Small Tech, Big Impact

Low-Cost ICT and SME Productivity

Microdata Evidence from Nine Economies in Asia

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Small Tech, Big Impact: Low-Cost ICT and SME Productivity – Microdata Evidence from Nine Economies in Asia

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FOREWORD

In an era of rapid technological transformation, the role of Information and Communication Technology (ICT) in shaping economic growth and firm productivity is more critical than ever. While digital innovation presents vast opportunities, it also risks widening existing inequalities, particularly between firms in developed and developing economies. Small and medium-sized enterprises (SMEs) in emerging markets often struggle to keep pace with digital transformation, facing constraints such as limited access to finance, unreliable infrastructure, and gaps in digital literacy. At the same time, the accelerating diffusion of digital tools offers new opportunities for firms to overcome these barriers and integrate more effectively into the global economy.

As economies worldwide strive for sustainable and inclusive growth, the need for economic upgrading strategies has never been more pressing. However, the extent to which digital adoption translates into tangible benefits varies across countries and industries, shaped by factors such as infrastructure, regulatory frameworks, and human capital development. These variations make it difficult to identify a one-size-fits-all solution. Nonetheless, ICT holds significant potential to enhance firm productivity, increase market competitiveness, and strengthen economic resilience, particularly as ICT usage among the general population in many countries continues to expand at an unprecedented pace.

This report examines whether and how ICT serves as a transformative force for firms in selected APO economies. By focusing on Internet access, mobile banking, and electronic payments, it explores the role of digital tools in reducing transaction costs, increasing financial inclusion, and boosting firm productivity.

Through an in-depth analysis of firm-level data from nine APO economies, this study provides empirical insights into the impact of ICT adoption on business performance. It assesses how firms across diverse economic contexts navigate the opportunities and challenges of digital transformation and identifies key barriers to adoption. The report also offers evidence-based policy recommendations to expand ICT infrastructure, enhance digital literacy, and develop regulatory frameworks that promote digital inclusion. These findings contribute to broader discussions on sustainable development and economic resilience, underscoring the need for coordinated efforts among governments, businesses, and international organizations to create an enabling environment in which ICT can drive meaningful economic progress.

The APO acknowledges the contributions of the experts who prepared this report, led by Chief Expert Dr. Dainn Wie, Associate Professor of National Graduate Institute for Policy Studies (GRIPS), Japan, along with national experts from India, Lao PDR, Malaysia, Mongolia, Nepal, Pakistan, the Philippines, Thailand, and Turkiye. It is hoped that *Small Tech, Big Impact: Low-Cost ICT and SME Productivity – Microdata Evidence from Nine Economies in Asia* serves as a valuable resource for harnessing the power of ICT to drive economic upgrading, enhance firm productivity, and support a more inclusive and sustainable future.

Dr. Indra Pradana Singawinata
Secretary-General
Asian Productivity Organization
Tokyo

INTRODUCTION

Can information and communication technology be a beacon of hope in a rapidly changing global landscape?

Technology is advancing at a breathtaking pace, deepening disparities and reshaping global competition. While rapid innovation is often viewed as an opportunity for small firms in developing countries to catch up, the speed of progress can be overwhelming, making it increasingly difficult for them to keep pace.

Technological development is also becoming highly concentrated in a few firms located primarily in the USA and the People's Republic of China (PRC). For instance, the number of Artificial Intelligence (AI) patents granted in 2022 was nearly three times that of 2020. Among these, the PRC accounted for 61.13% and the USA for 20.90%, underscoring both the speed of innovation and the widening gap between global leaders and those left behind (Maslen et al., 2024).

However, is there a beacon of hope? Another defining characteristic of today's technological advancement is the unprecedented speed of diffusion. Historically, the invention and widespread adoption of new technologies took decades. For example, the telephone invented by Alexander Graham Bell in 1876 required more than 70 years to reach 40% of US households (Fischer, 2023). In contrast, the World Wide Web, launched for public use in 1993, reached a similar level of adoption in developed countries by 2010, in less than two decades (International Telecommunication Union, 2010). This accelerated diffusion of technology may present new opportunities for firms in developing countries, potentially enabling them to integrate into the global markets more rapidly.

This report explores whether ICT, particularly Internet access and mobile phones, can help firms in developing countries overcome longstanding constraints. ICT has expanded rapidly over the last several decades, becoming increasingly accessible even in remote areas in developing countries. Due to its relatively low cost, mobile phone and Internet usage have grown swiftly, offering new avenues to bypass traditional barriers that firms face in these settings. For example, mobile payment systems were first introduced in the Philippines and Kenya in 2003 and 2007, providing financial access to previously underserved populations. As these examples show, ICT, despite being a relatively low-cost technology, has the potential to mitigate traditional barriers such as geographic isolation, limited market information, and high transaction costs by facilitating improved connections between firms and consumers.

This report re-examines the potential of ICT through the lens of recent trends in evidence-based policymaking. It draws on studies examining the impact of Internet access and electronic payments (e-payment) in nine countries, including India, Lao PDR, Malaysia, Mongolia, Nepal, Pakistan, the Philippines, Thailand, and Turkiye—using microdata from the World Bank Enterprise Survey (WBES). Each study examines how firm-level ICT usage is associated with productivity outcomes. Country chapters also present practical policy recommendations based on empirical evidence, ICT diffusion patterns, and specific national challenges.

Outline of the Report

Conceptual Framework of the Report

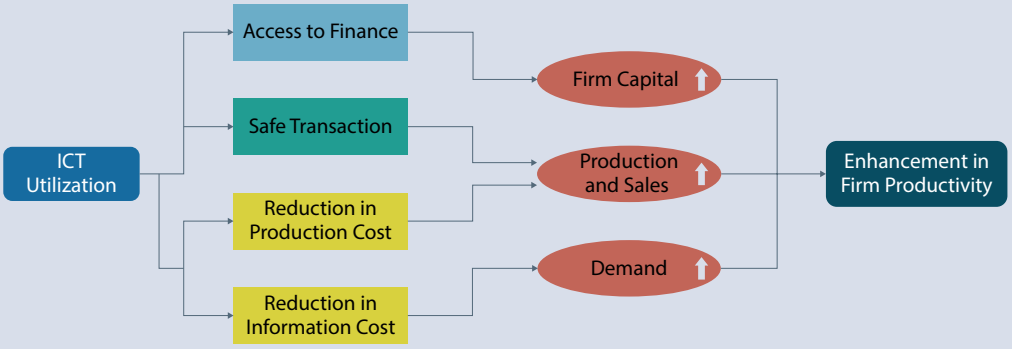
The report conceptualizes that the use of ICT, including mobile banking and payments, email communication, and the establishment of firm-specific websites, can help alleviate operational constraints faced by firms. These constraints include limited access to finance, high transaction risks, and elevated production and information costs.

The emergence of mobile banking offers significant potential to improve firms' access to finance. By enabling individuals, including those who are financially disadvantaged or living in rural areas, to open and maintain bank accounts, mobile banking expands access to formal financial services. This, in turn, facilitates capital acquisition for firms in developing countries, thereby bolstering their productivity and growth.

In addition, e-payment systems provide firms with secure channels for conducting transactions, reducing the risk of theft and financial loss. Enhanced transactional security can positively affect production and sales activities, ultimately improving firm-level productivity. Email and Internet-based tools also strengthen firms' ability to effectively search for necessary inputs and technological solutions, enhancing their production processes. Furthermore, maintaining a company website or using email enables firms to engage with the broader customer base, increasing market reach and expanding demand.

FIGURE 1

THE CONCEPTUAL FRAMEWORK.



Source: Author's Creation.

As illustrated in Figure 1, improved access to finance enhances firms' capital, while safer transactions and lower production costs contribute to increased production and sales. In parallel, a reduction in information costs boosts market demand. Capital availability, production improvements, and potential demand ultimately lead to higher firm-level productivity.

Methodology Employed in Country Reports

The nine country reports compiled in this study follow a consistent framework, focusing on three key aspects.

Identification of Challenges and Potential

Each country report begins with a brief overview of domestic firms' role in global supply chains and identification of significant operational constraints. It then outlines the country's current

position in ICT readiness and presents relevant statistics to explore the potential contribution of ICT to economic development.

Evidence-Based Policy Suggestions

Each country's report conducts multiple levels of analysis to formulate evidence-based policy recommendations. Although the positive relationship between ICT adoption and firm productivity in developing economies appears intuitive, empirical validation remains limited. Most reports in this study use firm-level microdata, such as those from WBES, to examine the relationship between ICT adoption and productivity. The analysis aims to validate the potential of ICT by leveraging available data and identifying emerging trends.

Holistic Policy Recommendations

Each report concludes with a set of holistic policy recommendations that address both current and future initiatives. They also provide a brief assessment of the potential impact of ICT policies on firms' skill development, supported by insights from national experts and their practical experience.

Key Findings from Country Reports

This section summarizes the key findings of each country report across four dimensions: key identified challenges, the potential of ICT, empirical analysis, and policy recommendations.

Challenges Faced by Firms

India

Micro, small, and medium enterprises (MSMEs), which contribute approximately 36% of the country's manufacturing output, face a shortage of skilled labor, limited access to finance, and an outdated and complex regulatory environment. With 95% of these firms operating informally, access to formal financial services remains severely constrained.

Lao PDR

Only certain sectors, such as textiles and handicrafts, are integrated into the global supply chain. As a landlocked economy with limited transport infrastructure, market access in the Lao PDR remains challenging.

Malaysia

Although manufacturing firms in Malaysia are well-positioned in the Global Value Chain (GVC), domestic value-added remains low due to their focus on final assembly. Heavy reliance on low-skilled foreign workers has delayed skill upgrading, limiting productivity and technological advancement.

Mongolia

Firms in Mongolia have limited access to the global market due to the country's landlocked position between the PRC and Russia. Around 80% of the country's exports are from mining and quarrying, reflecting low supply chain diversification.

Nepal

Firms in Nepal face multiple constraints stemming from the country's landlocked status and unique geographical features, restricting their participation in the global supply chain. Diplomatic trade facilitation via India remains the most viable option for market access.

Pakistan

Firms in Pakistan face multiple challenges, including inadequate infrastructure, limited access to finance, and shortages of skilled workers. Inconsistent policy support further hinders productivity growth.

Philippines

In the Philippines, the growth of services exports outpaces merchandise exports. However, the total value of imports exceeds exports, widening the country's trade deficit. The country's participation in GVCs is essentially through backward linkages, heavily relying on imported intermediate goods.

Thailand

Thai firms operate at various stages of GVC, reflecting the country's diverse economy. Nonetheless, progress is impeded by an aging workforce, brain drain, and the concentration of skilled workers in Bangkok.

Turkiye

Turkish firms focus on medium-technology segments in GVCs, with a strong presence in automotive, textiles, and machinery. They have also expanded exports to Europe and the USA. However, to comply with the EU's new carbon regulations, the firms must adopt sustainable production and engage in higher value-added activities.

ICT Potential and Adoption Trends

India

India's information and technology sector has been a major contributor to the growth of its service industry. Its telecommunications sector is the second largest in the world, and related manufacturing activities are expanding rapidly, along with the growth of data centers.

Lao PDR

ICT access in the Lao PDR is expanding rapidly, with mobile phone ownership reaching 50% in 2019. The adoption of mobile banking has increased bank account ownership from 26.8% in 2011 to 38.3% in 2021, highlighting its potential.

Malaysia

Both firms and households are well-connected through the Internet and mobile networks, and e-payment have surpassed debit and credit card usage in recent years, signaling widespread ICT adoption.

Mongolia

Given the country's vast and sparsely populated geography, mobile phone usage is more viable than broadband Internet. Mobile banking has seen remarkable penetration: 94% of adults have a bank account, and 97% use mobile banking, highlighting strong potential for secure digital transactions.

Nepal

Broadband Internet connects Nepal's core public sector, while 73% of households use smartphones. The rapid expansion of e-payment highlights ICT's potential to empower Small and Medium Enterprises (SMEs).

Pakistan

ICT usage in Pakistan remains comparatively low. However, mobile banking has expanded recently and now covers around 20% of the population, indicating rising potential for ICT-driven financial services.

Philippines

The 2019 National ICT Household Survey indicates that most households in the Philippines have access to mobile Internet, and 75% of individuals own a mobile phone. This highlights the significant potential of ICT. However, only 26% of Internet users engage in e-commerce, primarily due to security concerns. Additionally, foundational ICT skills such as spreadsheet use require further development.

Thailand

In Thailand, Internet usage is high among both households and firms. In 2021, nearly 15.7% of service sector firms and 8.6% of manufacturing firms engaged in online sales, reflecting the growing role of ICT in driving business growth and digital transformation.

Turkiye

Household Internet usage is high in Turkiye, with 51.7% of individuals engaged in e-commerce in 2024. The banking sector also leverages digital channels, with 37% of general-purpose loans issued online in 2020, highlighting ICT's potential to enhance firm productivity.

Insights from Empirical Analysis

India

The WBES data indicates that most firms in India can utilize ICT to upgrade skills. A majority maintain websites and use social media platforms. About 40% of firms generate sales through online channels, and almost none report issues with Internet connectivity.

Lao PDR

WBES regression analysis suggests that firms with websites exhibit approximately 50% higher labor productivity. In contrast, female ownership is associated with roughly 20% lower productivity, indicating the presence of gender-specific barriers.

Malaysia

WBES regression analysis indicates that small firms using online payment systems have 17% higher labor productivity. However, electronic service interruptions reduce productivity by 4.75%. Skill training programs benefit only large firms, with limited impact on small enterprises.

Mongolia

Time-series data reveal a positive correlation between ICT investment and labor productivity. Further, WBES regression analysis shows that firms with websites, foreign-licensed technology, and written business strategies have higher productivity levels.

Nepal

WBES regression analysis confirms that Internet access is a significant factor for higher labor productivity. However, power outages and e-payment usage have no significant relationship with productivity.

Pakistan

Regression analysis using data from publicly listed firms indicates a positive correlation between ICT adoption, workforce skill, and improvements in both labor productivity and firm-level total factor productivity (TFP).

Philippines

Empirical analysis of WBES data shows that firms adopting digital tools and investing in upskilling achieve significant productivity gains. Email communication is linked to a 45% increase in labor productivity, while maintaining a website yields a 25% boost. However, infrastructure issues like power outages are associated with productivity losses.

Thailand

WBES regression results show that firms with websites tend to have higher labor productivity, while power outages have the opposite effect. A negative correlation between innovation and productivity requires further analysis.

Turkiye

WBES analysis reveals significant variation in firm-level productivity, measured by both labor productivity and TFP. Regression results show that firms with websites consistently outperform those without, highlighting the importance of online presence.

Policy Directions and Recommendations

India

India should promote the adoption of advanced technologies such as AI and blockchain to enhance MSME productivity. These efforts must be supported by streamlining regulations and infrastructure while ensuring market competition and macroeconomic stability.

Lao PDR

Investments in infrastructure and a reliable power supply are critical to unlocking ICT's full potential. Enhancing ICT education will help develop human capital and improve digital literacy, while capacity-building programs for women can further promote inclusivity and productivity.

Malaysia

The implementation of the Twelfth Malaysia Plan for ICT infrastructure and the Digital Economy Blueprint should prioritize reducing the digital divide and address policy discrepancies across states.

Mongolia

The government's focus on e-government, legal reforms, and improved ICT infrastructure is essential for enabling secure electronic transactions, cybersecurity, and data protection. These policies must be sustained and inclusive, and support workforce skill upgrade for firms.

Nepal

Nepal laid the foundation for ICT with the Digital Nepal Framework 2019. Further action is required to strengthen infrastructure, expand training programs, and enhance the legal framework for e-payments.

Pakistan

Low levels of ICT adoption in Pakistan underscore the need for investment in essential infrastructure. Educational initiatives that improve financial literacy and ICT skills are also needed.

Philippines

While the Philippines received an 'advanced' rating in the 2024 assessment of digital readiness for policy, legal, and governance frameworks by the International Telecommunication Union, significant challenges persist. Addressing infrastructure, investment, financing, and skills development gaps is essential to ensure equitable digital transformation.

Thailand

National strategies such as Thailand 4.0, the Eastern Economic Corridor, Smart Cities Initiatives, and the Digital Economy and Society Development Plan are paving the way for a digital and high-value-added economy. Robust programs for workforce skill upgrading must complement these efforts.

Turkiye

Ongoing efforts to improve digital literacy and expand ICT infrastructure are well aligned with national priorities. The government should introduce financial incentives and training programs to drive ICT adoption among SMEs while enhancing resilience and ensuring cybersecurity.

Final Observation and the Way Forward

The nine country reports presented in this study provide a detailed overview of the challenges firms face in developing Asian economies. Each report offers comprehensive background information on the role of ICT, supported by current statistics that highlight how ICT can support firm development within specific economic settings.

The reports also include empirical analysis using microdata to underscore the productivity gains associated with low-cost ICT tools, such as maintaining a company website or using the Internet. However, persistent barriers like unreliable power supply and gaps in ICT literacy continue to limit broader adoption and are linked to lower firm-level productivity. Each country chapter concludes with assessing existing policies, their limitations, and future directions for policy focus.

This study provides a fresh perspective on the potential of everyday ICT tools to support SMEs, particularly in the face of widening economic disparities. By integrating ICT into national economic strategies, developing economies can harness their potential not only to improve productivity, strengthen resilience, promote inclusiveness, and enhance global competitiveness.

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INDIA

Summary

The International Monetary Fund (IMF) ranks India as the fifth-largest economy by market exchange rates and third-largest by purchasing power parity. With an average projected annual growth rate of 8% over the next 40 years, India is expected to grow at an average annual pace of 8% over the next 40 years, making it the fastest-growing major economy until 2050.

This paper focuses on the contribution of Information technology (IT) and IT-enabled services to the Indian economy and how government policies have facilitated this growth. It highlights that expenditure in the IT sector has increased by 10% over the past few years, which is associated with a 5% rise in revenue and has had a significant impact on industries such as manufacturing, IT, and IT-enabled services.

IT and IT-enabled services currently account for 10% of India's economy, while the MSME sector contributes around 36%, underscoring the crucial role both sectors play in the economy. This paper also examines the role played by these sectors, the challenges they face, and the policy interventions being implemented by organizations and the Government of India to address them. These include initiatives such as *AI for All*, the *National Policy on IT*, and the *National Skill Development Policy 2009*, among others.

Introduction

India, officially known as the Republic of India, is a South Asian nation and, as of June 2023, the world's most populous democracy. Geographically, it is the seventh-largest country in terms of area.

In 2024, India's nominal Gross Domestic Product (GDP) stood at USD3.94 trillion, while its economy was valued at USD15 trillion in terms of purchasing power parity (PPP), ranking third globally by PPP and fifth by market exchange rates, according to the IMF. India has been among the fastest-growing economies globally, with an average annual GDP growth rate of 5.8% over the past two decades and 6.1% during 2011–12. According to PricewaterhouseCoopers (2011), India's GDP is expected to surpass that of the US in PPP terms by 2045. It is further projected to grow at an average annual rate of 8% over the next four decades, making it the fastest-growing economy internationally until 2050 (The Economic Times, 7 January 2011).

