworks, that are necessary to facilitate digital trade. Furthermore, institutional factors, such as the strength of intellectual property rights and data privacy regulations, can also affect the impact of digital technology on international trade. For example, stronger intellectual property rights can encourage

innovation and investment in digital technology, while weaker data privacy regulations can limit consumer trust in digital platforms and hinder cross-border e-commerce.

Digital infrastructure can improve the efficiency of trade transactions by reducing transaction costs and streamlining supply chains. This can make it easier for businesses to engage in international trade and for countries to compete in the global economy. For example, digital platforms such as Alibaba have facilitated cross-border e-commerce, allowing small and medium-sized enterprises to access international markets. Moreover, digital policies can support the development of new business models that are more suited to the global economy. For example, the sharing economy has emerged as a new business model enabled by digital technologies, allowing businesses to connect with customers and suppliers across the globe. Digital policies can create an environment that is conducive to the development of these new business models, encouraging businesses to engage in international trade (Peng & Tao, 2022).

Additionally, digital infrastructure and policies can improve the quality of trade data and information available to businesses and governments. This can facilitate better decision-making and enable businesses to identify new markets and opportunities for growth. For example, big data analytics can provide insights into consumer behavior and preferences, allowing businesses to tailor their products and services to different international markets. Finally, digital infrastructure and policies can also improve the security and reliability of international trade transactions. For example, blockchain technology can be used to create secure and transparent supply chains, reducing the risk of fraud and counterfeiting. This can improve trust and confidence in international trade transactions, making it easier for businesses to engage in international trade.

#### 2.4. Definition of Terms

The following definitions will be used within the context of this study:

**Digitalization:** The process of using digital technologies to transform business operations and create new business models. It involves the use of digital tools, such as computers, software, and the internet, to improve productivity, reduce costs, and enhance customer experience.

**Global Value Chains (GVCs):** We adopt Gereffi, et al.'s (2005) definition of GVCs as cross-border production networks in which value is created “stage-by-stage” across multiple countries before final consumption.

**Digital technology:** It is the application of scientific knowledge for practical purposes in digital form. It includes hardware, software, networks, and data that enable the processing, storage, and communication of information.

**International trade:** It is the exchange of goods and services across borders. It involves a variety of activities, including production, transportation, and distribution, and can be facilitated by government policies, international agreements, and technological advancements.

**Industry 4.0 (I4.0):** Following Schwab (2024), I4.0 denotes the convergence of cyber-physical systems, industrial Internet-of-Things (IIoT), cloud/edge computing, artificial intelligence, additive manufacturing, and advanced robotics that enable data-driven, self-adapting production processes.

**Global crises:** Major events or circumstances that affect many countries or regions at the same time, such as pandemics, political upheavals, or economic recessions. These crises can have significant impacts on the global economy, international trade, and social well-being.

**Efficiency and effectiveness:** Efficiency refers to the ability to accomplish a task or produce an output with minimum waste of time, effort, or resources. Effectiveness refers to the ability to produce a desired outcome or result. Together, they are often used to measure the performance of businesses, organizations, and government agencies.

**Complexity:** The state or quality of being intricate, complicated, or difficult to understand. In the context of international trade, complexity can arise from a variety of factors, including technological advancements, global competition, and government regulations. It can affect the efficiency and effectiveness of international trade, as well as the ability of businesses and organizations to adapt to changing market conditions.

## 2.5. Problem Statement and Hypotheses

The rise in digital technology has transformed many aspects of international trade, with both benefits and challenges. This literature review has identified the key drivers and barriers to the adoption and success of digital trade practices, highlighting the importance of digital infrastructure, skills, and regulatory frameworks. The findings of this review can inform policy decisions and business strategies that promote the growth of international trade and economic development. Furthermore, this review can contribute to the development of a theoretical framework for understanding the impact of digital technology on international trade and its implications for economic growth and welfare.

With the increasing adoption of digital technology in trade processes, there has been a growing interest in understanding the impact of digitalization on international trade. A study by [Baldwin \(2017\)](#), found that digitalization has reduced the cost of trade by up to 90%, making it easier and faster for businesses to engage in international trade. Additionally, a study by the [World Economic Forum \(2020\)](#), found that the use of digital technology in trade processes can reduce transaction costs and time, making trade more efficient. Furthermore, digitalization has also enabled businesses to access new markets and expand their customer base. A study by the United Nations Conference on Trade and Development (UNCTAD), ([Canton, 2021](#)), found that digitalization has helped small and medium-sized enterprises (SMEs) to participate in international trade by reducing trade barriers and increasing access to information. In addition to reducing trade costs and expanding market access, digitalization has also increased the speed and efficiency of trade processes. For example, the use of digital platforms and e-commerce has enabled businesses to complete transactions more quickly and efficiently, reducing the time and cost of trade. A study by the International Trade Centre (ITC), ([Trade, 2017](#)), found that the use of digital platforms has reduced the time required for customs procedures by up to 25% and has improved the accuracy and reliability of trade documentation.

### H1. Digitalization accelerates the process of international trade.

Global crises have had significant impacts on the global economy. One area of interest is the impact of these crises on digitization and international trade. The evidence suggests that global crises can have both positive and negative impacts on digitization. On one hand, crises can accelerate the adoption of digital technology as businesses and governments look for new ways to operate in a disrupted environment. For example, the COVID-19 pandemic has led to a surge in remote work and online shopping, which has accelerated the adoption of digital technology in these areas. Crises can also lead to increased trade barriers and restrictions, which can decrease international trade. The COVID-19 pandemic has led to increased travel restrictions and disruptions to supply chains, which have decreased international trade in some sectors. On the other hand, global crises can also hinder the adoption of digital technology. For example, the USA/China economic war has led to increased restrictions on technology transfers and intellectual property, which can limit

the availability of digital technology in some regions. Similarly, Brexit has led to increased uncertainty and regulatory barriers, which can make it more difficult for businesses to adopt digital technology (Dutta, 2020; Hobolt et al., 2020, 2021).