Over the years, India's contribution to the global economy has steadily increased and is expected to continue rising in the coming decades. In 2023, India's share of global GDP, based on PPP, was 7.59%. The country accounted for 2.9% of global manufacturing production in the same year (Safeguard Global, 29 August 2024). It is predicted that India's share of global GDP will reach 8% in 2024, 9.2% in 2030, and 30% in 2040 (Statista, October 2024).

India has also seen a substantial growth in global services exports. Over the past decade, the number of Global Capability Centers (GCCs) in India has more than doubled, while revenues have quadrupled. In the fiscal year (FY) 2023, Indian GCCs generated revenues of USD46 billion.

India and the GVC

The World Bank's report, *Indian Development Update, India's Trade: Opportunities in a Changing Global Context,* indicates that India's economy is continuing to grow at a healthy rate despite global headwinds. India needs to expand its export basket and capitalize on GVCs that are synonymous with global production sharing to meet its objective of USD1 trillion in merchandise exports by 2030. (Open Knowledge Repository, 6 September 2024).

Over the past few decades, multinational corporations (MNCs) have expanded GVCs, which now account for more than two-thirds of global trade. The competitive business climate in the global economy has been changing rapidly due to internationalization, driven by the constantly growing GVCs. It has allowed new rivals to enter national marketplaces, creating a wealth of opportunities for businesses of all sizes, including large and small firms.

- **Overall participation in GVC:** India's GVC participation rate has grown over time but remains relatively low compared to other major economies. In 2022, India's GVC-related trade accounted for 40.3% of its total trade.

- **Exports:** India's exports of network products, like electronics and computers, remain limited compared to other countries. These products account for only 10% of India's overall exports of goods, compared to 50% for China, Japan, and Korea.

- **Forward linkages:** India's GVC participation is mainly focused on forward linkages, with the country primarily exporting raw materials and intermediate goods rather than engaging in final-stage value addition.

- **Key products:** India's key GVC-linked products include transportation equipment, chemicals, commercial services, coal, and petroleum.

- **Opportunities:** The reconfiguration of global supply chains in the wake of COVID-19 presents India with a strategic opportunity to increase its participation in GVCs. Fiscal and non-fiscal support: India can boost its GVC participation through fiscal and non-fiscal measures. Fiscal support may involve operational expenditure and capital expenditure (Capex) support, while non-fiscal support can include tariff simplification, streamlined taxation, skill development initiatives, and technology transfer programs.

MSMEs and the Indian Economy

MSMEs are essential to the Indian economy. According to the Ministry of Statistics and Program Implementation's most recent data, the gross value added of MSMEs as a percentage of India's GDP in 2019–20, 2020–21, and 2021–22 was 30.5%, 27.2%, and 29.2%, respectively. In the years 2019–20, 2020–21, and 2021–22, the manufacturing output of MSMEs accounted for 36.6%, 36.9%, and 36.2% of India's total manufacturing output, respectively. (Press Information Bureau 7 August 2023).

According to data from the Directorate General of Commercial Intelligence and Statistics, India's total export proportion of MSME-designated items was 49.4%, 45.0%, and 43.6% in 2020–21, 2021–22, and 2022–23, respectively (Press Information Bureau, 7 August 2023).

Significance of Integrating MSMEs in the Global Value Chain

The World Bank's World Development Report (WDR) 2020 highlights that GVCs may continue to increase growth and employment while reducing poverty, provided that industrial economies maintain their policies and developing countries undertake additional reforms (World Development Report 2020).

According to the Asian Development Bank Institute, it is estimated that the GVC will have an impact on the employment of all categories, including unskilled, skilled, male, and female workers. The association between GVC participation is presented in Table 1. The results show positive and statistically significant employment effects on both skilled and unskilled workers. The positive employment effects of GVCs are also observed for both male and female workers. However, the employment of GVC is higher for unskilled and female workers because the GVC impact drives more labor-intensive activities (ADB Institute Working Series Paper no 1469, July 2024)

TABLE 1

GVC PARTICIPATION AND EMPLOYMENT.

Variables	(1) Unskilled Workers	(2) Skilled Workers	(3) Male Workers	(4) Female Workers
GVC	0.494***	0.433***	0.273***	0.632***
	(0.006)	(0.005)	(0.008)	(0.009)
Size	0.537***	0.404***	0.444***	0.116***
	(0.0007)	(0.0006)	(0.0008)	(0.0009)
Age	0.006***	0.005***	0.013***	0.002***
	(9.86E–05)	(8.34E–05)	(0.0001)	(0.0001)
Capital intensity	–0.095***	–0.028***	–0.033***	–0.079***
	(0.0004)	(0.0004)	(0.0005)	(0.0006)
Constant	–5.324***	–5.625***	–5.324***	–0.346***
	(0.012)	(0.01)	(0.015)	(0.017)
Industry	Yes	Yes	Yes	Yes
Observations	438,949	438,949	438,949	438,949
R-squared	0.618	0.588	0.47	0.216
Number of years	10	10	10	10

Note: Standard errors in parentheses: ***p<0.01, ** p<0.05, *p<0.1.
Source: Sasidharan, S., Thangavelu, S., & Ramachandran, R. (July 2024). ADBI Working Paper No. 1469.

By joining GVCs, India's manufacturing sector could generate employment for four million by 2025, contributing to one-fourth of the country's USD5 trillion GDP in value-added terms, according to the Indian Economic Survey. A 1% increase in GVC involvement can lead to a more than 1% increase in per-capita income, according to cross-country studies, particularly when nations participate in both restricted and advanced manufacturing. Participating in GVC can significantly boost income in India, with studies indicating that a 1% increase in GVC participation can lead to a rise of more than 1% in per capita income, which is considerably higher than the increase achieved through traditional trade alone. This is primarily due to increased productivity, job creation, and access to advanced manufacturing within the global supply chain.

Participation in GVCs can lead to considerable increases in firm-level productivity. In comparison with non-GVC firms, Indian firms in GVC have a productivity premium of 13–22%, according to empirical evidence from the country's manufacturing sector. The productivity premium from GVC linkages is higher in the automotive, electronics, and IT sectors than in the textile and chemical sectors (Manghnani et al., 2021). According to recent research (Banga, 2022a), which examined the causal relationship between GVC involvement and TFP, manufacturing companies in India are more productive when they participate in GVCs and increase their GVC embeddedness. Additionally, it has been demonstrated that GVC associations increase employment, domestic value-added, and gross exports in India (Veeramani & Dhir, 2022). (Karishma Banga,17 September 2022)

After adjusting for firm-level capital intensity, the 2020 WDR indicates that manufacturing-related GVC companies exhibit higher labor productivity than one-way traders or non-traders. It has been observed that Indian firms participating in GVC generally exhibit higher labor productivity as compared to non-GVC firms, with evidence suggesting a significant productivity premium for companies involved in GVC linkages, particularly in sectors like automotive, electronics, and IT industries. This is primarily due to the ability to specialize in specific production stages, access better technology, and leverage economies of scale within the global market.

According to the paper *"Does GVC participation and position lead to innovation in an emerging economy?",* innovation is another component of competitiveness, and MSMEs can experiment with advanced technologies through pilot projects. Empirical findings from the report *Industry-level evidence from Indian manufacturing industries* published in the Journal of Business Research (Volume 186, January 2025, Article 114989) indicate that GVC status and involvement significantly enhance innovation performance, as reflected in the increased number of patent applications submitted.

In addition to promoting economic growth, integration into GVCs may prove to be a key tactic in the post-pandemic recovery, as they can contribute only a small part of a supply chain rather than a complete product. GVCs enable businesses to participate in global marketplaces with increased flexibility. By participating in GVCs, Indian firms can access international markets more flexibly, as they can specialize in producing specific components or parts of a larger product, rather than having to manufacture the entire finished good themselves. This allows them to leverage their comparative advantages and compete effectively on a global scale.

Factors Restricting GVC Integration of MSMEs in India

- Access to financing is essential for MSME integration into GVC; however, a concerning gap in India's MSME sector has been the lack of credit available to MSMEs. A lack of working capital often disrupts the day-to-day operations of MSMEs.

- Since 95% of India's MSMEs operate in the informal sector, formal financing access continues to be a significant barrier. Research indicates that less than 6% of bank credit is given to MSMEs overall.

- Banks could play the role of facilitator by helping arrange networking sessions with global companies.

Ninety-five percent of MSMEs in India are in the informal sector, and accessing formal finance remains a significant constraint. Research highlights that MSMEs receive less than 6% of bank

credit. MSMEs are reluctant to adopt digital solutions because they often lack the necessary knowledge and training.

Over one lakh applications, worth more than USD30 million, have been submitted by MSMEs on the MSME Samadhan delayed payment monitoring system.

Steps to Integrate Indian MSMEs into the GVC

- According to a recent PayPal poll on digital preparedness for MSMEs, 32% of these businesses reported improved payment solutions, and 29% reported an increase in online clients. GVCs can significantly benefit from the digital payment environment by expanding their online clientele and facilitating faster money transfers.

- Banks can play the role of facilitator by helping arrange networking sessions with global companies.

- To facilitate the digital transformation, MSMEs must receive training and raise awareness about the digitalization of business systems and their operational dynamics. Furthermore, there is an urgent need for a strong push towards further digitalization in the financial sector.

- To integrate MSMEs with the GVC, it becomes imperative to have reforms in labor markets, trade infrastructure, and to improve the overall business environment.

Importance of Skilled Human Resources in the GVC

Skilled human resources are crucial in GVCs for several reasons, including the complex and varied impact of skilled labor on GVCs, which depends on various factors such as sector, workers' skill level, and the company's position within the GVC.

- **Managing the GVC:** Skilled personnel are required in sectors such as logistics and transport to manage the GVC.

- **Complementary services:** Services like finance, telecommunications, and business services that support value chains also require skilled labor.

- **Higher-value added activities:** More skill-intensive tasks involving sourcing, design, branding, customer support, and R&D are crucial parts of the GVC.

- **Effective communication:** In an increasingly globalized GVC skilled workers are needed to communicate effectively with partner companies.

- **Organizational alignment:** Services like finance, telecommunications, and business services that underpin value chains also require skilled workers.

- **Industrial upgrading:** GVC participation can lead to industrial upgrading, which can result in increased labor productivity.

- **Skill premium:** The demand for talented labor is complemented by GVC, which can raise a nation's skill premium.

Key Challenges Faced by Indian Firms in Getting Skilled Manpower

A firm's access to skilled manpower can impact its performance, structure, and production costs. Skilled employees are more productive and efficient, which can lead to increased productivity and cost savings for the organization.

Indian enterprises in industries such as infrastructure, engineering, pharmaceuticals, electronics, automotive, chemicals, and food processing are facing significant challenges due to a severe shortage of trained workers.

A survey conducted by Ultimate Kronos Group, which surveyed over 300 businesses, found that 76% of companies reported that a shortage of skilled labor harmed their profitability in 2023, with 35% characterizing the effect as severe, and 5% claiming that it had no influence. Almost 19% stated that there was a minimal impact.

The results of the survey, shared exclusively with the Economic Times of India, show that:

- Due to a lack of qualified personnel, 28% of organizations experience production delays on front lines at least once every two weeks.
- Approximately 23% of the managers report seeing symptoms of employee burnout, such as fatigue, diminished effectiveness, and cynicism, at least once every two weeks, according to a poll of HR managers and leaders.
- A significant issue facing the manufacturing sector is high attrition, with an average attrition rate of 10–20% out of the 54% of businesses that were examined. At nearly 72% of the organizations polled, the lack of personnel is also causing other workers to work more overtime (43% moderate, 29% severe rise).
- In the year following the pandemic, when demand for products and services increased (49% moderate, 39% major), the lack of trained labor was highlighted more. Additionally, businesses were forced to expand their production capacity due to the increased demand (49% moderate, 36% major increase).
- Forty percent of Indian companies are addressing labor shortages by enhancing corporate culture and implementing succession planning, which prepares their current workforce for managerial positions.
- Nearly 39% offer apprenticeships, internships, and reskilling. Thirty-seven percent of organizations inquired are using technology to supplement or increase their staff, and are additionally cross-training existing personnel to fill gaps.
- Fifty-four percent of Indian enterprises strongly consider that people trained in a variety of tasks are more productive.

Companies have addressed the labor shortage in various ways, including collaborating with technical or community colleges (37%), hiring third-party contract workers (33%), proactively recruiting women (26%), and appointing mentors (25%).

Priorities of the manufacturers as expressed by them to bridge these issues over the next 12 months, and will include the following, among others:

- Employee wellbeing and safety (47%)
- Cybersecurity (41%)
- Digital transformation (40%)
- Sustainability initiatives (39%)
- Diversity, equity, and inclusion (39%)
- Strengthening supply chain (35%)
- Recruitment (32%),
- AI and Generative AI (35%)
- Disaster preparedness (27%)
- Retention (23%)

All the above interventions will lead to a reduction in dependency on the workforce, which will in turn address many of the issues cited in the previous section.

Due to this, some of the leading Indian ICT companies, including Infosys and Wipro, have developed their internal facilities to teach specialized skills required to meet the demands of their clients. These establishments utilize e-learning platforms to deliver content directly to their staff members' workplaces. It is believed that the industry's demand-driven engagement with educational institutions makes it easier for the latter to provide the talents that employers are looking for. This enhanced collaboration is becoming a productive and successful tool for talent advancement by ensuring a skills match. Even the global professional services company Deloitte has announced the launch of Deloitte Academics, a new suite of immersive learning experiences designed to upskill and support workforce development, with a focus on in-demand skill areas, including product innovation and AI. This project will provide learning opportunities for various worker groups, according to Deloitte.

ICT and Skill Development

Throughout the years, innovation has been at the center of economic growth, particularly in terms of competitiveness. The emergence and intensive utilization of ICT two decades ago made a significant impact and contributed to an increase in the digital economy's productivity. For example, in the informal sector, where unskilled labor constitutes a large bulk of the workforce, skill enhancement programs are impractical. Although nearly 90% of the workforce operates in the unorganized sector, their level of skills is not adequate for them to be absorbed into the formal sector. Unfortunately, this cost-ineffective approach exacerbates the existing labor market imbalance, creating skewed demand and supply conditions that are further complicated by constraints on all forms of skilled labor movement. Fortunately, ICT has advanced to the point where it can develop an infrastructure that would allow adequate training for the entire workforce.

ICT Scenario in India

ICT plays a crucial role in driving the knowledge-based global economy, which is essential for effective leadership. India, given its prominent standing in the IT and IT-enabled services sectors, is strategically positioned to develop and utilize its IT capabilities to advance this goal. Acknowledging the significance of ICT, India has made substantial investments in infrastructure and implemented forward-thinking policies to promote widespread adoption of technology. As a result, the Indian economy has experienced accelerated and more equitable growth, resulting in significant improvements in various development indicators.

The ICT field and Digital Economy generate more than 13% of India's GDP, making them essential components of the nation's economic health. The government plans to expand the ICT sector to reach USD1 trillion by 2025, which would represent 20% of the nation's projected GDP. The National Association of Software and Services Companies predicts an 8.4% annual growth rate, forecasting that India's technology sector will reach USD245 billion by 2023. Subsectors of the technology industry, particularly business process management, IT, and IT-enabled services, have witnessed double-digit growth in 2022. The US exported USD3 billion worth of computer and electronic equipment to India during 2022. Spending on IT in India is projected to grow by 11%, reaching over USD124.6 billion by 2024 (Refer to Table 1). India maintains a highly organized distribution network along with hosts and several well-established global ICT distributors.

TABLE 2

INDIA'S IT SPENDING FORECAST (IN USD MILLION).

	2022		2023		2024	
	Spending	Growth (%)	Spending	Growth (%)	Spending	Growth (%)
Software	13,115	15.1	14,931	13.8	17,689	18.5
Data center systems	3,607	18.6	3,766	4.4	4,121	9.4
Communications services	24,651	0.2	24,287	–1.5	25,148	3.5
IT services	21,837	13.3	23,262	6.5	26,651	14.6
Devices	49,853	2.0	46,309	–7.1	51,000	10.1
Overall IT	113,063	5.5	112,554	–0.5	124,609	10.7

Note: Total spending refers to capital expenditures (Capex), which includes both procurement and investment.
Source: Gartner Market Databook, 3Q23 Update (November 2023).

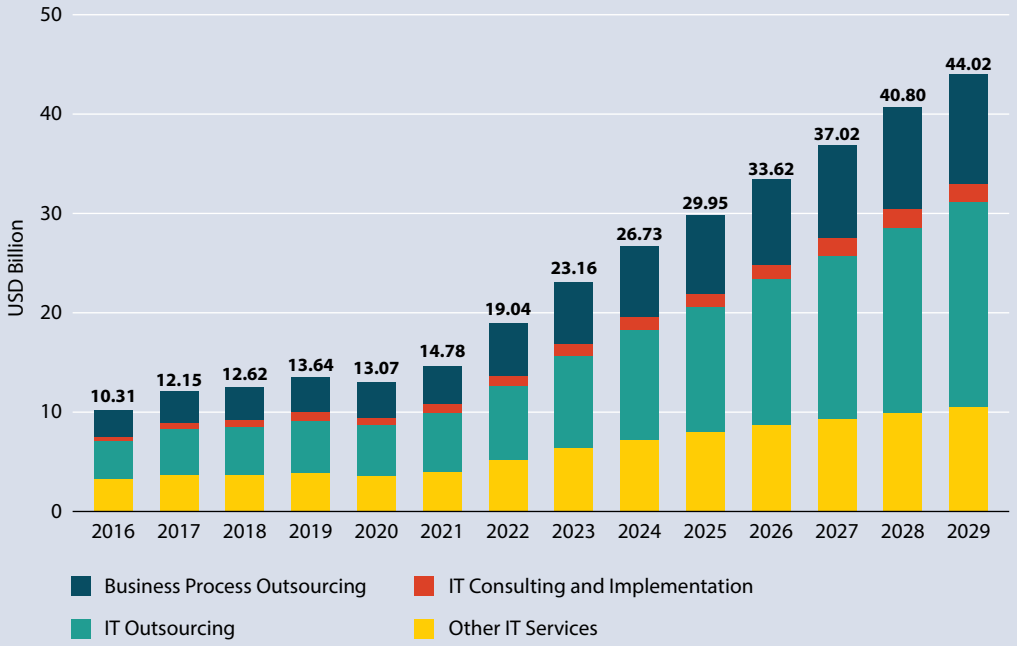
India seeks to transform itself into a knowledge-based global economy. India's economy achieved an 8% growth rate during the previous decade and became a USD139.08 billion industry in 2022, with 80% of its revenues generated from exports. By 2027, the Indian ICT Industry is projected to reach USD329.77 billion from its current size at a CAGR of 18.85%. ICT providers in India are expected to generate revenues of USD1,323.85 billion throughout the 2022–2027 period.

India is home to a thriving IT services market that has been experiencing significant growth in recent years.

Customer preferences: Customers in India are increasingly searching for creative, affordable, and customized IT services. The demand for services such as cloud computing, cybersecurity, and AI has increased accordingly.

FIGURE 1

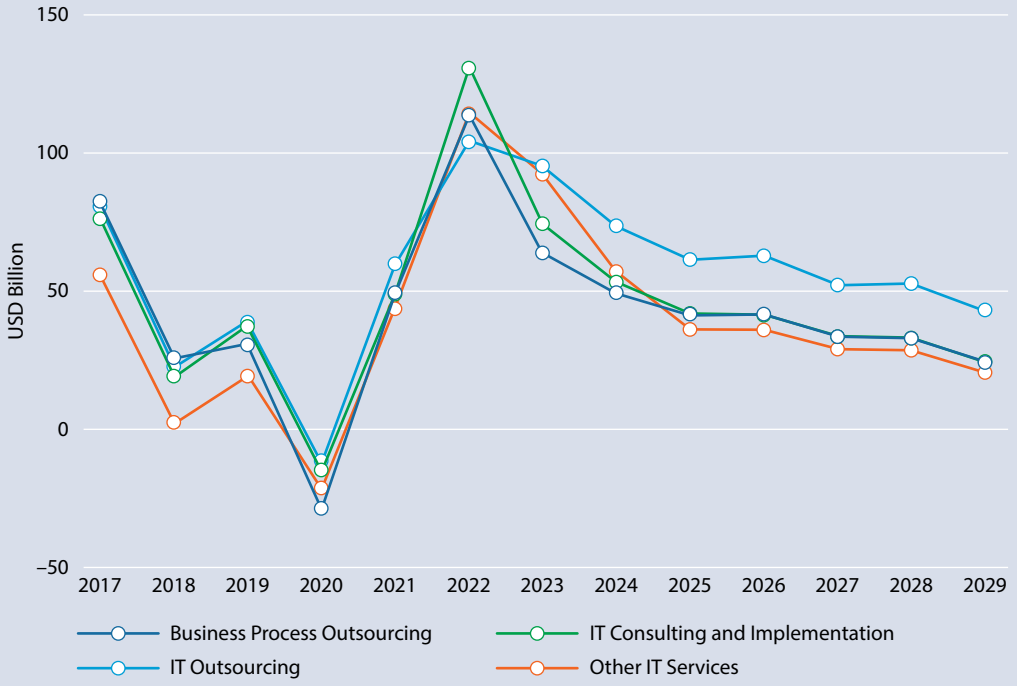
IT SERVICES REVENUE IN INDIA BY SEGMENT.



Source: IT Services – India, Statista Market Insights.

FIGURE 2

IT SERVICES REVENUE CHANGE IN INDIA BY SEGMENT.



Source: IT Services – India, Statista Market Insights.

India market trends: The trend toward digitization is one of the most significant developments in the Indian IT services. To remain competitive, businesses are increasingly adopting new technology, driven by the Indian government's push for a digital economy. The need for services including mobile app development, digital marketing, and e-commerce solutions has increased as a result. The growth of niche market players is another trend that has surfaced in recent years. Although the market is still dominated by giant IT services providers, smaller, more agile players are increasingly requesting specialized services. As a result, specialized service providers have emerged in fields such as blockchain, IoT, and machine learning (ML).

Local special circumstances: India's market for IT services is distinct in that the vast and expanding startup ecosystem in the nation has a significant impact on it. With more than 50,000 companies, India constitutes one of the global startup hotspots with the fastest rate of growth. Since many of these startups are concentrating on developing new technologies and disrupting traditional industries, there is an increasing need for IT services that can support their growth.

Underlying macroeconomic factors: India's market for IT services is directly related to the expansion of the nation's economy as a whole. With a GDP growth rate of 7%, India is among the main economies with the fastest rates of growth in the world. Companies in a variety of sectors, such as retail, healthcare, and finance, are now requesting more IT services as a result. As a result of companies all across the nation trying to stay competitive by implementing new technologies, the market for IT services in India is expanding significantly. The market will probably continue to change over the next several years due to the rising need for specialized, creative, and reasonably priced services.

Revenue trend: Indian IT Enabled services sector has persisted in its function as the economy's steady growth engine. Table 3 below illustrates the performance of this sector (including domestic and exports) over the previous 5 years:

TABLE 3

DOMESTIC AND EXPORT REVENUES IN INDIA (IN USD BILLION).

Description	2019–20	2020–21	2021–22	2022–23	2023–24 (Estimated)
Export	147	152	178	194	199.5
Domestic	44	45	49	51	54.4
Total Revenue	191	196	227	245	254
YoY Growth %	7.90%	2.09%	15.5%	7.9%	3.7%

Source: NASSCOM; Indian IT Industry How to profit from India AI Revolution Future of AI & Data by Fin2RESEARCH Investment Advisor (11 June 2024).

India is the second-largest telecom market in the world, with 1.2 billion fixed-line and cellular subscribers. India's mobile business has benefited from widespread acceptance, with 98% of phone usage being wireless. Deloitte estimates that by 2026, India will have 1 billion smartphones, up from the current 770 million. Furthermore, India is currently the world's second-largest producer of mobile phones. In India, there are also 856 million broadband users. India increased from 67 in 2021 to 61 in 2022 on the Portolans Institute's Network Readiness Index (NRI), scoring 51.19 out of 100 among 131 nations.

In December 2019, the GoI invested USD100 billion to establish the National Broadband Mission. USD35 billion will be allocated toward telecom towers, USD30 billion for optical fiber

infrastructure, and USD35 billion towards spectrum and R&D. To develop India's 5G telecom infrastructure, the Department of Telecommunications offered 51,236 MHz of 72,098 MHz spectrum spread across 10 bands for sale in July 2022. In October 2022, 5G services were launched in India to enhance high-speed Internet access, improve network infrastructure, and boost digital connectivity.

Policy and Regulatory Environment in India

The GoI has proposed new rules and industry promotion programs to address the outdated, challenging, and complex regulatory environment, aiming to improve the ICT sector. The Digital Personal Data Protection Act, which came into effect in August 2023, intends to protect the privacy and personal data of Indian citizens in the context of a globally interconnected digital economy. Compared to earlier versions, the Act adopts a permissive approach, permitting cross-border data exchanges.

In September of that year, the Indian Telecommunication Bill, 2022 draft was released by the country's Department of Telecommunications. This Act unifies and amends laws about the assignment of spectrum in addition to the development, growth, and operation of telecommunications services, networks, and infrastructure. It also addresses subjects related to or incidental to these laws. It gives the federal government the authority to establish guidelines for granting licenses, registering, authorizing, or assigning people, as well as managing their terms, conditions, and payments.

To facilitate the rapid expansion of the ICT industry, customs duties and taxes have also been simplified. The Equalization Levy, often known as the digital services tax, was implemented in India in March 2021. It is a digital tax equivalent to 2% of the amount of money that an e-commerce operator receives or is owed for the goods or services it provides. This method simplifies tax assessment and lessens the need for human engagement in tax procedures, particularly for digital firms. Given that online transactions can be evaluated digitally and align with the nature of the firm, this is especially pertinent. The levy took effect in April 2020, and in March 2024, India transitioned from the Equalization Levy to a new international tax framework, effective from the 2024 tax assessment period. The Act also expands the minimum taxation rules for income tax purposes by making the deduction of a loss carry forward unlimited for income under USD1 million, and 70% for income exceeding USD1 million. India joined 134 other nations in October 2021 in a two-pillar agreement designed by the Organization for Economic Cooperation and Development (OECD) to address tax issues arising from the global economy's digitization.

In December 2020, the government established the National Security Directive on Telecommunications Sector to protect against unsecured equipment in the nation's telecom network and to ensure supply chain security. The government announced a "Trusted Source/ Trusted Product" list for telecom service providers in response to this directive. In Indian telecom sector, "Trusted Source" or "Trusted Product" refers to a company or piece of telecommunications equipment that has been vetted and approved by the Indian government as posing no security threat to the nation, meaning telecom service providers can only procure equipment from these designated sources, which are typically evaluated based on their origin and security standards; this designation is primarily used to mitigate potential cyber security risks associated with certain foreign vendors. The National Security Council Secretariat

determines which companies and products are considered “Trusted Sources” through a process involving a dedicated “Trusted Telecom Cell”.

India unveiled a draft data center policy in November 2020 and aims to invest USD4.9 billion by 2025 to establish itself as a global hub for the data center sector. Although several U.S. cloud service providers already serve Indian businesses, the country’s top organizations have announced plans to build their data centers. To reduce expenses, Indian companies are rapidly digitizing their processes and leveraging cloud services. These initiatives led to digital transformation of businesses, massive adoption of cybersecurity initiatives, and growth in the e-commerce and fintech sectors.

Digital transformation: According to NASSCOM’s Annual CXO Outlook Survey 2023, digital transformation remains a top concern for Indian firms, with a particular focus on data analytics, cloud computing, AI, and cybersecurity. “Industry has set an ambitious goal to generate USD350 billion in revenue by 2026, with an 11–14% growth rate. The modernization of services and digitization are two major factors driving this increase. Banking, financial services, insurance, manufacturing, retail, consumer packaged goods, media, and entertainment industries are all adopting digital advances and modifying their business" models.

E-commerce: India’s e-commerce industry, one of the fastest growing in the world, is projected to increase from USD175 billion in 2022 to USD1 trillion by 2030, according to Bain & Company. The e-commerce market encompasses a variety of businesses, including “business-to-business, business-to-consumer, software as a service, online travel, online media, online food delivery, ed-tech, health-tech, online ride-hailing, and others”. India has been a popular destination for e-commerce due to its diverse population, large consumer base, supply chain ecosystem, and affordable digital infrastructure and services.

Cybersecurity: At 97.5 out of 100, India ranked tenth in the International Telecommunication Union’s 2020 Global Cyber Security Index. According to Gartner, India is expected to spend USD2.65 billion on risk management and security in 2023, an 8% increase from USD2.44 billion in 2022. The primary industry regions driving the growth of cybersecurity include banking, healthcare, insurance, capital markets, and critical information infrastructure, including energy, oil and gas, defense, transportation, and telecommunications.

Fintech and digital finance: Among the global financial technology markets, India has the fastest growth rate. Digital payments are the primary driver of this industry’s growth, followed by digital loans and other tech-enabled financial services. The Indian FinTech sector is expected to grow from USD50 billion in 2021 to USD150 billion by 2025, according to InvestIndia. The RBI reports that as of June 2023, the total value of digital payments was USD2.4 trillion, with a volume of 11.9 billion. Given its significance in the expansion of the Indian economy, the regulator has taken several actions that have contributed to the development of the Fintech ecosystem in India.

Productivity and ICT

There is a positive correlation between productivity and ICT adoption, which means that as businesses and individuals adopt more ICT tools, their labor productivity tends to increase. This is due to improved efficiency, streamlined processes, and better access to information, enabling employees to produce more output per unit of labor input.

Key points about the relationship between productivity and ICT adoption are:

- Increased efficiency
- Improved communication and collaboration
- Access to information
- Knowledge sharing

The necessity to foster productivity growth gave rise to the adoption of ICT policies like the National Policy on IT in India, which emphasizes IT-enabled strategies for addressing significant developmental obstacles in areas such as education, health, skill development, financial inclusion, job creation, governance, etc., which significantly increases economic efficiency overall.

ICT has facilitated communication among Indian industry employees, enabling them to stay in touch regardless of their location. ICT tools facilitate project tracking and personnel task management, avoiding bottlenecks that cause delays in deadlines. The effect of ICT on the productivity of Indian companies varies by company and sector. While the adoption of basic ICT is similar among businesses of different sizes, medium and micro Indian firms differ significantly in their adoption of more advanced ICT solutions and ICT abilities. Furthermore, ICT applications have varying effects on productivity among businesses of various sizes. While advanced software solutions and employees' ICT skills have a greater impact on productivity for medium and large enterprises, basic ICT applications can improve productivity for smaller firms.

Furthermore, the impact of ICT applications on firm-level productivity is significant for both the manufacturing and service sectors. Digitalization has had a significant positive impact on the productivity of firms, including those in the MSME sector. Some of the significant points are:

- According to a PayPal assessment of MSME digital readiness, 29% reported an increase in online customers and 32% experienced improved payment solutions. The ecosystem of digital payments presents MSMEs with enormous opportunities, facilitating faster money transfers and helping them expand their online customer base. It is undeniable that the adoption of digitalization by MSMEs requires greater assistance and leverage to offer creative financial solutions.

- To facilitate digital transformation, it becomes imperative to train MSMEs and increase their awareness about the digitalization of financial systems and their operational dynamics. Furthermore, there is a vital requirement for a significant effort towards further digitalization in the financial sector. By doing so, the MSMEs' reliance on unofficial funding sources would be reduced, and their operating expenses would be lowered as these sources tend to have higher lending rates.

- Banks could also assist MSMEs by organizing networking events with MNCs. It could be with regular market updates, enabling them to reduce risk. In this case, global banks can also assist by connecting customers worldwide.

- ICT adoption has a range of effects on a company's performance, including faster information and product processing, easier transitions in business practices, and better

internal management and organization that leads to increased productivity. In India, many people believe that ICT facilitates commercial operations and other procedures, which helps in raising productivity.

Thus, ICT affects economic growth and productivity through three channels:

- ICT application as an input in the production process
- Spillover effects of ICT
- Production of the domestic ICT sector

Manufacturing ICT domestically may lead to a decrease in the price of this technology as well as an increase in the productivity within the industry. Additionally, as productivity increases with more and better ICT per worker, a nation may indirectly benefit from ICT applications in the production process, as capital is enhanced. When the amount of ICT per effective unit of labor increases, the increase in human capital amplifies this effect. Lastly, due to externalities and spillover effects outside the ICT sector, primarily through reduced transportation and search costs, ICT can lead to an increase in TFP.

Even while ICT has spread significantly in some sectors (such as the rise in Internet usage, the proliferation of mobile phones, and initiatives to implement e-government in some circumstances), overall, its growth impact has remained positive.

Other key aspects of ICT spillover effects include knowledge transfer, improved supply chain efficiency, enhanced innovation, increased market access, and the development of human capital. All these contribute to enhancing productivity.

Keeping the above issues in consideration, it is felt that blockchain could transform the ICT field by reducing overhead expenditure for each transaction. It can also improve the speed of transaction completion time while adding a layer of security and trust.

Blockchain technology stands out as a source of efficiency and creativity in an era where digital transformation and ICT are driving the speed at which businesses operate. The importance of blockchain in contemporary businesses stems from its ability to provide decentralized, transparent, and secure solutions that revolutionize how businesses operate, communicate, and deliver value. Blockchain technology can enhance operational efficiency, reduce costs, foster trust, and boost profitability in various ways. Additionally, it offers a secure and decentralized solution to data security issues. Blockchain makes it harder to manipulate data by utilizing cryptographic methods to guarantee the integrity of transactions across several computers.

Integrating Blockchain Technology for Enhanced Productivity

Blockchain technology is rapidly transforming how businesses operate and creating new opportunities to enhance operational efficiency and productivity. It has the potential to simplify numerous corporate procedures by offering a decentralized ledger for securely and transparently documenting transactions. This technology has potential applications across various industries, including secure data transfer, smart contract enforcement, and supply chain management optimization.

The expenses related to middlemen and transaction conflicts are being significantly reduced in the workplace by implementing blockchain. Companies will be able to concentrate more on their primary development and innovation efforts due to the blockchain-based system's claim to decrease operating expenses and reconciliation time.

In the context of remote work, when preserving operational security and integrity is crucial, the incorporation of blockchain technology has proven very advantageous. Blockchain enables a safe and easy global information interchange by decentralizing the data management process. This ensures that teams have access to consistent and up-to-date information, regardless of their location. It is beneficial in settings where collaboration and real-time data are essential to sustaining productivity.

By promoting transparency, security, and traceability in several areas, including financial transactions, supply chain management, healthcare, and governance, blockchain could significantly accelerate India's growth.

Blockchain technology is gaining popularity in India, as it provides micro, small, and medium-sized businesses with enhanced transaction security, transparency, and efficiency. Because it provides a tamper-proof record of product history, enhancing traceability and reducing fraud, it is highly advantageous for supply chain management. Furthermore, blockchain can simplify financial transactions, lower intermediary costs, and boost digital transaction confidence. Automation tools and robotics are revolutionizing production lines and administrative tasks. By automating repetitive tasks, Indian MSMEs can significantly reduce labor costs, minimize human error, and increase output. In manufacturing and warehousing, robotics can handle complex tasks with high precision and speed, further boosting productivity and operational efficiency.

Blockchain technology has the potential to transform the Indian MSME ecosystem by enhancing access to finance, increasing transparency and traceability, improving security, and reducing fraud, while also facilitating access to global markets.

Here are some specific use cases that can help MSMEs in India benefit from blockchain technology.

1. **Supply chain management:** The efficiency and transparency of MSME operations may be increased by utilizing blockchain technology for tracking the origin and movement of commodities in their supply chain.

2. **Financial transactions:** By facilitating safe and transparent financial transactions, blockchain technology may reduce the risk of fraud and increase MSME access to financing. Blockchain technology utilizes distributed ledger technology to enable direct transactions without intermediaries, hence rectifying deficiencies of traditional payment systems. This technology facilitates transactions that can be finalized in seconds rather than days, thereby reducing costs and accelerating settlement times.

3. **Data management:** Blockchain technology can be utilized to provide secure, immutable data records, which can help MSMEs in sectors such as logistics, real estate, and healthcare.

4. **Identity management:** MSMEs that require the confirmation of their workers' or clients' identities may find blockchain technology beneficial in developing secure, decentralized identity verification systems.

The GoI has set an ambitious goal of enabling "Make in India" blockchain technology for global usage over the next five years, and it is actively developing national-level blockchain infrastructure in recognition of these revolutionary potentials. By 2026, a staggering 46% of Indians are expected to have adopted blockchain technology. The Indian blockchain market is expected to develop at a 47.3% Compound Annual Growth Rate (CAGR), up from USD0.28 billion in 2019 to USD4.3 billion by 2025, as per the white paper presented at Entrepreneur Web3 Summit in Bengaluru.

From providing unbanked access to financial services to transforming supply chain management with transparent records of all transactions, from digitally revolutionizing healthcare with secure patient record storage and sharing to promoting trust and accountability in governance, blockchain can have a significant impact on a progressive nation such as India.

Blockchain technology has the potential to transform the Indian MSME ecosystem by enhancing access to finance, increasing transparency and traceability, improving security, and reducing fraud, while also facilitating access to global markets.

Integrating AI for Enhanced Productivity

Another intervention of ICT is AI, which is making a positive contribution to productivity and has become one of the most rapidly developing technologies. It is now crucial to understand AI's role in enhancing productivity, as recent developments in machine learning (ML), deep learning, natural language processing, and computer vision have made it feasible to develop AI systems capable of tasks previously believed to be the sole purview of human intelligence.

Less experienced workers in a field or company can be more productive thanks to generative AI. AI can help create virtual settings where workers can hone their skills, receive immediate feedback, and track their progress over time. Organizations will be better equipped to navigate the complexities of the contemporary business environment as they utilize these tools. AI uses computers to analyze a person's learning preferences and style based on performance. By addressing their strengths and shortcomings, this data provides tailored activities, tests, and materials.

Additionally, there are other interesting examples. AI is employed for identifying fraud, assisting in legal and compliance analytics, and examining hard drives for anomalies.

It can read scans and identify issues in the medical field, recommending diagnoses and treatment plans based on test results and laboratory findings. By compiling insurance claims and summarizing medical records, it can lessen the amount of paperwork. Regardless of how effectively this is reflected in the productivity figures, the Indian economy would greatly benefit from lowering the cost of healthcare.