**H2.** *Global crises (e.g., the COVID-19 pandemic, Brexit, and the USA/China economic war) influence digitization and might decrease international trade.*

Technology has fundamentally reshaped international trade by enhancing both efficiency and effectiveness. Innovations such as automated cargo tracking and real-time supply chain management have significantly reduced shipping times and costs. Concurrently, the adoption of Electronic Data Interchange (EDI) systems has streamlined processes by minimizing physical paperwork and accelerating data exchange between trading partners. Furthermore, the rise in e-commerce platforms has democratized global market access for businesses of all sizes, while emerging technologies like blockchain are increasing transactional security and trust, thereby reducing the risk of fraud. Beyond routine efficiency gains, digitalization has proven to be a critical tool for building resilience in global trade against major disruptions. Evidence from recent crises demonstrates this capability across various scenarios. During the COVID-19 pandemic, a systematic review found that Industry 4.0 tools like cloud ERP and AI-enabled demand sensing shortened order-to-ship lead times by an average of 17%, sustaining export flows amid lockdowns. In the context of geopolitical conflict, OECD data showed that Ukrainian SMEs with high digital adoption were twice as likely to continue exporting after the February 2022 invasion. Similarly, digital-twin-assisted re-routing cut delay costs by 22% during the 2021 Suez Canal blockage, and following the 2011 Thailand floods, IoT tracking enabled Japanese automakers to restart production 34 days sooner. Complementing these operational tools, specific technologies like blockchain offer targeted risk mitigation, which becomes particularly valuable when trade routes are disrupted. For instance, firm-level panel data from 2015 to 2022 shows that early adopters of blockchain technology experienced a 12% smaller revenue loss during shock events compared to their peers. This highlights how secure, transparent digital ledgers can directly protect firms from the heightened risk of fraud that often accompanies periods of global instability. Technology has also improved the effectiveness of trade by increasing the transparency and accuracy of trade transactions. Blockchain technology, for example, can be used to create a secure and transparent ledger of trade transactions, reducing the risk of fraud and increasing the trust between trading partners (Trade, 2017; Kshetri, 2018; Canton, 2021).

**H3.** *Technology has made international trade more efficient and effective.*

Technology has revolutionized the way international trade is conducted, providing businesses with new tools to access new markets and improve efficiency. However, technology has also brought about new challenges and complexities that must be addressed. As trade has shifted towards digital platforms and transactions, the need for secure and reliable digital infrastructure has grown. This requires businesses to invest in new technologies and security measures, which can be costly and time-consuming. Another factor contributing to the complexity of international trade is the increasing complexity of supply chains. As businesses have sought to optimize their operations and reduce costs, they have turned to complex global supply chains that involve multiple countries and partners. This requires businesses to navigate a complex web of regulations, laws, and cultural norms, which can be difficult and time-consuming. Technology has also increased the complexity of international trade by creating new data management challenges. With the growth of e-commerce and other digital platforms, businesses are collecting and managing more data

than ever before. This requires businesses to invest in new data management technologies and processes, and to ensure that they are complying with increasingly strict data privacy laws (Kshetri, 2018; G. Zhao et al., 2019).

**H4.** *Technology has increased the complexity of international trade.*

As the world becomes increasingly connected, the importance of digital infrastructure and policies in supporting international trade has grown. Digital infrastructure, such as high-speed internet, mobile networks, and digital payment systems, can help businesses to access new markets and customers around the world. This allows businesses to expand their operations and increase their exports, which can contribute to economic growth and development. In addition to digital infrastructure, policies that support digital innovation and entrepreneurship can also play an important role in promoting international trade. For example, policies that support the development of new digital technologies, such as artificial intelligence and blockchain, can help businesses to improve their operations and compete more effectively in the global marketplace. Policies that support entrepreneurship and the development of digital start-ups can also help to create new opportunities for businesses to succeed in the global marketplace. There are some challenges associated with the increasing importance of digital technologies in international trade. For example, there is a risk that countries with less developed digital infrastructure and policies may be left behind, limiting their ability to participate fully in the global economy. There are also concerns about the potential impact of digital technologies on jobs and the labor market. As businesses adopt new digital technologies to improve efficiency and reduce costs, there is a risk that some jobs may be displaced or replaced by automation. This can have negative impacts on workers and their communities, particularly in countries where digital infrastructure and policies are less developed (Organisation for Economic Co-Operation and Development, 2019; Brynjolfsson & McAfee, 2014).

**H5.** *Countries with better digital infrastructure and policies are more likely to have higher levels of international trade.*

As digital technology continues to transform the global economy, there is growing interest in understanding how this technology is affecting international trade. While digital technology has the potential to support trade by reducing costs and increasing efficiency, the impact of this technology may vary depending on the level of economic development and institutional context of a country. Digital technologies such as e-commerce platforms and online marketplaces can help businesses to access new markets and customers around the world, reducing the costs and barriers associated with traditional trade. Digital technologies can also help businesses to streamline their operations, reducing the time and costs associated with international trade. However, the impact of digital technology on international trade may vary depending on the level of economic development and institutional context of a country. In high-income countries with well-developed digital infrastructure and institutions, digital technology may have a greater impact on international trade. In these countries, businesses may be better able to take advantage of digital technologies to expand their operations and increase their exports. In contrast, in low-income countries with less developed digital infrastructure and institutions, the impact of digital technology on international trade may be more limited (Brynjolfsson & McAfee, 2014; Ponte et al., 2019).

**H6.** *The impact of digital technology on international trade varies depending on the level of economic development and the institutional context of a country.*

## 2.6. Delimitations

Here are the known delimitations for this study:

1. The study could be limited by the research methodology used, such as theory triangulation. Different research methodologies may yield different results and may have different limitations.
2. The study could be limited by the availability of data on the impact of digital technology on international trade. For example, data on the use of digital technology in small and medium-sized enterprises may be limited in some countries.
3. The study could be limited by the institutional context of the countries being studied, such as differences in legal frameworks or regulatory environments. This could limit the ability to compare the impact of digital technology on international trade across different countries.

It is important to carefully consider these delimitations when designing a study on the impact of digital technology on international trade in order to ensure that the findings are meaningful and relevant.

## 2.7. Limitations

The following limitations should be considered when interpreting the results of this research study:

1. The accuracy and reliability of data on digital technology and international trade may vary between countries and sources, which could affect the validity of the findings.
2. The findings of a study conducted in one country or region may not be generalizable to other countries or regions, due to differences in institutional contexts, economic conditions, and other factors.
3. The measurement of variables, such as the level of digital technology adoption or the level of international trade, may be subject to measurement error or bias.
4. The availability and quality of data on the impact of digital technology on international trade may vary across countries and regions, which could limit the ability to draw meaningful conclusions.
5. Digital technology is rapidly evolving and changing, which could limit the ability to make long-term predictions about its impact on international trade.