AI can be compared to previous major technological advancements to better understand its potential to drive future productivity gains. Due to its ease of use and adaptability across a wide range of applications, AI is likely to accelerate industrial advancements and contribute to a general increase in productivity in the years ahead.

Although AI and related technologies can lead to employment restructuring, they may also help train workers in new skills, particularly in the technology sector. By employing AI, government training programs have enhanced learning for young people and retained older personnel. Over time, AI will become more integrated into daily life.

The research estimates that AI could contribute USD957 billion, or 15% of India's GDP, by 2035. India's large population and abundant data resources would foster the development and application of AI. Given this, the GoI is investing extensively in AI skills and capabilities.

AI is employed in "smart mobility, transportation, agriculture, education, healthcare, smart cities, and infrastructure" in India.

AI can also help Indian MSMEs in many ways, including:

- **Automating processes:** AI can automate tasks, thereby improving efficiency.
- **Improving decision-making:** AI can analyze large amounts of data to generate predictions and recommendations that help MSMEs make more informed decisions.
- **Optimizing sales:** AI can help MSMEs optimize their sales strategies and anticipate consumer trends.
- **Forecasting market dynamics:** AI can help MSMEs forecast market dynamics.
- **Streamlining operations:** AI can help MSMEs streamline their operational processes.
- **Increased operational efficiency:** Businesses can enhance overall operational efficiency by leveraging predictive analytics technologies to forecast demand, optimize inventory management, and streamline supply chains.
- **Credit decision-making:** AI can help MSMEs enhance their loan approval rates by analyzing data such as payment behaviors, cash flows, and seasonal trends.
- **Marketing:** AI can be used as part of a marketing strategy.

Overall, AI can offer low-cost solutions to improve productivity by automating repetitive tasks like data entry, customer support through chatbots, inventory management, and payroll processing, allowing for MSMEs in India to focus on strategic growth areas while utilizing data analytics for better decision-making and market insights, all at a minimal cost as compared to traditional methods. This includes features like predictive maintenance in manufacturing, personalized marketing based on customer data, and optimized supply chain management.

World Bank Enterprise Survey

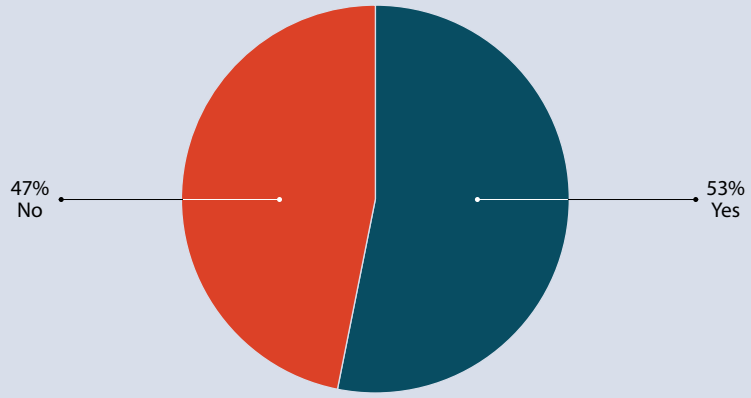
The World Bank conducted enterprise surveys in 2014 and 2022 for various sectors of the industry. Analyzing the data generated has resulted in the following:

Analyzing Figure 3 and Figure 4 shows that there is an increase of 7% in the number of organizations that have their own website, which is corroborates with the data shown earlier in Table 2 wherein it has been shown that in India, the IT Spending Forecast has increased by 5.5% which is USD113,063 million in financial terms.

Figure 5 shows that of the 18,657 enterprises surveyed, 39% had more than 50% of their sales from online transactions. This is due to the inroads that IT and IT-enabled services have made even within rural India. This figure also validates the data provided in the section 'Policy and Regulatory Environment in India' under E-commerce, where it was mentioned that India's e-commerce market

FIGURE 3

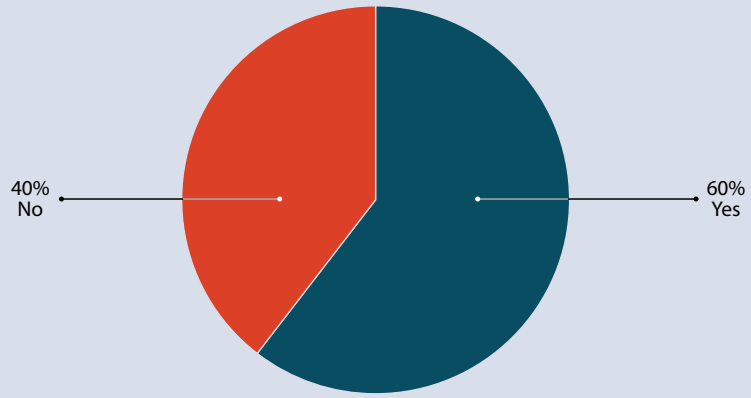
ESTABLISHMENT WITH WEBSITE AND SOCIAL MEDIA PRESENCE (2014).



Source: WBES Data (1984).

FIGURE 4

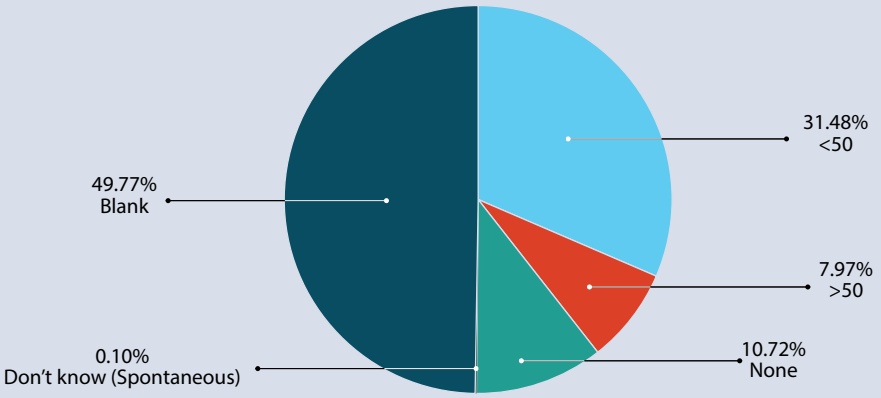
ESTABLISHMENT WITH WEBSITE AND SOCIAL MEDIA PRESENCE (2022).



Source: WBES Data (2022).

FIGURE 5

PERCENTAGE OF TOTAL SALES FROM ONLINE TRANSACTIONS (2022).

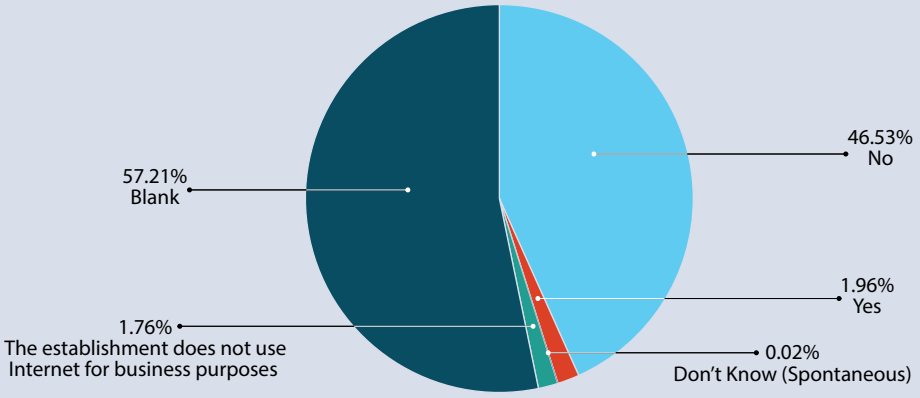


Source: WBES Data (2022).

is among the fastest-growing globally. This would also not have been possible had the expenses towards IT and IT-enabled services not been incurred. Furthermore, this was made possible by the Government of India's push to drive a digital economy.

FIGURE 6

INSUFFICIENT INTERNET CONNECTION FOR BUSINESS PURPOSES BY DURATION (IN %; 2022).



Source: WBES Data (2022).

Figure 6 shows that 46.5% of the enterprises surveyed did not experience an insufficient Internet connection for business purposes. This is a positive indicator, reflecting the investments made by both the government and the private sector in strengthening IT infrastructure. Table 1 highlights the increasing expenditure in this area.

In this context, an analysis of data related to the IT and IT-enabled services sector from the survey reveals the insight as presented in Table 4.

Sector: IT and IT-Enabled Services

TABLE 4

ANALYSIS OF IT AND ITES SERVICES IN INDIA.

Details	2014	2022	Remarks
Total number of organizations surveyed	248	204	It may be inferred that only those organizations that kept themselves abreast of technological development could survive the aftermath of COVID-19.
Number of permanent employees	41,188	13,677	With the decrease in the number of organizations, the number of employees has also come down. It can also be assumed that with the development of technology, many activities have become redundant, resulting in the elimination of jobs and the creation of opportunities in new areas.

(Continued on next page)

(Continued from the previous page)

Details	2014	2022	Remarks
Sales/employee in USD	3.548 million	7.14 million	Sales per employee have increased substantially in 2022 compared to 2014, which may be due to the increased use of IT and ITE services, where significant investment has been made and continues to be made.
Number of incidents of insufficient Internet connection in a typical month	210	160	With the improvement of IT infrastructure resulting from investments in this sector, this figure also shows a notable improvement.

Source: WBES Data (2014 & 2022).

Similarly in the manufacturing sector, the analysis of the data captured during the survey has been given below:

Sector: Manufacturing

TABLE 5

ANALYSIS OF THE MANUFACTURING SECTOR IN INDIA.

Details	2014	2022	Remarks
Total number of organizations surveyed	3,635	3,327	There has been a marginal decrease in the number of organizations, which may be due to the effect of COVID-19. Further, only those units that inducted new technology, IT, and IT-enabled services could survive the onslaught of COVID-19.
Number of permanent employees	1,62,145	2,68,174	In contrast to the IT and IT-enabled services sector, the manufacturing sector has seen a rise in employment, which might be the result of increased demand for its products to clear the backlog from the COVID-19 pandemic. Among the industries propelling the sector's expansion were chemicals, food items, coke, refined petroleum, and basic metals.
Sales in USD	23,68,269 million	26,39,781 million	Sales have increased substantially in 2022 compared to 2014, and the difference is USD27,1512 million, which may be due to the use of e-commerce.

Source: WBES Data (2014 & 2022).

Thus, it may be concluded that IT and IT-Enabled Services have played a crucial role in all sectors of industries towards revenue increase and making the industries more efficient and effective.

Policies to Promote Skill Upgradation

In the Indian ICT sector, skill development has become crucial for staying current with these new technologies. A cycle of high productivity, more job prospects, income growth, and development is facilitated by further skill development. A rise in the economy's real GDP, an increase in business profits, and a rise in worker wages are all examples of greater productivity.

India's 2009 National Skill Development Policy calls for integrating skill development into national development policies, such as infrastructure development, poverty alleviation, and the drive for decent work.

Over 5.43 million skilled workers were employed in the country's IT and IT-enabled services sector during the FY 2023–24. The market for IT and services enabled by it has been expanding globally, and India's IT exports have grown significantly, reaching USD199 billion in the FY 2023–24. Global competitiveness, the need to serve IT-savvy local and international markets, pressure to reduce costs and increase efficiency, and the requirement to offer client-centric services to a large number of consumers are some of the forces at play.

India is currently on the verge of development. One of the primary competitive advantages of the young Indian workforce (approximately 50% of the population is under 25) is its rapid adoption of new technologies. Based on this benefit, the increased application of ICT contributes to the steady expansion of the Indian economy. ICT has revolutionized businesses, developed new products and markets, and enhanced productivity and efficiency in other industries. It must be appropriately adopted for India to maintain its competitive edge in conventional sectors. ICT is vital in key sectors including defense, atomic energy, and space.

The government is also widely utilizing e-governance tools to enhance efficiency, accessibility, and transparency, in line with current trends. Social media is also being used to promote horizontal communication and peer-to-peer engagement, which will help build a more connected society.

The expansion of broadband infrastructure and the use of IT are strongly correlated. Many factors, like low-cost devices and inexpensive tariffs, have contributed to the widespread use of mobile telephones in India. Policy-driven convergence of business models and service capabilities, based on ICT, with rapidly changing telecom infrastructure, could support the expansion of citizen services and business models that will transform markets and governance.

India's Policy on Information and Communication Technology

As per the National Policy on IT, 2012, the GoI aims to achieve the following:

- Create an ecosystem for the Internet and mobile-driven service Industry
- Human Resource Development
- Development of language technologies
- Enabling service delivery through e-governance
- Enhancing productivity and competitiveness in key sectors through ICT
- GIS-based IT services
- Create an ecosystem for a globally competitive IT and IT-enabled services industry

- Promotion of innovation and R&D in the IT sector
- Security of cyberspace

India's AI for All policy, launched in 2018, aims to utilize AI to enhance social inclusion and economic growth, encompassing several key initiatives. These include:

- Investing in research and sectors that can maximize social impact and economic growth
- Creating high-quality datasets for research and innovation
- Building legislative frameworks for data protection and cybersecurity
- Developing AI capabilities that are indigenous to India

Policy Recommendations

Countries may differ in their specific policy priorities, but there are several key areas where meaningful policy reforms could be implemented. Governments must adopt a broad-based, inclusive growth strategy that integrates initiatives across five areas as outlined.

1. **Ensure macroeconomic stability and institutional efficiency:** Countries must maintain macroeconomic stability, promote real and financial openness, and significantly improve the allocative efficiency and functioning of markets and institutions. At the same time, governments must address the distributive impacts of market operations to ensure inclusive growth.

2. **Promote ICT development and digital governance:** To promote ICT production, increase competition, and dismantle monopolistic structures, the government must prioritize the development of electronic government. Policy incentives should encourage private sector participation and generate demand and supply in the ICT ecosystem.

3. **Strengthen physical and human capital:** Governments should strengthen their physical capital by prioritizing fundamental research, enhancing public R&D expenditure, and promoting science-industry information sharing to enhance physical and human capital. However, strengthening education and training, enhancing education-labor market relationships, and modifying labor market institutions to reflect rapid changes in labor demand could improve human capital quality and reliance.

4. **Remove barriers to competition and entrepreneurship:** Any barriers that hinder increased competition and market entry or exit need to be removed. This is primarily achieved by increasing access to high-risk funding, reducing administrative barriers, and fostering entrepreneurship. These initiatives could improve competition and market access to high-quality goods and services in these countries.

5. **Enhance GVC participation and integration:** GVC participation requires labor market reforms, trade infrastructure upgrades, and overall improvements to the business climate. Encouraging vertical GVC linkages between domestic MSMEs and larger enterprises can improve India's ICT trade position.

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LAO PDR

Summary

Lao PDR (Laos) is emerging as a player in the global supply chain, particularly through its key sectors—agriculture, textiles, and other industries. As GVCs evolve, adopting ICT is becoming increasingly vital for enhancing firm productivity and fostering skill development. This study explores how leveraging ICT can address Laos' challenges, including an underdeveloped digital infrastructure, a fragmented supply chain, connectivity barriers, skill gaps, and limited access to finance.

This study employs firm-level data from the 2018 WBES, which includes 298 firms, to examine the relationship between ICT adoption and productivity. Results highlight that owning a website increases a firm's sales efficiency by 40.4%, with a high statistical significance of 1%. This finding underscores the transformative impact of digital tools in improving market access, streamlining communication, and enabling e-commerce activities. Conversely, firms managed by women show a 20.1% reduction in sales efficiency, statistically significant at the 10% level, which may reflect systemic barriers or resource constraints faced by female managers in Laos.

Other factors, including firm size, legal status, access to finance, and export status, were not found to have statistically significant effects. The findings suggest that targeted interventions are essential, such as upgrading digital infrastructure, fostering digital literacy, and addressing gender-related challenges. By enhancing ICT systems, Laos can unlock its full potential for integration into global value chains, strengthening its economy and competitiveness.

Introduction

Current Position of Firms in the GVC

As outlined in the *Development Strategy of Five Selected Sectors in the Lao People's Democratic Republic (2020–25)*, the five key sectors identified for growth are agriculture and food processing, garment manufacturing, wood processing, handicrafts and artisan crafts, and IT (Ambashi, 2019).

The Lao agricultural and food processing sectors are central to the GVC, mainly focusing on crops like rice and coffee. Export markets include China, Thailand, and Vietnam, with growing interest in organic and high-value produce. In particular, the production of agricultural products with higher value-added has been a growing trend in several countries of the Association of Southeast Asian Nations (ASEAN).

This trend involves various activities, including production, processing, distribution, and delivery of the final products to consumers. The agricultural products supply chain is in its nascent stage of development. Subsistence can be used to describe a small-scale agricultural production. The domestic market is supplied with various products, including fruit, vegetables, meat, and aquatic products, which are sourced from production and agriculture. Furthermore, supply chains can potentially emerge across various provinces within a nation. For example, vegetables and fish are

transported from the Pakse district in Champasak province, located in the southern region, to the capital city of Vientiane in the central region.

Lao PDR's food value chain is not only linked to the domestic market but also to the regional market. For instance, in Champasak, agricultural producers export crops such as cassava and cabbage to Thailand. In the northern region, indigenous farmers sell agricultural commodities to Chinese buyers and investors, while also importing agricultural resources from China. These supply chains play a crucial role in generating income for local producers, especially regarding trade with China across borders (Onphanhdala, 2022).

In today's highly competitive markets, firms increasingly acknowledge the importance and benefits of consistently creating new products, particularly in the handicraft sector. Companies that launch superior and stylish products, aligned with seasonal trends, tend to experience greater financial gains than their rivals. However, Lao PDR's integration into GVCs is characterized by its focus on specific sectors like textiles, agriculture, and natural resources. Lao PDR's participation is mainly through the export of unprocessed materials and semi-processed goods, indicating a position in the lower segments of the value chain.

The Government of Lao PDR has implemented several measures to decrease the export of a variety of raw materials to guarantee a supply for the country's domestic production (KPL, 2021; Stirbat et al., 2015). However, access to the global market is not always easy. It is estimated that only 15% of the national road network is paved, 40% of the paved roads are in poor condition, and 40% of the roads not paved are inaccessible during the rainy season. Even roads already in existence are becoming more challenging to navigate due to the increasing frequency of extreme weather events such as heavy rainfall and flooding (World Bank, 2024).

The handicraft products of Lao PDR exhibit significant potential within local regions, and the increasing demand from both domestic and international markets will compel producers to enhance the quality of their goods. In terms of handicraft and artisan crafts, Lao PDR's home textiles have great potential to be positioned in Europe as a niche market for sourcing sustainable handmade home-textile products. To drive this, the Centre for the Promotion of Imports from developing countries (CBI) has launched the program "Hand-spun, naturally dyed cotton products with sustainable values", assisting Lao textile producers in accessing the European market.

In this specific sector of the textile industry, there is a diverse range of visually appealing ethnic woven patterns and naturally-colored dye options that may be of interest to European consumers (CBI, 2019). The textile industry relies on imported fiber, yarn, and fabric to manufacture finished textiles or garments, which are subsequently exported. The imported inputs constituted over 50% of the overall production expenses. This is due to the absence of domestic industries in the upstream sector.