## 3. Method

This study employs a systematic literature review, augmented by bibliometric analysis, to examine the convergence of digital innovation and resource optimization within International Trade. Systematic reviews provide a structured and transparent framework for identifying, evaluating, and synthesizing existing research, thereby mitigating bias and enhancing the reliability of findings (Bilge & Yaman, 2021). Our approach ensures methodological rigor, transparency, and reproducibility by adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2015). Incorporating bibliometric analysis further contributes quantitative insights into publication patterns, research trends, and collaborative networks in the literature (Donthu et al., 2021).

### 3.1. Data Sources and Search Strategy

To capture the multidisciplinary scope of this investigation, we conducted a comprehensive search across several prominent academic databases, including Web of Science,

Scopus, IEEE Xplore, and ProQuest BPC. This selection was deliberate, ensuring broad coverage across fields such as information technology, business management, environmental studies, and international trade.

### 3.2. Inclusion and Exclusion Criteria

We established stringent criteria to ensure the inclusion of only the most relevant and high-quality studies:

- **Inclusion Criteria:**
  - **Language:** Articles published in English.
  - **Publication Type:** Peer-reviewed journal articles.
  - **Time Frame:** Publications from January 2010 to October 2023 capture the latest advancements.
  - **Content Relevance:** Studies addressing at least two central dimensions—digital transformations and GVCs.
  - **Methodological Rigor:** Empirical studies (both qualitative and quantitative) and robust theoretical papers.
- **Exclusion Criteria:**
  - **Non-Peer-Reviewed Publications:** Conference proceedings, editorials, book chapters, dissertations, and reports.
  - **Irrelevant Studies:** Articles that focus exclusively on one dimension without establishing connections to the others.
  - **Duplicate Records:** Redundant entries were identified and removed to ensure uniqueness.

### 3.3. Study Selection Process

Following the PRISMA framework (See Figure 1), our study selection process unfolded in four distinct stages:

1. **Identification:** An initial search using predefined keywords across selected databases yielded 1857 articles. After eliminating 146 duplicates, 1711 unique records remained.
2. **Screening:** Two independent reviewers screened the titles and abstracts of these 1711 records against the established inclusion and exclusion criteria, identifying 288 potentially relevant articles.
3. **Eligibility:** A full-text review of 288 articles was then conducted, assessing each for methodological rigor and relevance to our research questions, which further narrowed the pool to 136 articles.
4. **Inclusion:** A final set of 86 articles was selected for the systematic review and bibliometric analysis.

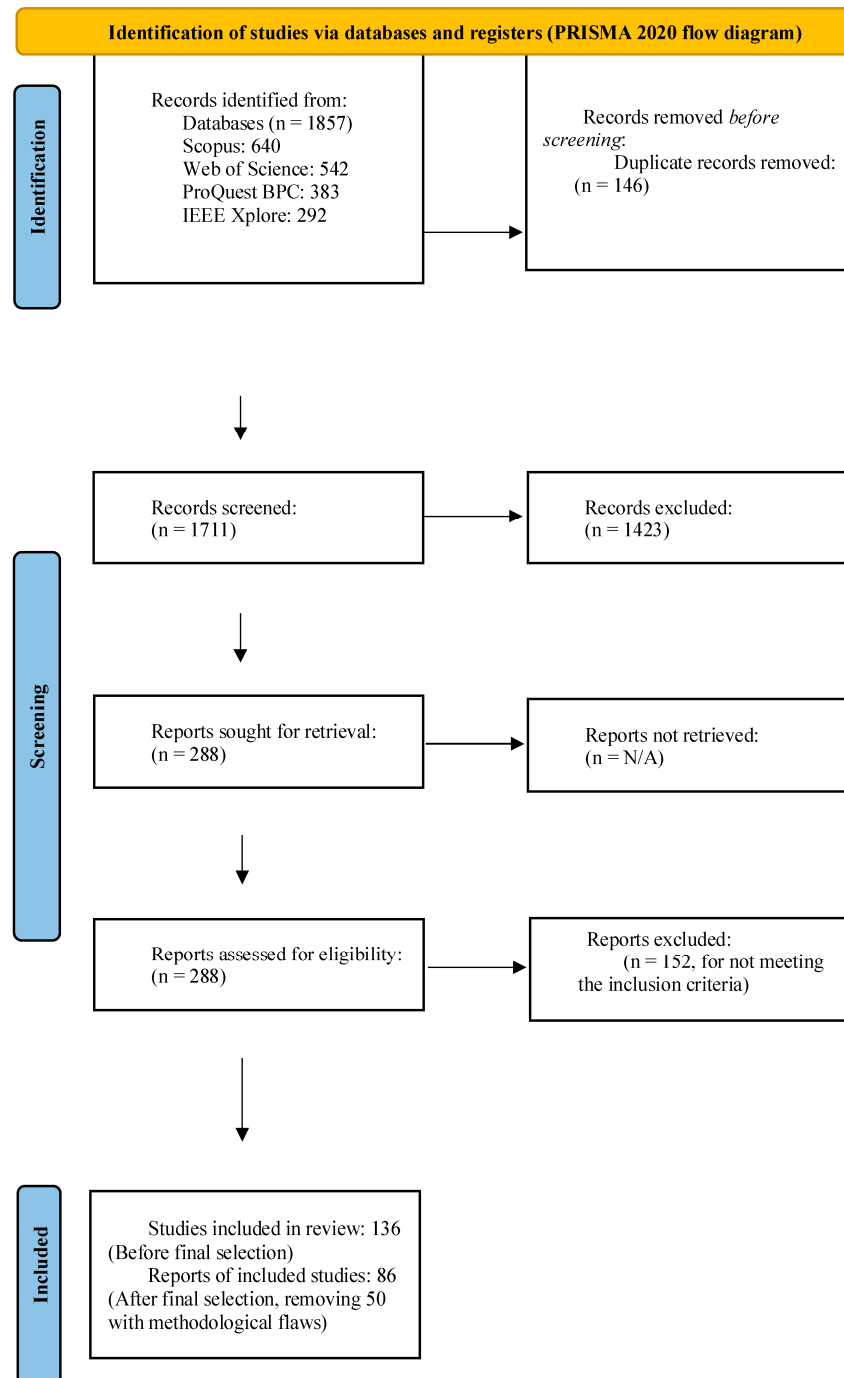


**Figure 1.** PRISMA 2020 flow diagram for Identification of studies via databases and registers.

Any discrepancies between reviewers were resolved through discussion or consultation with a third reviewer, ensuring an unbiased selection process.

### 3.4. Data Extraction and Management

A standardized data extraction form was developed to systematically capture pertinent information from each selected study, including the following:

- **Bibliographic Information:** Author(s), year of publication, journal name, DOI.
- **Study Characteristics:** Research objectives, theoretical framework, methodology, sample size, and data sources.
- **Findings:** Key results related to digital technologies, resource efficiency, and GVCs.

- **Implications:** Contributions to theory and practice, identified gaps, and suggestions for future research.

Data were managed using reference management software (e.g., EndNote) and organized within a structured spreadsheet to facilitate analysis.

### 3.5. Quality Assessment

To rigorously appraise the quality of the included studies, we applied the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018), which is suitable for evaluating qualitative, quantitative, and mixed-methods research. The assessment focused on several dimensions:

- **Clarity of Research Questions:** Whether the study objectives and research questions were explicitly stated.
- **Methodological Appropriateness:** The suitability of the research design in addressing the stated questions.
- **Data Collection and Analysis:** The rigor and transparency of the methods employed.
- **Validity and Reliability:** The extent to which biases, limitations, and the robustness of conclusions were addressed.

Studies with lower quality scores were critically discussed but not necessarily excluded to minimize the risk of publication bias. By integrating systematic review methodologies with bibliometric analysis, this study aims to comprehensively understand the intersection between digital innovation and resource optimization in GVCs, offering valuable insights for academics, practitioners, and policymakers alike. Gray literature was excluded to maintain methodological homogeneity and to minimize the risk of untraceable or non-replicable findings; we recognize, however, that policy reports often capture emergent practices and therefore highlight this as a fruitful avenue for complementary scoping reviews.

## 4. Discussion and Results

### 4.1. H1: Digitalization Accelerates the Process of International Trade

According to the findings based on the different articles that were investigated, the first hypothesis is confirmed. While researchers studied the impacts of digitalization on international trade from varied perspectives, they reached a similar conclusion: a positive relationship between digitalization and the internationalization process of firms. Businesses apply digital technologies to achieve a competitive advantage in the international environment and being able to share knowledge and obtain a share of the foreign market.

As a matter of fact, studies on the effects of digital technologies on internationalization occurred from different perspectives; however, most of them prove that DTs play an influential role in facilitating internationalization. Digital technologies contribute to creating more appropriate value for the firm (Cherbib et al., 2021); to shaping the traditional interaction between consumers and businesses (Taiminen & Karjaluoto, 2015); and to affecting business processes, operational routines, and organizational capabilities (L. Li et al., 2018).

According to the study of Brieger, S. A. et al., which was conducted based on multilevel modeling on a sample of more than 6000 entrepreneurs from 62 countries, digitalization increases the internationalization of new ventures like start-ups. Entrepreneurs who sell their products and services via the internet tend to be more internationalized. However, digital infrastructure in the home country influences this process. The authors indicated that digital entrepreneurs in countries with weak digital infrastructure are motivated to find new customers abroad.

In the meantime, they have a greater need to seek customers due to the lack of adequate digital platforms in comparison to their counterparts in countries with well-established digital infrastructure. Despite this, based on previous studies, it seems strong digital

infrastructure in the home country accelerates the internationalization of new ventures because of beneficial points, including immediate, inexpensive, and reliable access to customers, business partners, and other supply chain partners around the world. Brieger, S. A. et al.'s findings indicate that a strong digital infrastructure in the home economy can reduce the willingness of digital entrepreneurs to internationalize, and conversely dependened them to the domestic market. Because the existence of digital companies in their country that work as intermediaries can reduce their need to sell products over the internet directly (Brieger et al., 2022).

Hervé et al. provided a quantitative research design and explained that there is a relationship between the degree of digitalization and entrepreneurial orientations (EO) of micro-, small-, and medium-sized firms and between each EO component and MSMEs' internationalization intensity. Digital entrepreneurship emerged with the advent of digital technologies and, through them, has overcome the uncertainty inherent in the processes and results of entrepreneurship. Digital technologies, by providing a wide range of opportunities, positively impact the firm's EO, including innovation, aggression, and risk-taking, to boost their market knowledge, enhance skills, improve resources, etc. Consequently, these elements lead to expanding the competitive advantage of companies in the foreign market (Hervé et al., 2021).

In another study, the authors investigated the role of e-business digital technologies on a firm's internationalization. E-business digital technologies are different with e-commerce, while the first means the use of cloud computing and/or software applications enabling firms to share information with their suppliers, customers, and business partners along the supply chain, the second refers to digital technologies such as websites, e-commerce, and social media, which are used to carry out transactions as well as marketing and promotion activities.

According to their findings, e-business digital technologies have a positive effect on the internationalization of businesses by being embedded in production with the process and organizational innovations, and with appropriate human capital investments. Companies can use digital technologies to increase their capabilities to achieve a competitive advantage in international business. And the firm's ability to transform digital technologies into capabilities critically depends on human capital with adequate skills to develop, preserve, and make use of them, including managerial skills and problem-solving skills, in addition to core technical skills (Cassetta et al., 2020).

Moreover, digital technologies are considered as a "pre-condition" for a company to internationalize because innovative new digital technologies lead to new processes, goods, and services, as well as novel methods of interacting with suppliers and clients. So, they may improve internal capabilities and efficiency, which will have an impact on a company's ability to internationalize. This perspective focused on the relationship between the adoption of new digital technologies and firms' internationalization, especially two types of export and FDI, and claimed the existence of a positive relationship between European businesses' efforts to expand internationally and their embrace of cutting-edge digital technologies. And exporting operations have a higher coefficient than FDIs. Another significant factor seems to be the level of digitalization.

On the one hand, it appears that total adoption has a substantial impact, but the partial degree of adoption has a larger coefficient. The results, however, indicate that by distinguishing between the various forms of internationalization, only the firms that claim to have partly implemented new digital technologies are more likely to engage in exporting or FDI (Teruel et al., 2022). In addition, based on case study research, neglecting digital technologies is risky for SME because they act as an important tool that supports value creation and customer engagement. The adoption of digital instruments has enhanced

the international presence of the companies, expanding the number of markets and the percentage of foreign sales. Moreover, using digital technologies leads to a reduction in international entry barriers (Matarazzo et al., 2020).

Finally, digitalization is proven as a crucial tool to overcome internationalization challenges of firms, especially SMEs, to establish a collaborative network to gain a competitive advantage in foreign markets and obtain the right information (Costa et al., 2020).

#### *4.2. H2: Global Crises (e.g., the COVID-19 Pandemic and Brexit) Influence Digitization and Might Decrease International Trade*

Despite global crises negatively influencing international trade, it seems digitization is a crucial way to combat the limitations arising from them to pass the recession and their negative economic impacts. For example, the COVID-19 pandemic accelerated the process of digitalization (Amankwah-Amoah et al., 2021), as the global economy has had to adapt to new ways of working (Pereira et al., 2022). So, the second hypothesis was rejected by the growth of digitalization in an emergency, which acts as a survival function for businesses.