Numerous factors hinder the progress of the apparel industry. The Foreign Value-Added share in gross exports had a proportion of over 15% from 1990–2005, but it declined to 12% from 2010–17 in terms of upstream GVC participation (AJC, 2021). Wood processing is another important industry. Lao PDR has a vast expanse of forest that contains a diverse array of hardwood and softwood, which can be harnessed to produce a wide variety of wood products.

The Prime Minister's Order No. 15 (13 May 2016) enhanced the governance and oversight of timber harvesting, timber transportation, and the timber sector. It banned the export of any partially processed or raw timber. The Ministry of Industry and Commerce (MOIC) has issued a revised agreement, No. 0002 (3 January 2018), concerning processed wood products. This agreement includes a list of timber products that can and cannot be exported. It also regulates exporting processed wood products that exceed the specified use and size.

The regulations are designed to create wooden products with high added value, while simultaneously conserving the raw wood materials found in forests. Last but not least, Laos has been progressing towards embracing Industry 4.0, also known as the fourth industrial revolution. This revolution is characterized by the convergence of technologies that blur the boundaries between the digital, biological, and physical realms. Some examples of these technologies encompass cutting-edge wireless technologies, robotics, 3D printing, AI, and the Internet of Things (IoT).

The country is continuously improving its approach to Industry 4.0 as part of its core strategy to promote economic growth, reduce poverty, and improve digital literacy among the general population (MTC, 2021; World Bank, 2021).

Importance and Necessity of Skill Upgrading

Technical and Vocational Education and Training (TVET) institutions collaborate closely with industries to develop curricula and training programs that meet sector standards. This collaborative endeavor promotes the cultivation of graduates with technical proficiency and a thorough comprehension of the practical challenges and standards that characterize the industries they plan to join. Furthermore, non-formal TVET is overseen by the Ministry of Education and Sports in TVET institutions and training facilities. In addition, more than 300 Community Learning Centers across the country offer vocational training. These programs provide basic vocational training in construction, culinary arts, cosmetology, poultry farming, aquaculture, mushroom cultivation, and timber processing (UNEVOC, 2024).

TVET programs significantly contribute to the overall economic development by fostering a skilled workforce, enhancing industry competitiveness, and promoting innovation. This is particularly essential for nations seeking to strengthen their industrial infrastructure and broaden their range of products. An industrial park known as the Vientiane Industry and Trade Area (VITA Park) has established an internal college for labor training to cultivate industrial skills. This initiative aims to supply high-quality human resources to the factories and businesses situated within the park.

In addition, the Lao National Chamber of Commerce and Industry (LNCCI) also arranges Dual-Cooperative Training (DCT). The TVET system has integrated DCT to enhance students' readiness for formal employment and entrepreneurship. The TVET portfolio has become more pertinent, resulting in students being better prepared to secure employment upon graduation due to the courses closely aligning with the actual labor market demands. Due to the increasing availability of DCT courses, more businesses are enthusiastic and ready to cooperate with TVET institutions.

DCT is publicly open, allowing local and foreign firms to join the program. The firms may use the following steps (LNCCI, 2024):

1. **Contact:** There are multiple ways to contact and join DCT, such as calling, texting, or calling the call center to seek more information and advice.

2. **Check:** Businesses can explore the DCT courses offered and determine whether the enrollment requirements are satisfied.

3. **Decide:** Sign a Memorandum of Understanding with a TVET institution.

4. **Select:** Assign a coordinator, in-company trainer(s), and select trainees.

5. **Prepare:** Establish a training program for the curriculum.

6. **Start:** Manage, oversee, and plan in-house training closely with the TVET institution.

Constraints on Firms' Skill Upgrading and ICT Potential

Access to Finance

One factor contributing to the comparatively slow expansion of small businesses in Laos is the challenge of acquiring working capital at reasonable interest rates. According to the Bank of the Lao PDR data, only 20% of SMEs could obtain bank loans in 2016. Short- and medium-term project financing typically entails exorbitant interest rates, and numerous SMEs lack the necessary assets to serve as collateral for bank loans.

To enhance the growth and innovation of the SMEs and support their success as a fundamental component of the economy, the MOIC has formally requested funding from the World Bank. The SME Access to Finance Project was approved by the World Bank in 2014. This project currently offers businesses throughout the country with funding sources that are available for medium- and long-term durations (World Bank, 2021).

Safety of Transactions

The successful digital transformation of Laos will require the development of a robust policy and regulatory framework, supported by the gradual digitization of government services. This includes establishing regulations to streamline digital transactions and safeguard users of online services, building a robust institutional framework that enables timely and efficient implementation of reforms, and, significantly, improving the digital skills of citizens, businesses, and government employees. Ensuring equitable access to high-quality digital skills will be essential for achieving inclusive and sustainable development, and is directly linked to higher GDP per capita (World Bank, 2021).

Access to the Global Market

Connectivity is crucial for Laos as it aims to achieve greater integration into both regional and global economies. The country has the potential to establish itself as a vital link between South-East Asia and other regions by enhancing its infrastructure, improving digital networks, and promoting better cross-border cooperation. Enhancing connectivity will facilitate the flow of goods and capital, stimulate cultural interactions, enhance the tourism industry, and generate prospects for innovation and growth. The interconnectivity is crucial in driving Laos' economic development, allowing the country to utilize its advantageous position and significantly contribute to the broader global economic environment.

- **Air transportation:** The Government of Lao PDR has been striving to improve its air transportation network to support economic growth, meet the increasing demand for air travel, and enhance regional connectivity. The airport has undergone expansion and

improvement initiatives. Notably, there is an increased number of non-stop flights to prominent cities like Shanghai, Singapore, Seoul, and other popular destinations;

- **Road transportation network:** Laos has been trying to improve its road and highway infrastructure to enhance domestic and international connectivity. This initiative encompasses infrastructure projects to improve road networks in rural and urban areas. Laos has been increasing and prioritizing efforts to improve road transportation to take advantage of its favorable geographical location and facilitate the shift from being a landlocked to a "land-linked" nation. Improving its domestic and regional connectivity is crucial for achieving this transformation.

  The Government of Lao PDR is working closely with neighboring countries and development partners to enhance regional cross-border and road transport. This collaboration aligns with the Greater Mekong Subregion Framework Agreements and the ASEAN. Investments in transport infrastructure development have consistently been ranked as the most important among investments in hard infrastructure. Around 35–50% of government spending is dedicated to the development and maintenance of transportation infrastructure (Nolintha, 2016).

- **Railway transportation:** Despite its landlocked status, Laos is strategically positioned to serve as a bridge between China and several significant Southeast Asian markets such as Thailand, Vietnam, and Cambodia. This aligns with the objectives of the Belt and Road Initiative (BRI) to enhance regional connectivity. The country perceives the BRI as a chance to improve its transportation infrastructure and streamline trade operations, particularly logistics.

  Laos aspires to enhance its logistics sector and establish itself as a pivotal transportation and commercial center in the region through its involvement in the BRI. The Lao-China Railway (LCR), also known as the Kunming-Vientiane Railway, is a significant project under the BRI in Laos. The railway serves as a crucial transportation link for the BRI and aims to facilitate trade and tourism. Furthermore, the country is actively implementing supplementary transportation initiatives, including expanding road networks and border crossings, to improve connectivity both domestically and with neighboring countries.

  These initiatives aim to enhance international trade, lower transportation expenses, and streamline the exchange of goods and services (Phuong, 2023). Table 1 illustrates the quantity and value of imports, exports, and goods transferred using the LCR transportation system. Launched in December 2021, the LCR, which connects Vientiane with Kunming, is seen as a game changer. It reduces transportation costs and transit time, increasing trade volumes between the two nations.

  Increased trade has diversified the availability of goods in local markets, providing consumers with a more comprehensive range of products at competitive prices. The quantity and value of imports and exports increased significantly from late 2021 to mid-2023. On the other hand, as a gateway from China to other countries, the value of goods started to increase after 2022.

TABLE 1

QUANTITY AND VALUE OF IMPORT AND EXPORT THROUGH THE LCR SYSTEM[1].

	Container			Value (USD million)		
	2021	2022	2023*	2021	2022	2023*
Export	130	48,300	14,792	1.5	1,012.01	459.80
Import	323	6,864	6,871	6.9	155.27	121.38
Transfer (PRC–Thailand)	2,266	8,961	650	195.58	253.73	68.74
Transfer (Thailand–PRC)	0	2,764	601	0	20.07	63.78
Total	2,719	66,889	22,914	204	1,441	713.70

Note: * January to May 2023
Source: Customs Department, Ministry of Finance.

- **Dry port:** Situated in the heart of Southeast Asia and devoid of direct access to the sea, Laos has strategically prioritized the establishment of dry ports to bolster its connectivity and trade networks. Dry ports, alternatively referred to as inland ports, serve as vital terminals located inland from conventional seaports. Their primary role is to facilitate the efficient transshipment of maritime cargo to various inland destinations, streamlining the flow of goods across the country's borders. It also contributes to the country's economic growth and development. Currently, Laos has three operational dry ports.

Background and Obstacles of ICT Adoption in Laos

Digital connectivity, defined as the ability to access affordable and reliable Internet services, has emerged as a critical engine for economic and social development in today's increasingly online world. Across the globe, economic activities and essential government services are progressively shifting to digital platforms, making robust Internet access indispensable. However, Laos faces significant challenges. Compared to similar regional economies, Laos lags considerably in Internet accessibility, quality, and affordability. This digital divide hampers its potential for growth and development. While there has been some progress, with mobile broadband access gradually increasing, rural and remote communities remain largely underserved.

The availability of fixed broadband, crucial for high-capacity data transmission, is particularly scarce in Laos. Even where such services exist, they come at a prohibitively high cost. The steep prices associated with Internet services are a significant barrier, leading to a lower mobile and broadband penetration rate than neighboring countries. One of the key issues contributing to this problem is the minimum retail tariff regime for mobile, voice, and data services. This regulatory framework may inadvertently stifle competition among service providers, preventing them from offering consumers more affordable and diverse service options. As a result, the quality of service and affordability of the Internet remain ongoing concerns, slowing down the widespread adoption and use of digital services and applications vital for development.

The Internet speeds available to most users in Laos are suboptimal. While the average 2G/3G connection is relatively slow, even the 4G speeds, though within regional averages, are offered by only one operator in the country, making Laos the only nation in the region with such a limited 4G service market.

[1] Year 2023 (January to May 2023)

Consumer surveys indicate widespread dissatisfaction with Internet services, citing slow speeds and unreliable connections as key issues contributing to a perception of poor value for money.

Although there have been improvements in regulatory capacity and expertise, these advancements are still insufficient to support significant market growth or attract substantial investment. Without stronger regulatory frameworks and incentives, Laos's digital landscape will likely remain underdeveloped, limiting the country's ability to compete on a regional scale. The country stands at a critical juncture with the opportunity to harness digital connectivity to enhance economic growth, competitiveness, and the provision of services. However, to capitalize on this opportunity, strategic interventions are necessary (World Bank, 2019).

Although approximately 80% of the population is now within the coverage area of the fastest available mobile broadband networks (4G/LTE), the coverage does not necessarily translate to access. The actual 4G/LTE broadband subscription in Laos is considerably lower than in other countries in the region. While the quality of mobile broadband is improving, it varies significantly across the country. According to Ookla Speed test crowdsourced data from February 2022, mobile broadband performance in Laos is somewhat slower than in Thailand and Vietnam, faster than in Cambodia, Indonesia, and the Philippines, and comparable to Malaysia. However, the affordability of mobile broadband remains a challenge for many, with the lowest entry-level monthly mobile data package priced above the ITU-UNESCO affordability threshold of 2% of income per capita.

Fixed broadband penetration in Laos remains low, with only 8.8% of households having access to it. Crowdsourced data indicates a local median throughput of 30 Mbps. This penetration level is significantly behind that of countries like Vietnam, Thailand, Malaysia, the Philippines, and Indonesia, and only slightly ahead of Cambodia. This low penetration particularly affects larger institutional users such as banks, larger businesses, schools, and government offices. Substantial investments in fixed broadband infrastructure are urgently needed. Rolling out a mass-market fiber optic network will require significant coordination and effort, supported by a strong regulatory framework to promote infrastructure sharing and ensure cost-based, nondiscriminatory access.

The quality of fixed broadband service in Laos is relatively low, while affordability is another major concern. Entry-level fixed broadband packages cost around KIP 140,000 (USD12.26), higher than comparable packages in Vietnam and Thailand, even though the speeds are slower. In Laos, entry-level broadband tariffs are more expensive than in Vietnam and Thailand but lower than in Malaysia, Indonesia, and the Philippines. However, the entry-level throughput is low, with Lao Telecom and ETL offering just 3 Mbps. Only Unitel Company provides 30 Mbps at the same tariff, following an upgrade to their fiber to the home speeds in September 2021. Higher throughputs, in the commonly desirable range of 10-100 Mbps, are very expensive in Laos and are likely out of reach for most of the population (World Bank, 2021).

The digital economy in Laos is estimated to be around 3% of the GDP, and it is anticipated to grow to about 10% by 2040. Approximately 51.1% of the country's population has Internet access. Similarly, about 98.3% of the population has access to mobile devices while only 8.8% of households have fixed broadband. Figure 1 shows an increasing trend in the percentage of mobile phone users with Internet access, rising from 21% in 2015 to 51% in 2019. This growth is the result of several interrelated factors. Major efforts to develop a mobile radio network infrastructure,

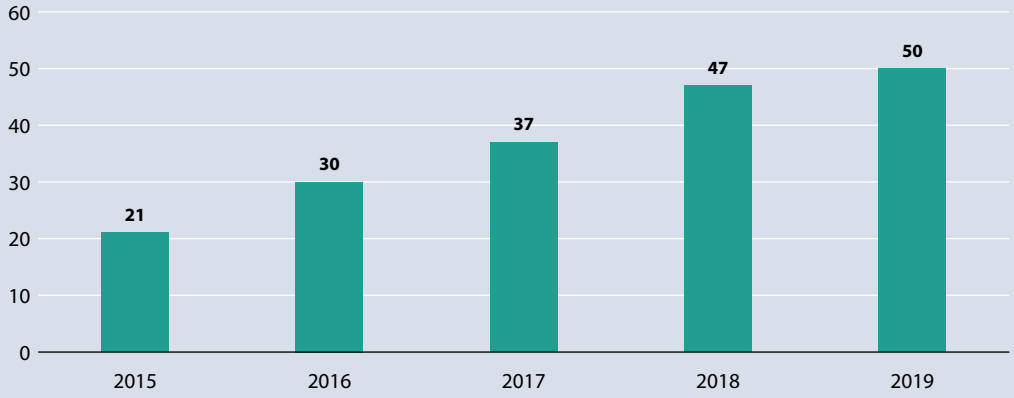
particularly towards 3G, 4G, and 5G expansion, have increased mobile access even in regions with little fixed broadband availability.

The proliferation of handheld devices has also made it easier for people from the lower economic segment to possess gadgets that can connect to the Internet. Furthermore, the rising use of mobile-based services such as social media, mobile banking, e-commerce, and various digital government services has contributed to the growing demand for mobile Internet services. At the same time, government policies to encourage digital inclusion, combined with the low-cost data plans offered by mobile operators, have further increased Internet accessibility.

Most businesses (more than 92%) in Laos are classified as micro-businesses, and their level of digitalization is relatively low. Laos is ranked 131 out of 182 countries in the ITU Cybersecurity Index 2020, while the UN E-government Development Index (2020) places Laos at 167 out of 193 economies, compared to Cambodia at 124, and Vietnam at 86 (LSB, 2024; World Bank, 2021).

FIGURE 1

PERCENTAGE OF MOBILE PHONE USERS WITH INTERNET ACCESS IN LAOS.



Source: Lao Statistics Bureau (LSB, 2024).

Electronic Payment

In recent years, the use of banking services in Laos has grown, driven by government initiatives and efforts from financial institutions (FIs) to improve financial inclusion. According to the World Bank, the percentage of Lao citizens with bank accounts rose from 26.77% in 2011 to over 37.32% in 2021. However, this remains below the 2021 global average of 66.76% across 121 countries (Globaleconomy, 2021).

The electronic banking sector in Laos is still in its early stages, but the government and FIs have been actively promoting and expanding its use. Several Lao commercial banks now offer e-banking services, including online banking, mobile banking, and ATM services, allowing customers to manage their accounts and perform transactions remotely without visiting a physical branch.

To further encourage the adoption of e-banking and other e-payment methods, the Bank of Lao PDR issued a directive to develop secure and reliable e-payment systems. The Lao National Payment Network Co. Ltd (LAPNet), a joint venture between the Bank of Lao PDR and

seven major banks, was recently launched in 2019. This collaboration aims to create a more efficient payment system by integrating e-payment across the country's banking network (Vietlaotrade, 2019).

Under LAPNet, customers of various banks in Laos can now transfer funds using a mobile application. This integrated e-payment system facilitates mobile transfers across multiple banks, allowing customers to use their smartphones for money transfers anytime, anywhere, and through any payment channel. Sixteen institutions in Laos have connected their ATM networks, enabling seamless cash withdrawals and balance inquiries. Among the 10 institutions that now support ATM-based cash transfers and participate in this integrated money transfer initiative are Banque Pour Le Commerce Exterieur Lao Public, Lao Development Bank, Agriculture Promotion Bank, Lao-Viet Joint Venture Bank, Joint Development Bank (JDB), ST Bank, BIC Bank (Lao), Public Bank (Vientiane), Maruhan Japan Bank Lao, and Kasikornthai Bank (Vientiane) (JC Lao, 2023).

The number of credit card users is very low, accounting for only 1% of the population in 2021, far below the global average of 21.26% (Globaleconomy, 2023). The lack of a credit reporting system in Laos makes it difficult for FIs to evaluate the creditworthiness of potential debtors, which may contribute to the country's low credit card penetration. In addition, many individuals in Laos still prefer to conduct transactions with cash, and there is a general lack of awareness regarding the advantages of credit cards.

Data Analysis and Interpretation

Due to the limited data available for the Laos case study, this study relies on the 2018 WBES. Drawing on data from 332 firms in the country, the WBES provides a robust set of variables to evaluate firms' ICT use and performance. However, despite the broad range of indicators described in the "Enterprise Surveys Indicator Description", many specific data points are unavailable for Laos. This limitation underscores the challenge of conducting a comprehensive analysis and necessitates careful interpretation of the available data.

The rise of mobile banking holds the potential to significantly enhance firms' access to finance. Mobile banking expands the reach of financial services by enabling individuals, including those in financially disadvantaged or rural areas, to open bank accounts. This broader access to finance can help firms in developing countries secure the capital they need, ultimately boosting their productivity.

E-payment methods provide firms with a secure way to conduct transactions, reducing the risk of theft. This added security positively influences firms' production and sales, increasing overall productivity. Moreover, email and the Internet allow firms to efficiently search for essential inputs and technological solutions, further optimizing their production processes.

Table 2 illustrates the correlation between female management, number of employees, power interruptions, female ownership, companies that engage in exporting, and firms that face financial difficulties, with the ownership of a website. It indicates that larger enterprises, particularly those with over 100 employees, are more likely (75%) to have a website like many of their counterparts with more staff. Also, more businesses engaged in export activities have a website (54.5%). On the contrary, very few small enterprises (1-5 employees) have websites.