The limitations on economic activity during the COVID-19 pandemic led to a steep decline in international trade (Arriola et al., 2022). Meanwhile, the environmental uncertainty due to the pandemic highlighted the importance of the value of timely and accurate data for business operations and decision-making. Hence, this uncertain situation may speed up digitalization as a consequence of disrupting traditional business models (Döhring et al., 2021), because digitalization improves information processing capability to enable firms to anticipate, make prompt decisions, and adjust proactively to reduce the negative impacts of adverse situations (Joseph & Gaba, 2020).

Digitalization is positively related to organizational resilience, which leads to a firm's growth. Firms equipped with more digital technologies were less likely to be affected by the operational disruptions caused by the COVID-19 outbreak (J. Zhang & Qi, 2021). In comparison to larger businesses, SMEs were more under pressure and vulnerable (Hamburg, 2021). The problem in the context of digitalization regarding SMEs was a lack of knowledge or skills to plan, manage, and optimize digital transformation (Guo et al., 2020). So, one way was boosting their digital transformation by scaling up SME internal capacity through governments, including financial support for technology, reducing training costs, building a data culture, and raising the digital security profile.

During the restrictions, the value of information and communication services (ICT) exports increased because of the boost in the usage of digital technology tools in many economies. Businesses were motivated to adopt digital tools, helping to drive a 6% increase in worldwide exports of ICT services. Moreover, while total services exports declined by 20%, worldwide exports of digitally deliverable services fell by only 1.8%. Digitally deliverable services contributed less than 1 percentage point of the total decline in services exports. Meanwhile, the growth of ICT services partially offset reductions in the trade of other service products by over half a percentage point (United Nations Conference on Trade and Development (Canton, 2021)). In other crises like Brexit that disrupted not only the EU and UK but also affected the global environment and produced environmental uncertainty for businesses (McGovern, 2023), digitalization might play a crucial role in overcoming the negative impacts on international trade.

#### *4.3. H3: Technology Has Made International Business More Efficient and Effective*

Progress in technology has provided valuable support to international business. The internet is widely used by millions of people worldwide for diverse purposes, ranging from online research to purchasing products. Its impact on businesses is far-reaching, as the internet has become an essential tool for advertising, conducting routine business activities,

and generating income. As a result, an increasing number of companies are adopting internet-based solutions for their day-to-day operations (Terzi, 2011).

The implementation of digital transformation empowers businesses to develop flexibility and efficiency, streamline manufacturing procedures, create innovative value propositions within ecosystems, and promptly meet the demands of the market (Feliciano-Cestero et al., 2023). When a company decides to expand its business overseas, it can view digital transformation both as a tactic and a strategy. By utilizing digital platforms, firms can quickly connect with potential importers and exporters and establish e-commerce and social media channels to attract foreign clients and partnerships. Embracing digital technologies and pursuing innovation can lead to numerous benefits, including gaining knowledge advantages, engaging in international entrepreneurship, and improving sustainability and competitiveness. Internet technologies offer opportunities to connect and expand networks, enhance global strategies, increase competitiveness, and promote international business and entrepreneurship (Feliciano-Cestero et al., 2023).

A study by Terzi (2011), showed that the internet has the potential to boost international trade in a similar manner to the removal of other trade barriers. Consequently, the utilization of e-commerce is expected to lead to an increase in the volume of global trade. Developing countries that permit imports from high-income economies will benefit from knowledge sharing. The impact of e-commerce on trade in services is also likely to be significant. While the development of e-commerce is expected to create new jobs, it may also lead to job losses. The information and communication technologies sector is expected to benefit from the creation of new jobs, while increased demand and productivity may indirectly generate additional employment opportunities. The net effect on employment will depend on the demand for skills.

There are also several operational benefits in adopting IoT-based smart solutions. Like in other sectors, the application of IoT has the potential to bring about benefits such as minimizing waste and enhancing energy efficiency (Y. Zhang et al., 2017). Alternatively, the improvement of parking space utilization could also be considered (Mishra et al., 2019).

There are more advantageous impacts of technology on business that lead to efficiency. Over the last ten years, there has been a decrease of over 20% in the expenses associated with hardware and software, and at the same time, there has been an annual improvement of about 5% in the performance of robotic systems (Strange & Zucchella, 2017). Moreover, the implementation of the IoT will assign distinct labels to items, connecting them to details about their origin, usage, and destination. This fusion will eliminate the necessity to align product and information movements, leading to enhanced productivity and distribution efficiency, particularly for global value chains. Consequently, the IoT could decrease the expenses related to international manufacturing and encourage further international labor division in the worldwide factory (Buckley & Strange, 2015).

A study by T. Zhang et al. (2022), reviewed the previous literature and found that digital technology can enhance enterprise production efficiency by reducing costs, improving efficiency, and promoting innovation. The author conducts an empirical study using data from listed manufacturing companies in the Shanghai and Shenzhen stock exchanges between 2009 and 2017, using a differences-in-differences (DID) model to investigate the relationship between digital transformation and production efficiency. The results suggest that digital transformation plays a significant role in promoting economic benefits, and the findings are robust. The paper proposes countermeasures and suggestions to promote the development of enterprise digital transformation based on the actual situation of Chinese enterprises. Overall, this study has significant implications for Chinese enterprises to maintain a dominant position in the new wave of global industrial revolution.

According to research conducted by (Gölzer & Fritzsche, 2017), digital technology can be utilized in business processes to enhance production performance. The study revealed that intelligent decision-making and control systems can enhance the efficiency of enterprise operation and management. In addition, according to a study, digital technology can play a significant role in driving the intelligent transformation of products and services offered by enterprises, as well as facilitating the creation of new marketing operations. This, in turn, can contribute to the enhancement of the enterprise's market share and overall performance (F. Li, 2020).

Furthermore, technology increases the effectiveness of international business. In this case, the possible consequences of Big Data Analytics (BDA) for international business are evident and significant. Specifically, companies will have the capability to observe emerging patterns and possibilities in foreign markets without having to invest significant resources in local marketing subsidiaries. In addition, they can more efficiently enhance their global supply, production, and distribution operations (Strange & Zucchella, 2017). Moreover, a study entitled "The influence of organizational facilitating conditions and technology acceptance factors on the effectiveness of virtual communities of practice" discovered that "organizational facilitating conditions" had a favorable impact on "effectiveness," and that this relationship was partially explained by a feeling of "virtual community." Furthermore, the study observed that the effects of "facilitating conditions" on "effectiveness" were moderated by two factors: perceived usefulness and perceived ease of use, which acted through the sense of "virtual community" (Peñarroja et al., 2019).

In essence, the concept of digital transformation effectively influences the development of business model innovation (T. Zhang et al., 2022). A conducted research from a regional perspective, which revealed that an increased level of regional digitization has a positive impact on innovation performance. However, if there is too much emphasis on digital application, platform, and equipment construction, it could impede innovation performance in the region (T. Zhao et al., 2020).

Based on the information provided, the research hypothesis that "Technology has made international business more efficient and effective" can be confirmed. The adoption of digital transformation, IoT-based smart solutions, and big data analytics has led to numerous operational and strategic benefits, including enhanced productivity, improved distribution efficiency, and increased competitiveness. The internet and digital technologies have facilitated global networking, knowledge sharing, and entrepreneurship, and have made it easier for firms to connect with potential partners and clients overseas. The overall impact of technology on international business has been positive and has led to improved efficiency and effectiveness. Several studies report diminishing marginal returns once firms reach a "digital saturation" threshold, where additional platforms increase coordination costs (e.g., duplication of dashboards) or heighten cyber-risk exposure. Although such cases are fewer than the positive ones in our corpus, they remind policymakers that indiscriminate digital adoption can erode, rather than enhance, trade efficiency when governance capacity lags.

#### 4.4. H4: Technology Has Increased the Complexity of International Business

Complexity defines the amount of effort needed to comprehend and manage a system. In Information Systems, complexity can lead to the loss of information. Complexity analysis aims to describe and identify the different obstacles that emerge between the components of a system throughout its lifespan (Ali et al., 2022). The adoption of technology becomes even more complicated when the technology is newly introduced, and its worth is yet to be determined, as per the research conducted by Kornak et al. (2004) and Daley

(2005). Analyzing IT adoption is challenging due to the interplay of both technological and organizational factors, which makes adoption difficult to manage (Ali et al., 2022).

In a literature review on system complexity, Baccarini (1996) defined complexity as the existence of multiple components that interact with each other and are interdependent. The author identified two types of complexity:

**Organizational complexity**, which pertains to the interdependence of various components, including management levels.

**Technological complexity**, which refers to the number of connections among inputs, outputs, activities, and technologies in the system.

The field of international business is inherently complicated due to several key factors, namely the involvement of numerous countries, products, technologies, and firms; the complexity of international transport and communications networks; the diversity of political, cultural, and regulatory environments; and the rapid and unpredictable pace of change (Casson & Li, 2022). Numerous studies have emphasized that digitalization has the capacity to make internationalization more convenient. Nonetheless, digital transformation could also generate adverse consequences, as well as difficulties and intricacies in the process of internationalization.

Essentially, the level of technological complexity plays a significant role in determining development (Nepelski & De Prato, 2020). Organizations are facing novel and unforeseeable information security challenges because of technologies. For example, due to their extensive use, smartphones can become a prime target for cybercrime, making them a significant security risk (Ameen et al., 2021). In firms that adopt cyber-physical systems, there is a concern that cyberattacks and data breaches could compromise the security of the organization during the process of digital transformation. Research indicates that cybersecurity issues related to employees using digital technologies are a significant concern for international firms because handling customers' and companies' data at an international level can be complicated due to different laws and regulations. Hence, these concerns should be considered as a potential drawback of acquiring digital transformation technologies in business (Queiroz et al., 2020).

Pappas et al. (2021) investigated the complexity of decision-making processes and IoT adoption in accommodation SMEs. They state that although smart solutions are being adopted in the accommodation industry, there are limitations and risks associated with their implementation. One such limitation is that customers may feel uncomfortable or not competent in using the technology. Additionally, there may be concerns about the security and privacy of personal data. Thus, while these technological solutions may offer benefits, they must be implemented carefully to address these concerns and ensure customer satisfaction. Therefore, four potential forms of decision-making were identified by their study to ameliorate the complex process of decision-making due to technological advancement.

The complexity of technological inputs can affect the costs and feasibility of producing goods and services in a foreign country. When tasks are more complex, they require more technological information to be transferred, which can increase the costs of offshoring. For instance, knowledge transfer about R&D and product design may be challenging and expensive for foreign affiliates. This implies that the complexity of technological inputs is an essential factor to consider when deciding whether to offshore production or keep it domestic (Keller, 2010). This can affect organizations in several ways. The size of an affiliate's revenue from sales to local customers is influenced by trade costs, which in turn are affected by the complexity of technology.

The share of intermediate inputs imported from the parent firm in terms of total costs is decreasing with transport costs and at a slower rate in technologically complex

industries. This means that the cost share of imports is declining more slowly in technologically complex industries because these industries are intensive in intermediates whose production is harder to move offshore. Also, as trade costs between exporting and importing countries increase, trade becomes more technologically complex. Empirical evidence supports propositions, showing that the gravity of multinational sales is stronger for complex goods and that the share of affiliate imports tends to be high for complex goods because the technology for those is difficult to transfer. Moreover, the relationship between technological complexity and trade costs for U.S. exports shows that trade becomes more technologically complex as trade costs increase (Keller, 2010).

Another factor contributing difficulty in businesses and organizations is the installation of smart appliances and sensors for effective communication between virtual and physical environments, which leads to increased implementation expenses (Saadeh et al., 2018; Pappas et al., 2021). Furthermore, if the company lacks strong organizational and technological foundations to support these innovations, the investment required for successful implementation may be even higher (Ho et al., 2017; Saarikko et al., 2017).

Although the cloud has been a significant and constantly advancing advancement in computing history and IT applications, many companies, including governments, have encountered difficulties in adopting it, with the latter finding it particularly complicated to make decisions about cloud adoption (Ali et al., 2022). This research indicated that complexity plays a crucial role in the decision-making process for organizations considering the adoption of cloud computing. The findings showed that a lower level of complexity can have a positive and significant impact on the adoption of cloud computing and other advanced technologies, which is contrary to what one might expect. Moreover, even though cloud computing is generally acknowledged as a straightforward approach to managing IT, ironically, one of the main reasons for the low adoption of cloud computing was the perceived “complexity” by organizations that were considering its adoption (Alismaili et al., 2016).