TABLE 2

CROSS-TABULATION INFORMATION BETWEEN OWNING A WEBSITE AND OTHER CHARACTERISTICS.

		Establishment With a Website			
		Percentage	Yes	No	Total
Female manager	Yes	Count	31	78	109
		% within section	28.40	71.60	100.00
	No	Count	63	160	223
		% within section	28.30	71.70	100.00
Employees	1–5 employees	Count	9	42	51
		% within section	17.60	82.40	100.00
	6–50 employees	Count	63	183	246
		% within section	25.60	74.40	100.00
	51–99 employees	Count	7	8	15
		% within section	46.70	53.30	100.00
	More than 100 employees	Count	15	5	20
		% within section	75.00	25.00	100.00
Power outage	Yes	Count	80	172	252
		% within section	31.70	68.30	100.00
	No	Count	14	66	80
		% within section	17.50	82.50	100.00
Female ownership	Do not know	Count	1	1	2
		% within section	50.00	50.00	100.00
	Yes	Count	25	73	98
		% within section	25.50	74.50	100.00
	No	Count	68	164	232
		% within section	29.30	70.70	100.00
Export	Yes	Count	18	15	33
		% within section	54.50	45.50	100.00
	No	Count	76	223	299
		% within section	25.40	74.60	100.00
Access to finance	No obstacle	Count	52	99	151
		% within section	34.40	65.60	100.00
	Minor obstacle	Count	16	39	55
		% within section	29.10	70.90	100.00
	Moderate obstacle	Count	9	41	50
		% within section	18.00	82.00	100.00
	Major obstacle	Count	11	40	51
		% within section	21.60	78.40	100.00
	Very severe obstacle	Count	6	19	25
		% within section	24.00	76.00	100.00

Source: Based on the calculation by the national expert using the 2018 WBES data.

TABLE 3

FACTORS AFFECTING A FIRM'S PRODUCTIVITY.

	(1) lnsale	(2) Lnsale	(3) lnsale	(4) lnsale	(5) Lnsale	(6) lnsale
Owning web	0.410***	0.405***	0.405***	0.397***	0.406***	0.404***
	–0.093	–0.092	–0.093	–0.093	–0.094	–0.094
Female		–0.197*	–0.197*	–0.196*	–0.193*	–0.201*
		–0.089	–0.09	–0.09	–0.09	–0.09
Acc finance			0.00313	0.00222	0.0028	–0.00164
			–0.025	–0.025	–0.025	–0.025
Legal status				0.0534	0.0558	0.0551
				–0.052	–0.052	–0.052
Direct export					–0.00133	–0.00139
					–0.002	–0.002
New product						–0.0684
						–0.044
Constant	8.060***	8.125***	8.121***	7.962***	7.958***	8.087***
	–0.05	–0.057	–0.064	–0.168	–0.168	–0.187
N	298	298	298	298	298	298
R–sq	0.062	0.077	0.077	0.08	0.081	0.089
Robust SE	No	No	No	No	No	No

Note: Standard Error in parentheses. * p<0.05; ** p<0.01; *** p<0.001.
Source: Based on the calculation by the national expert using the 2018 WBES data.

$$\text{Log}\left(\frac{Sales}{\#\ of\ employees}+1_i\right)=\beta_0+\beta_1\ Owning\ Web_i+\beta_2 Female_i+\beta_3 Acc\ Finance_i\ +\beta_4 Legal\ status_i\ +\beta_5 Direct\ export_i+\beta_6 New\ product_i+\varepsilon_i \quad (1)$$

The results presented in Table 3 summarize the findings of a Linear Regression Model examining the relationship between firm productivity (measured as the sales-to-labor ratio) and a set of independent variables. These include owning a website, female management, access to finances, firm legal status, direct export, and a new product (used as a proxy for innovation). The dataset is derived from the 2018 WBES for Laos, which initially consisted of 332 observations. However, 34 cases lacked information on labor force size, reducing the sample size to 298 firms for this analysis.

Key findings from the regression analysis reveal the following:

1. **Owing a website:** Firms with a website exhibit a significant increase in productivity, with sales efficiency improving by 40.4%. This effect is statistically significant at the 1% level and indicates a strong positive relationship. The result highlights the importance of digital presence in driving operational efficiency, likely by enhancing market access, streamlining communication with customers, and facilitating online transactions.

2. **Female management:** Interestingly, firms managed by women show a 20.1% decrease in sales efficiency, with statistical significance at the 10% level. While this finding suggests a negative association, it may reflect systemic barriers female managers face in Laos. These include gender biases, limited access to resources, or differences in managerial networks. It also emphasizes the need for further investigation into how gender dynamics influence firm performance in this context.

3. **Other variables:** Variables such as access to finance, firm's legal status, direct export status, innovation, and the number of employees did not show a statistically significant effect on productivity. This lack of significance suggests that while these factors may be relevant in a broader context, their direct impact on sales efficiency in Laos-based firms is less pronounced in this dataset.

The findings underline the critical role of ICT, specifically website ownership, in boosting firm productivity in Laos. They support the argument for policy interventions to promote digital adoption, such as reducing barriers to Internet access, providing digital literacy training, and incentivizing firms to establish an online presence. Conversely, the observed negative impact of female management warrants further exploration to address gender-related challenges and ensure equitable opportunities for female business leaders.

Policy Discussion

Capacity Building Initiatives

The Government of Lao PDR should provide financial assistance and training grants to companies implementing employee training programs. This effort should be carried out in collaboration with universities and vocational schools to design tailor-made programs with practical internships and apprenticeships.

The government should also establish technology hubs and innovation centers to advance cutting-edge technologies and facilitate knowledge adoption through international collaboration. Additionally, it should develop or support e-learning platforms that offer a variety of online courses using flexible study methods. To ensure the quality of training, national and international standardized certification schemes should be created, and training providers should be regularly assessed. Incentives such as training investment tax credits and reduced tax rates should be offered to firms that demonstrate significant improvements in employee skill levels and productivity.

Finally, awareness campaigns should be launched to highlight the advantages of skill upgrading for firms and workers, showcasing success stories from industries that have effectively developed their workforce.

ICT Infrastructure

A holistic approach is essential for a digitally empowered society to thrive. This should begin with implementing national digital literacy campaigns for all age groups, integrating ICT into school syllabi, and training teachers to effectively use digital tools in education. Promoting business innovation by providing grants and tax incentives for ICT startups and establishing incubation and acceleration centers to nurture innovative ideas is also essential.

Additionally, infrastructure should be centered on providing high-speed Internet to urban and rural regions while simultaneously providing free or cheap public Wi-Fi in strategic places to ensure

connectivity for everyone. Moreover, substantial funds should be set aside for ICT Research and Development (R&D) by forming partnerships between government agencies and higher learning institutions to enhance cutting-edge research activities and develop future industry leaders.

The country should also strengthen the legal framework by establishing and enforcing cybersecurity legislation to safeguard information integrity and promote e-governance initiatives to facilitate efficiency improvement in processes while increasing transparency within institutions that serve the public.

To address issues related to power outages, the government may consider implementing a comprehensive energy management strategy. This would involve upgrading and maintaining aging electrical infrastructure, investing in smart grids for better monitoring and response, diversifying energy sources by incorporating renewable energy such as solar, wind, and hydroelectric power, and establishing emergency response plans and backup power systems to ensure the continuity of critical services.

Promoting Research and Development

The Government of the Lao PDR could adopt several policy measures to promote R&D activities among companies. These include tax incentives such as R&D tax credits, accelerated depreciation for R&D-related capital expenses, and funding support through grants, subsidies, and public-private partnerships.

Enhancing intellectual property protection and streamlining bureaucratic processes is essential to create a supportive regulatory environment. Infrastructure development should include the development of science or technology parks and providing access to high-speed Internet to support digital R&D activities. Building capacity through investments in Sciences, Technology, Engineering, and Mathematics (STEM) education, vocational training, and incentives to attract and retain talent is also critical. Promoting awareness of R&D through campaigns and seminars, as well as showcasing success stories, can encourage more firms to invest in innovation.

Lastly, participating in international research consortia while establishing bilateral agreements for joint R&D initiatives will enable companies in Laos to go global. These policies, together, can foster a strong R&D ecosystem that will drive innovations and support the economic growth of the Lao PDR.

Promoting Online Marketing Through Websites

To incentivize local companies, the government can adopt a win-win approach that includes providing website development grants and tax holidays, as well as organizing seminars to train businesses in website and digital management skills. Moreover, forming public-private partnerships with companies that build websites at lower cost would help make digital adoption more affordable for small firms. It is also crucial to integrate digital literacy into the education system in Laos to ensure a future-ready workforce. Furthermore, the government should address this issue by establishing a clear legal definition of digital business in the long run.

Enhancing Female Management

The government should implement targeted initiatives to address the unique challenges women face in leadership roles while fostering an enabling environment for their professional growth. Key measures include establishing capacity-building programs focusing on leadership, strategic

decision-making, and financial management tailored to the local context. Additionally, the government could provide subsidies or grants to firms that offer mentorship and training opportunities for female managers, thereby promoting a culture of inclusivity.

Conclusion

The findings of this study indicate that the Government of Lao PDR has made significant efforts to provide the labor force with the necessary skills to enhance firms' productivity. TVET institutions work closely with industries to develop curricula and training programs that meet sector-specific standards. This collaboration promotes the development of graduates with technical proficiency and a strong understanding of the practical challenges and standards of the industries they plan to join.

Several factors can support economic upgrades, including access to finance, secure transactions, and access to the global market. Notably, interconnectivity is crucial in driving the country's economic development, enabling Laos to leverage its strategic geographic position and contribute significantly to the broader global economic environment.

To fully capitalize on these opportunities, the government must focus on air transportation, railway transportation, road connectivity, and dry port infrastructure. Among the key productivity drivers, developing a website has emerged as the most important means of enhancing the sales-per-labor ratio. Based on the research outcomes, the study has provided policy recommendations for capacity-building initiatives, ICT infrastructure development, R&D promotion, and online marketing advancement through website creation.

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MALAYSIA

Summary

This study examines the relationship between economic upgrading strategies, including skills development and ICT utilization, and productivity growth in Malaysia. National policy frameworks, such as the Twelfth Malaysia Plan (12MP) and the New Industrial Master Plan 2030 (NIMP 2030), highlight the importance of skills upgrading to address structural challenges at both the aggregate and firm levels. Similarly, ICT-focused strategies, including the National Broadband Initiative (NBI, 2010) and the Financial Sector Blueprint (2022–26), underscore the expanding role of ICT in driving national productivity.

The empirical analysis offers insights into the role of firm size in shaping productivity outcomes, with a particular focus on MSMEs. The TFP analysis reveals that medium and large firms tend to be more capital-intensive, while small firms remain labor-dependent, reflecting broader economic trends. The study also identifies a positive association between ICT utilization, especially online payment systems, and productivity growth in both small and large firms.

However, challenges such as unreliable electricity supply hinder the effective use of ICT, particularly for smaller firms. In response, recent policy initiatives, including the 12MP and the Malaysia Digital Economy Blueprint (2021–30), prioritize skill development, ICT infrastructure, and targeted sectoral support. These initiatives are designed to foster economic upgrading and enhance productivity by strengthening digital capabilities and addressing infrastructure constraints.

Overall, the study highlights the critical role of well-targeted policies in supporting productivity across different firm sizes and sectors in Malaysia.

Introduction

Since gaining independence in 1957, Malaysia has implemented a series of strategic initiatives to strengthen its macroeconomic foundation and achieve key social objectives. In the early stages, particularly during the pre-New Economic Policy (NEP) period of 1957–70, the focus was on diversification strategies designed to reduce reliance on resource-based activities such as rubber and tin mining, the mainstays of national growth since the pre-independence era. The government spearheaded these diversification efforts by introducing new agricultural crops, including palm oil, pepper, and pineapple. At the same time, rice cultivation was intensified to enhance self-sufficiency, while petroleum, mining, and timber production were elevated as part of a broader economic growth strategy.

Building on these early diversification efforts, Malaysia subsequently introduced the NEP (1971–90), followed by successive long-term development frameworks, including the National Development Policy (NDP, 1991-2000), the National Vision Policy (2001–10), and the New Economic Model (2011–20). While these policies varied in their approaches to economic growth and social progress, they consistently emphasized productivity improvement as a primary objective (Lee, 2021). For example, while the NEP primarily focused on poverty alleviation and addressing ethnic disparities in economic participation, it also sought to enhance productivity by developing a

modern agriculture sector and expanding essential social services and infrastructure, including education, healthcare, water supply, and electricity.

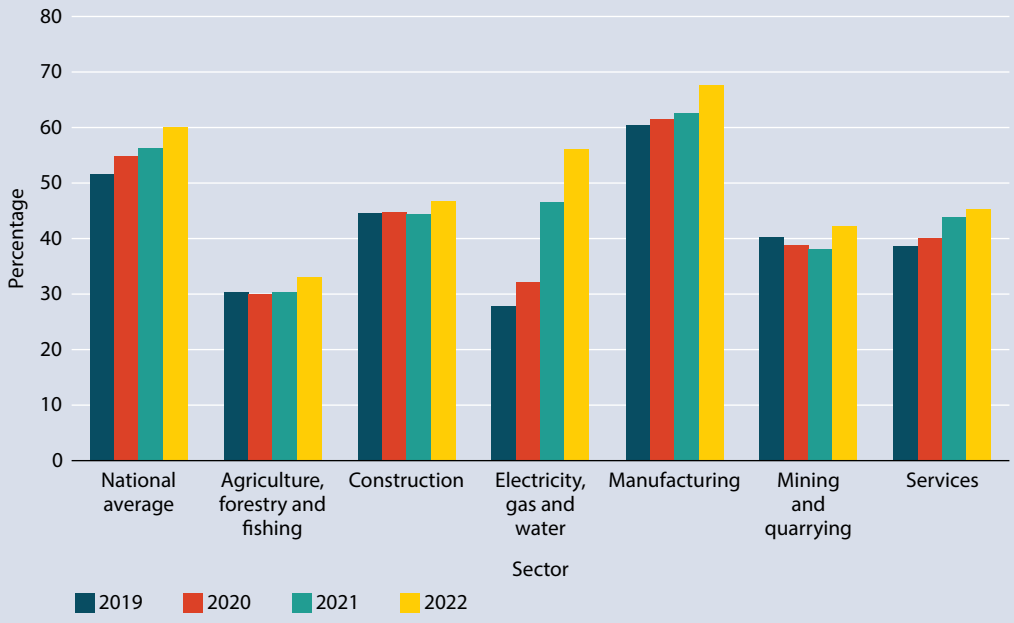
During the NDP period, Malaysia shifted its growth strategy from an input-driven model to a productivity-driven approach aimed at generating higher TFP and larger output (World Bank, 2021). This strategic transition reflects the country's long-term commitment to impactful upgrading and transformation, moving from an agriculture-based economy to an industrialized and, eventually, service-oriented economy. Beyond diversification, entrepreneurship, technology, investment, finance, and institutional development have been identified as significant contributors to this comprehensive transformation journey.

Current Position of Firms in the GVC

A key outcome of Malaysia's economic transformation has been its successful integration into the GVC. Over the years, Malaysia's position in the GVC has strengthened considerably, with the share of GVC-related trade rising from 51.5% of gross trade in 2019 to 60.0% in 2022 (Figure 1). Despite the global disruption caused by the COVID-19 pandemic, Malaysia demonstrated resilience and emerged with a more robust trade performance. This improvement was primarily driven by the manufacturing sector, where GVC-related trade exceeded the national average, rising from 60.4% in 2019 to 67.5% in 2022.

FIGURE 1

PERCENTAGE OF GVC-RELATED TRADE.

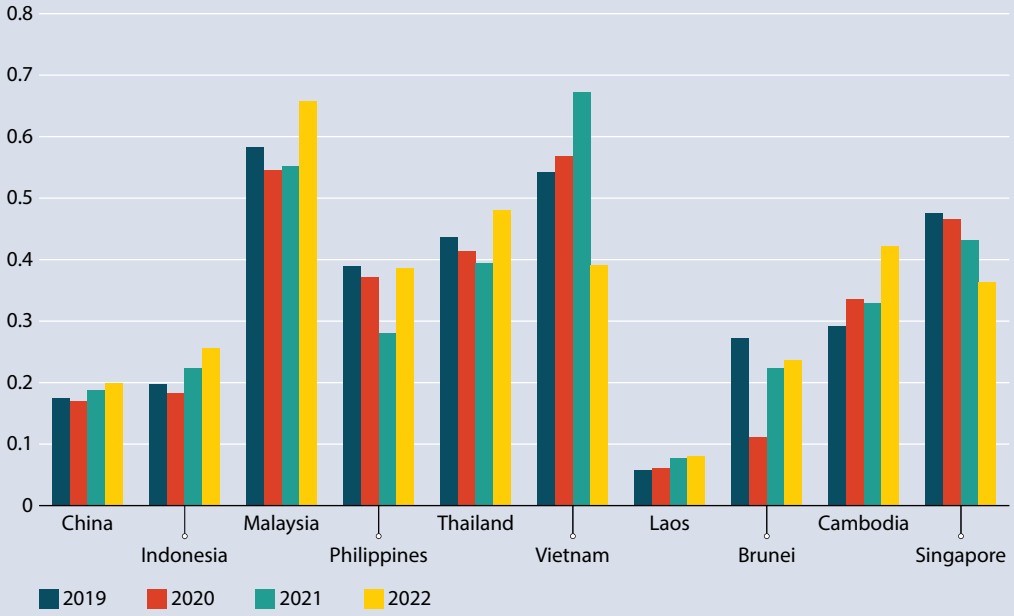


Source: World Bank (n.d.).

The performance of the manufacturing sector is closely linked to the E&E industry. Malaysia's GVC participation in the E&E sector is notably high, as evidenced by its impressive score on the GVC Participation Index (ADB, 2023). Figure 2 illustrates Malaysia's competitive standing relative to other Southeast Asian economies, underscoring the country's robust integration and influence within the GVC for E&E products.

FIGURE 2

GVC PARTICIPATION INDEX FOR THE ELECTRICAL SECTOR.



Source: ADB (2023).

The E&E sector in Malaysia comprises several specialized categories, as outlined in Table 1.

TABLE 1

CATEGORIES OF MALAYSIA'S E&E SECTOR.

	Category
1	IC and system design and development
2	Semiconductor front-end and wafer fabrication
3	Assembly, test, packaging, and outsource assembly and test services
4	Electronic manufacturing services
5	Photovoltaic and renewable energy
6	Equipment automation and mechanization
7	Electronic healthcare and medical devices
8	Industry 4.0 and system integrators
9	Transportation electronic systems
10	LEDs, optics, and photonics
11	Memory storage systems
12	Electronic connectors, cables, and interconnects
13	Communication systems (RF, 5G, microwaves, and wireless)
14	Office automation and printers
15	Other E&E support and services

Source: Electrical and Electronics Marketplace Malaysia (n.d.).

Malaysia's GVC participation rate[1], comprising both backward and forward linkages, has averaged around 65% and remained stable from 1990 to 2019 (ASEAN-Japan Centre, 2021). The country's GVC engagement is characterized mainly by backward linkages, where the foreign value added (FVA) in exports exceeds the domestic value added in exports (DVX). This reflects Malaysia's specialization in the middle stages of GVC, such as final assembly or production stages, which typically generate lower value-added output.

To address this challenge, the Government of Malaysia is actively pursuing strategies to ascend the value chain. One such effort involves strengthening collaboration with ASEAN member economies to enhance participation in higher value-added activities within the GVC (Ministry of Investment, Trade and Industry, 2023). Malaysia seeks to leverage the collective strengths and resources through its regional partnerships, enhance complementarities, and promote regional cooperation to capture greater value within the GVC.

To fully capitalize on these opportunities, Malaysia must first upgrade its capabilities and strengths across higher-value segments within the GVC. Priority sectors include semiconductors (IC design and wafer fabrication), advanced materials (such as graphene and rare earth production), and clean energy technologies (like EV batteries and renewable energy solutions).

Current initiatives also focus on increasing the participation of MSMEs in the GVC. This is critical to building a more robust supporting industry ecosystem, which could stimulate the growth of new sectors and further strengthen Malaysia's GVC participation. Additionally, improving MSME participation is essential for boosting their contribution to economic growth, as these enterprises face challenges due to weak production interlinkages, which limit their impact on growth despite representing over 95% of all business establishments in Malaysia.

Importance and Necessity of Skill Upgrading

Skill upgrading is the central theme in Malaysia's current development agenda. Its importance is emphasized in key national policy documents such as the 12MP and the NIMP 2030 (Ministry of Investment, Trade and Industry, 2023; Ministry of Economy, 2021a). The emphasis is well justified by the challenges identified at both macroeconomic and sectoral levels, which continue to hinder economic transformation and inclusive growth.

Twelfth Malaysia Plan

At the macro level, the 12MP highlights several areas where skill deficiencies are recognized as critical barriers to progress.

1. **Slow structural economic transition:** As Malaysia transitions beyond the pandemic, the need to move up the value chain and diversify its sources of growth becomes increasingly urgent. This includes developing new and complex products within the services and manufacturing sectors to remain competitive in the global market. However, many industries in Malaysia continue to operate in the lower segment of the production value chain due to their labor-intensive nature and dependence on economic activities with low technological content. Workforce skill limitations are frequently cited as a key deterrent

[1] A country can participate in GVCs through either backward participation, measured by the share of FVA in its exports, or forward participation, captured by the share of domestic value-added incorporated in other countries' exports, also referred to as indirect value-added exports, or DVX in gross exports (ASEAN-Japan Centre, 2021).

to investment in the manufacturing and services sectors, highlighting the need for significant improvements in human capital development.

2. **Weak performance in key sectors:** Although Malaysia holds a strong position in the GVC, particularly in the E&E sector, its continued growth and global competitiveness are constrained by the shortage of skilled talent. Specific gaps exist in top-end design engineering and research roles, which are critical for supporting innovation and meeting evolving industry needs. Additionally, the sector's reliance on low-skilled foreign workers has discouraged investment in innovation, automation, and new technologies, stifling the demand for high-skilled workers. This reliance poses a significant barrier to the sector's ability to advance the value chain and sustain its competitive edge.

3. **Low productivity among MSMEs:** The productivity levels of MSMEs in Malaysia remain low despite various policy interventions. During the Eleventh Malaysia Plan, MSMEs were found to be three times less productive than large firms, largely due to their high dependence on low-skilled workers, limited technology adoption, and the restricted diffusion of technological innovation. Given that MSMEs account for the vast majority of business establishments, targeted skill upgrading is essential for closing the productivity gap and strengthening their contribution to economic growth.

New Industrial Master Plan 2030

At the sectoral level, the NIMP 2030 outlines the need for targeted skill upgrading in the manufacturing and manufacturing-related services sectors. The plan is focused on industrial development and workforce readiness.

1. **Prolonged use of low-skilled foreign workers:** Malaysia initially gained an early mover advantage by liberalizing foreign direct investment (FDI) in 1971, attracting export-oriented, labor-intensive manufacturing, aided by its relatively low labor costs. However, the subsequent opening of the PRC to global FDI flows introduced stiff competition. In response, Malaysia extended its reliance on low-skilled foreign workers to remain competitive rather than transitioning to more technology-intensive activities. This strategy has ultimately delayed the modernization of its manufacturing sector.

2. **Skills mismatch and talent shortage:** Skill-related underemployment in Malaysia has risen by 6.9% annually since 2017, with over one-third of employed individuals with tertiary education engaged in semi- and low-skilled occupations (Ministry of Investment, Trade and Industry, 2023). This mismatch stems from several factors, including firms' limited capacity to generate skilled positions due to the misalignment between the education system and labor market demands (Kana, 2024; Abdul Wahab, 2024). Additionally, the migration of local talent to overseas labor markets, such as Singapore, in search of higher wages, exacerbates the situation. Addressing this challenge requires skill upgrading to align the workforce with high-skilled job opportunities and foster a more responsive labor market.

3. **Low female labor force participation:** Despite high rates of female enrollment in education, labor force participation among women in Malaysia remains low. This disparity can be attributed to various factors, including family responsibilities and workplace inequalities. Additionally, the concentration of women in certain occupations and sectors

leads to a significant misallocation of human capital resources, particularly in the manufacturing industry. This further limit the potential contributions of women to the broader economy.

Constraints on Firms' Skill Upgrading and ICT Potential

MSMEs constitute 96.9% of all business establishments in Malaysia, totaling 1,101,725 firms as of 2023 (Department of Statistics Malaysia, 2024a). Given their overwhelming presence in the economy, MSMEs' constraints are particularly relevant when discussing skill upgrading and adopting ICT. This section synthesizes insights from policy documents and available studies to explore these constraints within the Malaysian context.

Access to Finance

Despite the long-standing availability of microcredit schemes in Malaysia, access to finance remains a significant challenge for MSMEs. Initially introduced in the late 1980s and 1990s as a poverty eradication measure, microcredit programs, such as those provided by Amanah Ikhtiar Malaysia (AIM) and the Economic Fund for National Entrepreneurs Group (TEKUN), have evolved. AIM focuses primarily on poverty alleviation, while TEKUN extends microcredit to individuals below and above the poverty line. However, these initiatives have not fully addressed the financing challenges MSMEs face, arising from supply- and demand-side constraints (Ramlee & Berma, 2013).

1. **Supply-side constraints:** FIs often consider MSMEs as high-risk borrowers due to limited collateral, insufficient credit history, and perceived volatility in their operations. These perceptions lead to stringent lending requirements, making it difficult for MSMEs to access financing.

2. **Demand-side factors:** Many MSMEs lack the financial literacy and business acumen to navigate financial products and sustain operations effectively. This often leads to difficulties in loan repayment, reinforcing the perception of MSMEs as high-risk borrowers.

3. **Limitations of existing microcredit schemes:** While microcredit programs are intended to bridge the financing gap, they often face challenges, including limited outreach, high interest rates, and a lack of tailored financial products to address the diverse needs of MSMEs.

Safety of Transactions

The adoption of e-payment systems has become an essential part of the business ecosystem in Malaysia, especially following the shift in customer payment behavior after the pandemic (PayNet, 2022). The Central Bank of Malaysia regulates these systems under the Financial Services Act 2013 and the Islamic Financial Services Act 2013 (Central Bank of Malaysia, 2022). Despite the strong regulatory framework, MSMEs continue to express concerns about the safety of online transactions. Fears of fraud, data breaches, and other cyber threats contribute to hesitancy in adopting digital payment tools. This reluctance can, in turn, limit the opportunities for MSMEs to upgrade their digital skills and fully capitalize on the efficiencies and competitive advantages offered by ICT.

Access to the Global Market

Malaysia is part of 13 free trade agreements (FTAs) at both bilateral and multilateral levels. Still, many local firms, including MSMEs, face significant hurdles in expanding their domestic and

international market reach (Ministry of Economy, 2021a). The utilization rates of these FTAs remain below expectations, partly due to a lack of awareness and understanding among firms.

1. **Uncompetitive nature:** Low adoption of advanced technologies, lack of skilled talent, and limited management expertise diminish the global competitiveness of many MSMEs. These challenges and heavy reliance on unskilled labor exacerbate the productivity gap between MSMEs and larger firms.

2. **Market penetration barriers:** MSMEs often lack the resources and knowledge to navigate international market entry requirements, including regulatory compliance and standards. These limitations restrict their global outreach and market diversification.

3. **Challenges for Small and Medium Professional Practices (SMPPs):** SMPPs encounter additional difficulties securing large international projects due to capacity, capability, and project experience constraints. Furthermore, the current investment and procurement policies of government-linked companies often favor larger, more experienced firms, limiting opportunities for SMPPs at both the global and domestic levels.

Access to Skilled Human Capital

Access to skilled human capital remains a critical challenge for Malaysia's economic advancement. The continued reliance on low-skilled labor, particularly in agriculture, manufacturing, and construction, has depressed wages and limited the country's progression up the value chain (Ministry of Economy, 2021a). This dependence reduces the demand for high-skilled jobs and hinders economic growth.

Moreover, there is a significant mismatch between the supply and demand for skilled labor. While the number of graduates in Malaysia has increased steadily, by 5.1% from 2021 to 2022, the predominance of MSMEs places a considerable pressure on a few large enterprises to create high-skilled positions (Department of Statistics Malaysia, 2023a). This imbalance contributes to brain drain, as educated individuals seek better opportunities abroad, thereby depleting the local talent pool. This further exacerbates the challenge of accessing skilled workers locally.

Background Statistics of ICT

This section analyzes data drawn from key resources, including the NBI, ICT-related reports at both the establishment and household levels, the Financial Sector Blueprint (2022–26), and the 12MP (MCMC, n.d.; Department of Statistics Malaysia, 2022, 2023b, 2024b; Central Bank of Malaysia, 2022; Ministry of Economy, 2021a). The objective is to provide a comprehensive overview of Malaysia's ICT infrastructure, usage patterns, and prevailing challenges.

Infrastructure of Broadband Internet

The NBI, launched in 2010, represents a strategic nationwide effort to enhance Malaysia's broadband infrastructure and increase Internet accessibility (MCMC, n.d.). This initiative was introduced to bridge the digital divide, foster economic growth, and support the country's transition to a knowledge-based economy.

From an infrastructure perspective, the NBI prioritizes the development and expansion of broadband networks. Significant efforts have been made to deploy high-speed fiber optic networks, establish

community broadband centers, and offer wireless broadband services. Since its inception, the NBI has significantly improved Malaysia's broadband landscape, reflected in increased penetration rates across various sectors. Table 2 presents the percentage of Internet access by type and sector from 2015 to 2021.

TABLE 2

PERCENTAGE OF INTERNET ACCESS BY TYPE AND SECTOR (2015–21).

Sector	Year	Fixed Broadband#	Mobile Broadband*	Both
Agriculture	2021	93.1	70.1	63.1
	2019	92.6	60.9	53.3
	2017	75.1	36.0	–
	2015	78.4	28.0	–
Mining and Quarrying	2021	97.5	46.6	44.1
	2019	87.1	39.5	36.0
	2017	78.8	36.6	–
	2015	79.4	30.5	–
Manufacturing	2021	92.0	74.9	66.9
	2019	85.1	66.3	58.6
	2017	76.1	55.7	–
	2015	72.6	54.4	–
Construction	2021	99.7	73.8	73.5
	2019	87.2	73.3	63.4
	2017	80.0	48.0	–
	2015	70.1	36.3	–
Services	2021	91.8	75.7	67.5
	2019	83.1	71.1	60.3
	2017	81.0	34.7	–
	2015	75.2	25.8	–
Total	2021	92.7	75.4	68.0
	2019	83.7	70.8	60.3
	2017	80.5	37.0	–
	2015	74.8	28.5	–

Note: # Fixed broadband refers to technologies with a speed of at least 256 kbit/s in one or both directions, including wired fixed broadband and fixed wireless broadband; * Mobile broadband includes technologies with a minimum speed of 256 kbit/s in one or both directions, including 3G/LTE/4G, UMTS, CDMA2000, and future technologies.
Source: Department of Statistics Malaysia (2023b).

Household Usage of Internet and Mobile Phone

The benefits of the NBI extend to households and individuals, resulting in increased connectivity and more affordable services. Tables 3 and 4 illustrate the percentage of households with Internet access and mobile phones by strata and the percentage of individuals using the Internet by type of portable device and strata from 2021 to 2023.

TABLE 3

PERCENTAGE OF HOUSEHOLDS WITH INTERNET ACCESS AND MOBILE PHONE BY STRATA (2021–23).

Year	Strata								
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
A. Mobile Phone									
	Mobile Phone			**Feature Phone**			**Smart Phone**		
2023	99.3	99.6	98.4	16.3	13.6	25.5	97.6	98.6	94.1
2021	99.6	99.6	99.2	15.2	13.1	24.5	96.6	97.7	91.8
B. Internet Access									
	Internet			**Mobile Broadband**			**Fixed Broadband**		
2023	96.4	98.4	89.8	95.3	97.4	88.5	47.1	54.0	24.2
2021	95.5	96.9	89.2	94.0	95.3	88.1	41.2	46.5	18.1

Note: Strata (1) refers to the total population; (2) Urban areas; (3) Rural areas.
Source: Department of Statistics Malaysia (2022, 2024b).

TABLE 4

INDIVIDUALS USING INTERNET BY TYPE OF PORTABLE DEVICES AND STRATA (2021–23) (IN %).

Year	Mobile Phone			Tablet			Portable Computer			Other Portable Devices		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
2023	99.0	99.0	98.8	26.5	29.2	18.1	38.7	42.7	26.0	13.5	15.6	6.8
2021	99.7	99.7	99.6	30.9	33.2	22.5	45.1	49.6	28.5	18.0	19.9	11.1

Note: Strata (1) refers to the total population; (2) Urban areas; (3) Rural areas.
Source: Department of Statistics Malaysia (2022, 2024b).

Electronic Payment Systems

Since 2019, e-payment systems have increasingly become the preferred method for financial transactions in Malaysia, with E-money showing the most significant growth. Credit and debit card usage has also risen steadily, particularly for online transactions. Despite these trends, credit and debit card usage still lag behind the widespread adoption of E-money. The shift towards e-payments has led to a decline in traditional payment methods, such as cheques. These changes are supported by findings from PayNet's study in 2022, which highlights significant shifts in customer payment behavior, particularly after the pandemic.

Overall, these developments reflect the ongoing transformation of Malaysia's payment landscape, driven mainly by the Financial Sector Blueprint (Central Bank of Malaysia, 2022). Figure 3 illustrates the payment trends by instrument.

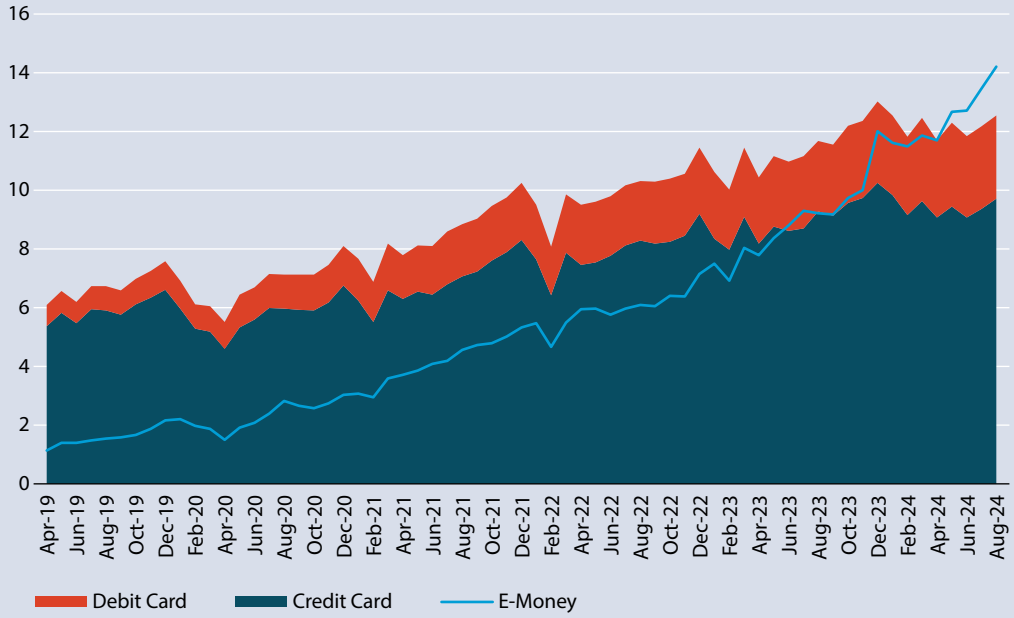
Obstacles to ICT-Driven Growth

Despite considerable progress in broadband Internet infrastructure and increased Internet utilization among businesses and households, several key obstacles persist. The 12MP identifies two critical challenges: the digital divide and policy discrepancies (Ministry of Economy, 2021a).

1. **Digital divide:** The digital divide in Malaysia has exacerbated economic inequality, widening the gap between affluent and disadvantaged populations. Accessibility remains a major issue, particularly in rural areas, where difficult terrains hamper efforts to expand

FIGURE 3A

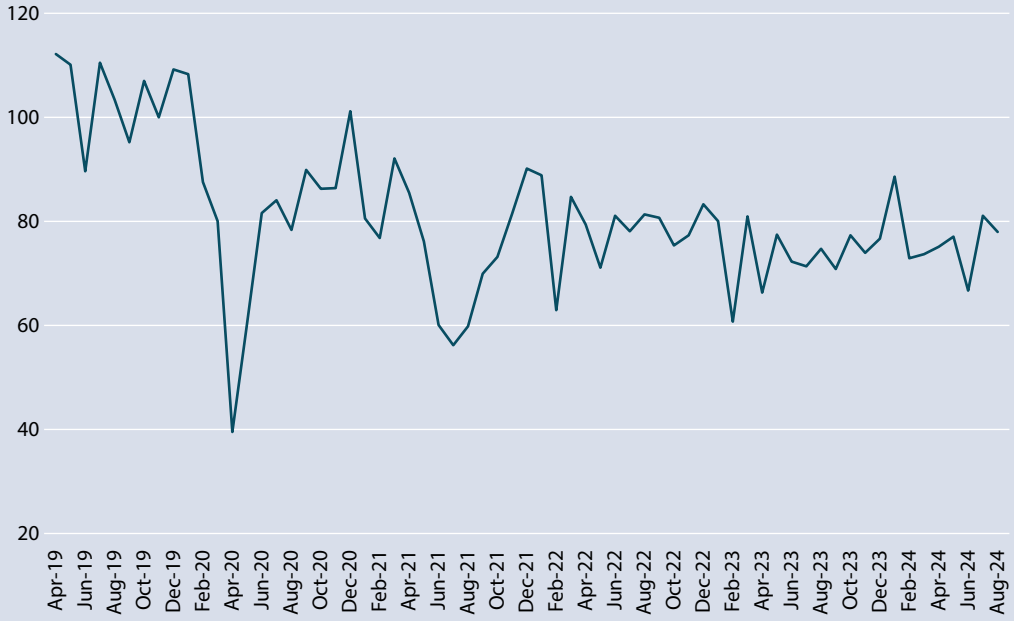
PAYMENT TREND BY DEBIT CARD, CREDIT CARD, AND E-MONEY (APRIL 2019–AUGUST 2024).