The move towards digitizing goods and services has the potential to pose a significant threat to economies. While Industry 4.0 is creating a greater number of job opportunities in the digital sector, there is also a decline in employment opportunities due to the rise in automation (Feliciano-Cestero et al., 2023). The shift towards digitalizing products and services has the potential to significantly impact economies, as Industry 4.0 introduces a range of new employment opportunities in the digital realm while also reducing job opportunities due to increased levels of automation. This complex interplay between job creation and displacement is driven by advancements in technology, which can both augment and replace human labor. As a result, policymakers and industry leaders must carefully navigate the potential benefits and drawbacks of these shifts to ensure that the workforce can adapt and thrive in the digital age. After conducting thorough research and analyzing various sources, it can be concluded that the hypothesis, “Technology has increased the complexity of international trade,” is confirmed.

International trade has become increasingly complex due to technological advancements. The use of technology has allowed for more efficient and faster communication, which has enabled companies to expand their operations globally. However, this expansion has also led to more complex trade relationships between countries and has increased the number of regulations and standards that must be followed. In addition, technology has also led to an increase in the volume of trade and the number of products traded. The use of electronic payment systems, automated processes, and online marketplaces has made it easier for companies to participate in international trade, but has also made it more difficult to regulate and monitor. Overall, it can be concluded that technology has increased the complexity of international trade, and this trend is likely to continue as

technology continues to advance. It is important for businesses and governments to adapt and develop new strategies to manage this complexity and ensure that international trade remains efficient and beneficial for all parties involved.

#### *4.5. H5: Countries with Better Digital Infrastructure and Policies Are More Likely to Have Higher Levels of International Trade*

One of the main themes that emerges from the literature is the importance of digital infrastructure for increasing international trade. Digital technologies have the potential to reduce transaction costs and increase efficiency in trade logistics, particularly for small- and medium-sized enterprises (SMEs). The [United Nations Conference on Trade and Development \(2020\)](#) similarly notes that high-speed internet access and digital payment systems are critical for enabling e-commerce and expanding market access.

However, the literature also highlights some of the challenges associated with developing digital infrastructure in certain regions. Developing countries often face significant barriers to accessing digital technologies, such as limited internet connectivity and inadequate digital skills. This can make it difficult for these countries to fully participate in international trade and take advantage of the potential benefits of digital technologies.

In addition to digital infrastructure, the literature also highlights the importance of policies related to e-commerce, data protection, and cybersecurity. The [Organisation for Economic Co-Operation and Development \(2019\)](#) notes that clear and consistent policies related to digital technologies can help to reduce uncertainty for businesses and facilitate cross-border trade. The [World Economic Forum \(2021\)](#) similarly emphasizes the need for international cooperation on digital trade rules to ensure a level playing field for all countries.

Another theme that emerges from the literature is the potential benefits of emerging digital technologies, such as blockchain and artificial intelligence (AI), for international trade. The [Asian Development Bank \(2020\)](#) notes that blockchain can help to reduce transaction costs and increase transparency in international trade, while the [International Chamber of Commerce \(2020\)](#) highlights the potential of AI to improve supply chain management and reduce the risk of fraud.

However, the literature also notes some of the challenges associated with adopting these technologies, such as concerns around data privacy and security. The [World Trade Organization \(2019\)](#) notes that developing countries may be at a disadvantage when it comes to adopting new digital technologies due to limited resources and expertise.

Overall, the literature supports the hypothesis that countries with better digital infrastructure and policies are more likely to have higher levels of international trade. However, it also highlights some of the challenges associated with developing digital infrastructure and adopting new digital technologies, particularly for developing countries. To address these challenges, policymakers should prioritize investments in digital infrastructure and skills development, as well as develop clear policies related to digital technologies. They should also promote international cooperation on digital trade rules to ensure a level playing field for all countries.

In conclusion, the triangulation of recent literature provides a comprehensive understanding of the relationship between digital infrastructure and international trade. By analyzing data from multiple sources, we can identify key themes and challenges associated with this relationship and develop evidence-based policy recommendations to promote the growth of the digital economy and increase participation in international trade.

Furthermore, some studies suggest that the positive relationship between digital infrastructure and international trade may be moderated by factors such as economic development, institutional quality, and human capital. For instance, a study by [Liao et al. \(2021\)](#) found that the effect of e-commerce adoption on export performance is stronger in countries

with higher levels of economic development and human capital. Similarly, a study by Wang et al. (2020) found that the impact of digital infrastructure on international trade is stronger in countries with better institutional quality.

However, the literature also suggests that the relationship between digital infrastructure and international trade is not always straightforward. While digital infrastructure has a positive effect on export performance, this effect is weaker for firms in high-tech industries. The authors argue that this may be because firms in high-tech industries are more likely to have already developed their own digital capabilities, making them less reliant on external digital infrastructure.

Another potential challenge associated with the relationship between digital infrastructure and international trade is the risk of digital divides, both within and between countries. While the adoption of digital technologies has increased in Latin America and the Caribbean, there are still significant disparities in access to digital infrastructure and skills between urban and rural areas, as well as between high- and low-income households.

To address these challenges, policymakers need to take a holistic approach to digital infrastructure and policies, considering factors such as economic development, institutional quality, and human capital, as well as the potential for digital divides. For example, a study by Ali et al. (2022) argues that policymakers in developing countries should focus on building digital infrastructure that is inclusive and accessible to all, rather than simply focusing on attracting foreign investment in the digital sector.

In summary, the triangulation of recent literature suggests that countries with better digital infrastructure and policies are indeed more likely to have higher levels of international trade. However, this relationship is complex and may be moderated by factors such as economic development, institutional quality, and human capital. Policymakers need to take a holistic approach to digital infrastructure and policies, focusing on building inclusive and accessible digital ecosystems that can support the growth of international trade and promote equitable development.

#### *4.6. H6: The Impact of Digital Technology on International Trade Varies Depending on the Level of Economic Development and Institutional Context of a Country*

The impact of digital technology on international trade is a complex issue that has attracted significant attention from scholars and policymakers. While some argue that digital technology has the potential to drive economic growth and enhance international trade, others suggest that the impact is context-specific and dependent on a country's level of economic development and institutional context. This paper aims to provide a triangulation discussion of the existing literature on the impact of digital technology on international trade, focusing on the hypothesis that "the impact of digital technology on international trade varies depending on the level of economic development and institutional context of a country."

Several studies have shown that digital technology has a positive impact on international trade. For example, according to a report by the World Economic Forum (2022), digital technologies have contributed to the growth of international trade by increasing productivity, reducing costs, and improving the efficiency of supply chains. Similarly, a study by Wang et al. (2020) found that institutional quality, digital infrastructure, and international trade are positively correlated in China. The authors suggest that better digital infrastructure enhances a country's trade competitiveness by reducing transaction costs and improving access to information.

The influence of digital technology on international trade is not uniform; it varies according to each country's stage of economic development and the quality of its institutions. In more advanced economies, ample resources and greater absorptive capacity tend to amplify the gains from adopting new digital tools. By contrast, the effectiveness of digital

solutions in many Asian economies hinges largely on supportive policy frameworks and regulatory environments that specifically encourage digital trade.

Digital technology also produces mixed outcomes for firms. On the one hand, online platforms have expanded opportunities for cross-border e-commerce. On the other, they have intensified competition and compressed profit margins—pressures that fall especially hard on small and medium-sized enterprises. Likewise, rapid digitalization can realign global value chains in ways that disadvantage some developing-country producers, heightening the risk of job displacement and widening income gaps.

Finally, the spread of digital tools can deepen existing trade barriers and economic divides. When connectivity, skills, or infrastructure lag, technology may widen rather than narrow the digital divide. At the same time, rising concerns over data protection and privacy have encouraged new forms of trade protectionism, adding layers of complexity to cross-border digital commerce.

In conclusion, the existing literature provides mixed evidence on the impact of digital technology on international trade. While some studies suggest a positive relationship between digital technology and trade, others argue that the impact is context-specific and dependent on a country's level of economic development and institutional context. Moreover, studies have shown that the impact can be both positive and negative, and that digital technology can exacerbate existing trade barriers and inequalities. Therefore, it is important for policymakers to carefully consider the potential risks and benefits of digital technology when formulating policies that promote international trade.

## 5. Conclusions

The evidence presented in this study supports the hypothesis that digitalization accelerates the process of international trade. Digital technologies have become crucial tools for SMEs, enabling them to enhance their international presence, expand into new markets, and reduce entry barriers. Digitalization has also been proven to be an effective tool for overcoming internationalization challenges and establishing collaborative networks for competitive advantage in foreign markets. The COVID-19 pandemic and Brexit have highlighted the importance of digital technologies in mitigating the negative impacts of global crises on international trade, with increased adoption of digital tools helping to offset declines in other service products.

Furthermore, technology has made international business more efficient and effective, as the adoption of digital transformation, IoT-based smart solutions, and big data analytics has led to operational and strategic benefits such as enhanced productivity and improved distribution efficiency. The internet and digital technologies have facilitated global networking and knowledge sharing, making it easier for firms to connect with partners and clients overseas, and ultimately improving overall efficiency and effectiveness in international business.

However, it should be noted that technology has also increased the complexity of international trade, with the expansion of trade relationships between countries, the increase in regulations and standards, and the volume of products traded. The use of electronic payment systems, automated processes, and online marketplaces has made it easier for companies to participate in international trade but has also made it more difficult to regulate and monitor. Therefore, it is crucial for businesses and governments to adapt and develop strategies to manage this complexity and ensure that international trade remains efficient and beneficial for all parties involved.

The existing literature provides mixed evidence on the impact of digital technology on international trade, and it is important for policymakers to carefully consider the potential risks and benefits when formulating policies. While digitalization has undoubtedly

accelerated the process of international trade and brought about numerous benefits, it has also presented challenges and complexities that need to be addressed. Governments and businesses need to work together to harness the potential of digital technologies for international trade while addressing issues related to regulations, standards, inequalities, and the varying contexts of different countries.

Digitalization is reshaping international trade by lowering search, coordination, and entry costs, particularly for small and medium-sized enterprises (SMEs) that can now reach overseas buyers with unprecedented speed and precision. Across the 86 studies reviewed, the preponderance of evidence points to positive trade effects when firms combine e-commerce channels, cloud services, and data analytics with supportive national digital infrastructure. Yet the benefits are not automatic: where broadband is patchy, data governance weak, or skills in short supply, digital tools yield only marginal gains or even raise coordination costs.

The phrase “mixed evidence” in our findings refers to three dimensions. First, the causal direction is contested—while panel studies report export gains that follow digital adoption, several cross-sectional analyses cannot rule out reverse causality. Second, the magnitude of impact varies widely, from negligible effects in low-income economies to double-digit export growth among digitally mature OECD SMEs. Third, conditionality matters: digital dividends are strongest where institutional quality, human capital, and logistics performance are high, and weakest where these complements are missing.

Our review is not without limitations. We restricted sources to peer-reviewed English-language articles published between 2010 and 2023 to ensure methodological consistency; this choice may exclude emerging insights from policy reports, non-English scholarship, and very recent gray literature. The evidence base remains largely cross-sectional, and the absence of effect-size data precluded formal tests for publication bias. These constraints should be borne in mind when generalizing our conclusions.

#### **Implications reach beyond government policy.**

SMEs and exporters should prioritize incremental digital capability building—starting with cloud-based customer management and gradually layering IoT tracking or AI analytics—while guarding against vendor lock-in and cyber-risk concentration.

Technology developers and platform providers can create value by offering modular, interoperable solutions that lower onboarding costs and by supporting open standards that ease cross-border data flows.

Policymakers must align broadband rollout, skills programs, and data-protection rules to foster inclusive digital ecosystems; targeted vouchers or tax credits can help smaller firms bridge capability gaps.

Future research would benefit from longitudinal designs, effect-size meta-analysis, and broader linguistic coverage to capture fast-moving developments in digital trade. By acknowledging both the promise and the pitfalls of digital transformation, stakeholders can craft strategies that make international commerce more efficient, resilient, and inclusive.

In conclusion, the findings from this study support the notion that digitalization has accelerated the process of international trade, as evidenced by the adoption of digital technologies by SMEs, the positive impact of digital technology on efficiency and effectiveness in international business, and the role of digitalization in mitigating the negative impacts of global crises on trade. However, the complexity of international trade has also increased with the advent of technology, and the impact of digital technology on trade is context-specific, dependent on the level of economic development and institutional context of a country. Policymakers need to take a comprehensive approach to digital infrastructure and policies, considering the potential risks and benefits, and working towards inclusive and accessible digital ecosystems that promote equitable international trade. Further research

in this area is needed to better understand the multifaceted relationship between digital technology and international trade and to inform evidence-based policymaking. Formal detection of publication bias (for example, Egger regression) was not feasible without pooled effect estimates; future quantitative syntheses should address this issue explicitly. Overall, digitalization has emerged as a critical driver of international trade, and its continued impact on global trade dynamics will be a significant area of research and policy focus in the coming years.

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