Source: Central Bank of Malaysia (n.d.).

FIGURE 3B

PAYMENT TREND BY CHEQUE (APRIL 2019–AUGUST 2024).



Source: Central Bank of Malaysia. (n.d.).

digital infrastructure and services. This disparity has led to low participation in the digital economy among rural communities. The COVID-19 pandemic further highlighted the urgency of accelerating efforts to bridge this gap.

2. **Policy discrepancies[2]:** Differences in digital infrastructure policies across states and the lack of data synchronization present substantial challenges to ICT development. In some states, exclusive rights are granted to specific companies for managing and providing digital infrastructure. This practice has resulted in high permit fees and complex approval processes, limiting competition and deterring investment. Consequently, digital infrastructure development remains uneven across the country.

Data Analysis and Interpretation

This section presents findings from the cross-sectoral analysis conducted using data from the WBES. The analysis focuses on three main areas: firm productivity, the role of ICT utilization in driving productivity growth, and the obstacles to effective ICT utilization. While the dataset provides a rich and detailed source of information, limitations persist due to missing values in key variables, which constrain the comprehensiveness of the analysis.

Firm Productivity

With a sample exceeding 1,000 observations, the WBES offers a detailed examination of various dimensions of firm performance in Malaysia. A central focus of this analysis is the TFP, which provides insights into the underlying drivers of productivity growth. This study of Malaysia analyzes TFP at four levels: the aggregate economy and separately within small, medium, and large firms.

Table 5 presents the results of the TFP analysis, using methodologies developed by Olley and Pakes (1996) and Levinsohn and Petrin (2003). Although the methodology proposed by Ackerberg, Caves, and Frazer (2015) offers a more rigorous approach to TFP estimation, limitations in the dataset precluded its application in this context.

TABLE 5

TOTAL FACTOR PRODUCTIVITY ESTIMATES (2019).

	Aggregate		Small		Medium		Large	
	OP	LP	OP	LP	OP	LP	OP	LP
Labor	0.8122	0.8122	0.8872	0.8872	0.7143	0.7143	0.7317	0.7317
Capital	0.2124	0.1637	0.1230	0.0791	0.3130	0.2765	0.1854	0.1482
Intermediate		0.2005		0.3084		0.0889		0.2051

Note: OP = Olley and Pakes (1996); LP = Levinsohn and Petrin (2003).
Source: Author's calculation based on WBES

At the aggregate level, the findings indicate that Malaysian firms exhibit a substantial reliance on labor in their production processes. Analysis using the OP and LP models reveals labor coefficients exceeding 0.8, highlighting the dominant role of labor in production. This high labor dependency suggests that, on average, firms in Malaysia rely heavily on human resources to drive production. The significant labor coefficient highlights the essential contribution of the workforce to firm productivity and output, which may be attributable to cost factors (including labor costs) and the prevailing industrial composition in the country.

[2] For more information, refer to the discussion on the widening digital divide in Chapter 11, Boosting Digitalisation and Advanced Technology, of the 12MP (Ministry of Economy, 2021a).

A more nuanced perspective emerges when examining firms by size. Small firms, in particular, show a marked dependence on labor as the primary input. The elevated labor coefficient for small firms suggests a strong reliance on human resources to sustain operations. This dependency may stem from limited access to capital, which restricts small firms' ability to invest in advanced machinery and technology. As a result, these firms often employ labor-intensive production methods. Additionally, many small firms operate in sectors inherently reliant on manual labor, further reinforcing their dependence on workforce input.

In contrast, medium and large firms display a different production profile, characterized by greater capital intensity. The analysis shows that these firms place more emphasis on capital inputs, as reflected by significantly higher capital coefficients than small firms. This capital orientation can be attributed to better access to financial resources, enabling investments in advanced machinery, technology, and infrastructure. Such investments enhance production efficiency, reduce dependence on labor, and contribute to productivity gains. Furthermore, medium and large firms may operate in capital-intensive sectors, such as manufacturing and technology, where substantial capital investment is essential to maintain competitiveness and achieve economies of scale.

The trend towards capital intensity among medium and large firms suggests potential productivity gains through technological advancements and automation. By leveraging capital resources, these firms can optimize production processes, reduce costs, and improve output quality. This shift from labor-intensive to capital-intensive production aligns with broader trends in Malaysia's economic development and industrialization.

ICT Utilization

While the previous subsection highlights notable variations in the drivers of TFP among firms in Malaysia, the available findings do not provide sufficient information on how ICT utilization directly contributes to productivity growth. To address this gap, additional analysis was conducted using specific indicators from the WBES dataset that reflect the levels of ICT utilization. The selected indicators include the use of websites and online payment systems in business operations, training programs, manager experience, and innovation. These indicators were analyzed for their association with firm productivity levels, with the results presented in Table 6.

TABLE 6

FIRM PRODUCTIVITY LEVELS AND ICT UTILIZATION ASSOCIATION (2019).

Variables	Aggregate	Small	Medium	Large
Website	0.0395	0.1637	–0.0314	–0.1536
	–0.0652	–0.1045	–0.1158	–0.1334
Online payment system	0.1700***	0.2034*	0.114	0.1917*
	–0.0631	–0.1123	–0.1086	–0.1041
Training programs	0.0763	–0.064	0.0457	0.2175*
	–0.059	–0.0967	–0.1017	–0.1224
Manager's experience	0.2143**	0.1533	0.1267	0.1666
	–0.1035	–0.1575	–0.1913	–0.2121

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Variables	Aggregate	Small	Medium	Large
Innovation	0.0512	–0.0674	0.1296	0.0987
	–0.0577	–0.1015	–0.099	–0.1
Constant	4.8540***	4.8804***	5.0275	5.0564***
	–0.1471	–0.2174	–0.2733	–0.3287
Observations	409	155	140	114
R-squared	0.0446	0.0444	0.0289	0.1045

Note: Standard errors in parentheses. *** p<0.01; ** p<0.05; * p<0.1.
Source: Author's calculation based on WBES.

As indicated in Table 6, the analysis identifies online payment as a statistically significant determinant of productivity. It reveals that online payment is positively associated with firm productivity at both the aggregate level and within small and large firms. The findings suggest that online payment system usage (1-unit change) is associated with a 17% increase in productivity at the aggregate level. The associated increases for small and large firms are approximately 20% and 19%, respectively. These findings highlight the critical role of digital financial transactions in enhancing operational efficiency and streamlining business processes. For small firms, the availability of online payment options reduces transaction costs and broadens market access, thus enhancing productivity. Similarly, large firms benefit from online payment systems through improved cash flow management and heightened customer satisfaction, contributing to overall productivity gains.

In addition to online payment systems, training programs show a positive and statistically significant association with productivity, particularly among large firms. This suggests that investment in employee training and development enhances performance by equipping employees with the necessary skills and knowledge to execute tasks more efficiently and effectively. For large firms with complex operations and substantial workforces, targeted training initiatives that foster a skilled and competent workforce can lead to significant productivity gains.

Managerial experience also emerges as another key driver of productivity at the aggregate level, with results indicating that managerial experience is positively significant at the 5% level. Experienced managers contribute valuable insights, strategic thinking, and leadership capabilities essential for navigating business challenges and seizing growth opportunities. Their ability to make informed decisions, optimize resources, and implement effective strategies is vital in enhancing productivity across firms of varying sizes.

Remaining Obstacles in ICT Utilization

Building on the findings from the section on ICT Utilization, which identified online payment systems as a critical driver of productivity, this section extends the analysis to examine additional obstacles to ICT utilization. The section analyzes two key indicators, electricity interruption and Internet reliability, to assess their association with ICT utilization and productivity. The results are presented in Table 7.

TABLE 7

FACTOR HINDERING ICT UTILIZATION IN MALAYSIA (2019).

Variables	Aggregate	Small	Medium	Large
Electricity interruption	−0.0350*	−0.0475*	−0.026	−0.0248
	−0.0181	−0.0259	−0.0359	−0.0354
Internet reliability	0.0145	0.0311	0.0186	−0.0136
	−0.0193	−0.0294	−0.0351	−0.0379
Constant	0.2835***	0.2423***	0.2660***	0.3587***
	−0.0317	−0.0491	−0.0544	−0.0637
Observations	409	155	140	114
R-squared	0.0091	0.0226	0.0041	0.0085

Note: Standard errors in parentheses. *** p<0.01; ** p<0.05; * p<0.1.
Source: Author's calculation based on WBES.

The analysis reveals that electricity-related challenges significantly hinder ICT utilization. The results indicate a statistically significant negative association, at the 10% level, between electricity interruption and the utilization of ICT at both the aggregate level and among small firms. This highlights the adverse impact of electrical infrastructure issues, such as power outages or unstable electricity supply, on the effective use of ICT. Small firms, which may lack the resources to invest in backup power solutions, are particularly vulnerable to such electricity-related issues. These findings underscore the crucial need for reliable and stable electrical infrastructure to support the widespread utilization of ICT.

Conversely, the analysis suggests that Internet reliability is not significantly associated with the utilization of ICT across firm sizes. This indicates that most firms may not perceive the reliability of the Internet as a significant obstacle to utilizing ICT. Firms might have adapted to the fluctuations in Internet quality or implemented strategies to mitigate its effects, such as utilizing multiple Internet service providers (ISPs) or investing in technologies that ensure continuous connectivity. The absence of a significant association with Internet reliability implies that other factors, particularly electricity infrastructure, are more pressing constraints influencing ICT utilization by businesses in Malaysia.

Policy Discussion

National-level policies drive economic growth by providing top-down guidance that shapes planning and development strategies. While bottom-up policies are also significant, the variations in governance structures at the state level have created challenges in harmonizing growth trajectories across different regions in Malaysia. This section examines the key policy documents that currently guide efforts to promote firm skill upgrading and ICT infrastructure development.

Current Policies to Promote Firms' Skill Upgrading

In Malaysia, policies promoting skill upgrading among firms are primarily articulated through the 12MP, which provides a macroeconomic framework for national growth (Ministry of Economy, 2021a). The strategies under the 12MP adopt a sectoral approach, focusing on key economic sectors such as E&E and extending to MSMEs. This cascading approach ensures that broad economic objectives are effectively translated into targeted actions at the sectoral and firm levels.

1. **Accelerating talent development at the sectoral level**

    a. **Agriculture:** Training curricula and modules are reviewed to produce certified and knowledgeable agriculturists who can meet current and future demands. A professional body has also been formed to recognize trained and experienced farmers, agricultural technicians, and scientists as professional agriculturists, thereby elevating the status and recognition of the agriculture sector workforce.

    b. **Construction:** Industry players are encouraged to collaborate with training institutions to provide industrial training in the latest technologies. Embedding industry expertise in academic curricula strengthens university-industry linkages, ensuring the workforce remains abreast of evolving technological needs. Additionally, training and accreditation programs offered by the Construction Industry Development Board help upskill existing workers and develop qualified local talent for the sector.

    c. **Manufacturing:** Industries work with skills training institutions to design customized training programs that address specific needs as firms move up the value chain. Efforts also focus on expanding micro-credential programs to meet current reskilling and future skill requirements, such as software coding and data analytics, and align them with market needs.

    d. **Services:** As Malaysia transitions to a knowledge-based economy, the human resources in the services sector must be equipped with the latest professional and practical skills. The country is developing a new Services Sector Blueprint to guide talent development, particularly in automation tools and advanced technologies aligned with Industry 4.0.

2. **Uplifting talent development and capability**

    a. **E&E:** Talent development and capacity building in the E&E sector is being accelerated through the expansion of micro-credential programs based on the Triple Helix model. Key initiatives include establishing industry-led 4IR skills development centers, incentivizing reskilling and upskilling, and creating an AI-enabled data platform for workforce planning.

3. **Enhancing entrepreneurship development program for MSMEs**

    a. **MSMEs:** Entrepreneurship development programs are being enhanced to cultivate the right mindset among aspiring entrepreneurs. Education and training initiatives focus on equipping students and aspiring entrepreneurs with essential skills to become job creators. Triple Helix collaboration enables entrepreneurs to acquire competencies, while outreach programs aim to build entrepreneurial capabilities among youth and targeted groups. In addition, incubation spaces are being established in rural and less developed areas, and intrapreneurship development within organizations is being strengthened.

Current Policies to Promote ICT Infrastructure

Similar to the strategies for skill upgrading, the 12MP prominently features the promotion of ICT infrastructure from a macroeconomic perspective. Recognizing the pivotal role of ICT in fostering economic prosperity and social well-being, the country launched the Malaysia Digital Economy Blueprint in 2021 (Ministry of Economy, 2021b). This blueprint aims to transform Malaysia into a digitally driven, high-income nation and position it as a regional leader in the digital economy.

Twelfth Malaysia Plan

1. **Improving connectivity in rural areas:** Efforts are underway to expand Internet and telecommunication coverage to facilitate economic activities and enhance market access through digital platforms. This initiative addresses connectivity issues in industrial estates in Sabah and Sarawak, which have traditionally faced significant challenges.

2. **Optimizing community Internet centers:** Community Internet centers are being optimized to promote digitalization among rural entrepreneurs. Programs like DesaMall@KPLB, a government-backed online e-commerce platform, are being expanded to assist rural entrepreneurs in transitioning from traditional business methods to online platforms, thereby enhancing their market access.

Malaysia Digital Economy Blueprint (2021–30)

The blueprint identifies digital infrastructure as one of its key thrusts. This includes broadband, data centers, and submarine cable landing stations, all essential for generating, exchanging, and storing data. These efforts are critical in addressing broadband access and speed gaps, particularly in rural areas. The blueprint outlines six initiatives under this thrust.

1. **Reviewing laws and regulations:** The regulatory framework is being reviewed to create a supportive environment for telcos, facilitating the accelerated rollout of digital infrastructure.

2. **Mandating broadband as basic infrastructure:** Amendments to federal and state laws are proposed to mandate broadband as basic infrastructure for new developments, including residential and commercial buildings.

3. **Expanding project planning platforms:** The OSC 3.0 Plus Online platform is being extended to more local authorities to streamline the process of obtaining planning permissions and related approvals for development projects, enhancing efficiency and transparency.

4. **Enhancing real-time broadband demand platform:** A data-driven platform has been developed to monitor broadband demand in real-time, aiding in the planning and addressing coverage and speed gaps for both fixed and mobile services.

5. **Boosting capabilities of domestic data centers:** The government is working toward creating an enabling environment for local data center companies to support high-end cloud computing services, in partnerships with global technology providers.

6. **Attracting international submarine cables:** Malaysia is developing strategic plans to attract investments in submarine cable landing stations and encourage international data companies to establish hosting facilities there. This will help expand global connectivity and improve broadband services in the country.

Conclusion

This study uses data from the WBES to provide a comprehensive analysis of firm productivity and ICT utilization in Malaysia. The findings reveal key productivity drivers by firm size, the role of ICT in enhancing productivity, and the critical barriers to adoption of digital technologies.

The TFP analysis confirms a strong dependence on labor input, especially among small firms. In contrast, medium and large firms demonstrate a shift towards capital-intensive production, driven by access to financial resources and sector-specific demands. This trend is consistent with Malaysia's broader economic development trajectory, where firms increasingly leverage capital and technology to achieve productivity gains and enhance competitiveness. However, the dependency on labor among small firms highlights the need for targeted policies to improve their access to capital and technological advancements, enabling firms to improve efficiency and adapt to changing economic landscapes.

The study identifies a significant positive association between online payment systems and productivity at both the aggregate level and within small and large firms. This highlights the transformative impact of digital financial tools in enhancing operational efficiency and market reach. Training programs and managerial experience also emerge as crucial factors for productivity, particularly in larger firms. Training programs equip employees with essential skills, while experienced managers contribute strategic insights that drive firm performance.

The study further identifies key obstacles to ICT utilization. It reveals that an unstable electricity supply has a statistically adverse effect on ICT utilization, particularly for small firms, which are less equipped to mitigate power disruptions. While Internet reliability appears less of a constraint, access to stable electricity is essential for digital tools to be used effectively. These findings highlight the need for robust infrastructure development, especially in regions where firms face frequent power outages.

The policy analysis reflects the current initiatives to address these challenges through skill development, ICT infrastructure improvements, and targeted support for key sectors. Policies under the 12MP emphasize the need for a sectoral approach to skill upgrading, while the Malaysia Digital Economy Blueprint prioritizes ICT infrastructure as a foundational element for economic growth. The government's efforts to enhance Internet connectivity, especially in rural areas, and its focus on mandating broadband infrastructure aim to address existing gaps and enable firms to transition towards digital platforms.

Overall, it highlights the importance of a multi-dimensional approach to improving productivity and ICT utilization. Future policies should consider the unique needs of firms across different sizes and sectors, focusing on fostering access to capital, enhancing digital skills, and strengthening infrastructure. By addressing these areas, Malaysia can promote sustainable productivity growth and position itself as a competitive player in the global economy.

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MONGOLIA

Summary

This research explores low-cost approaches to skill upgradation within firms in Mongolia, leveraging ICT to offer stakeholders valuable insights for policy- and decision-making in ICT development. Although the ICT sector's revenue has shown steady growth, its contribution to Mongolia's GDP remained modest at 2% in 2022. Key challenges in the country's ICT development include weak basic infrastructure, inadequate e-commerce legislation, and limited ICT skill development. The study also highlights a strong correlation between ICT utilization and firm productivity, factoring in elements such as skill enhancement and access to finance.

Introduction

Over the past few decades, Mongolia has experienced significant growth in economic and labor productivity, largely due to increased foreign investment in the mining sector. However, low productivity and poverty continue to pose serious challenges. A large share of the labor force has shifted from agriculture and manufacturing to the service sector, resulting in human capital shortages in traditionally low-productivity sectors. At the same time, this shift across sectors necessitates skill upgrades, which are further accelerated by the emergence of new technologies and job opportunities.

Businesses in Mongolia have limited access to the global markets due to the country's geographic position, landlocked between China and Russia. The bulk of Mongolia's exports—around 80%—comprises mining and quarrying products, followed by agriculture at 13–15%, and tourism at just 2%. In 2020, only 2% of the country's SMEs reported any exporting activity. Mongolia's major exports include crude coal (USD6.48 billion), copper ore (USD2.73 billion), gold (USD2.05 billion), animal hair products (USD430 million), and iron ore (USD389 million), with China serving as the primary destination. This pattern highlights the country's strong reliance on mineral resources and its close economic relationship with its neighboring countries.

According to the *Global Value Chain Development Report* (2021), Mongolia ranks among the economies with the fastest-growing direct and indirect exports and GVC participation rates. Nevertheless, the economy's reliance on a limited number of sectors underscores its vulnerability to external shocks. For instance, declining global commodity prices can significantly disrupt the country's economy. This highlights the urgent need for diversification to enhance resilience.

To better integrate non-mining firms into global supply chains, Mongolia must improve Internet connectivity, energy infrastructure, and logistics. By addressing these challenges, Mongolia can foster a more resilient and diversified economy, capable of withstanding fluctuations in the global market.

Constraints on Firms' Skill Upgrading and ICT Potential

ICT plays a significant role in enhancing firm productivity, especially in the face of workforce shortages. By adopting ICT, firms can automate tasks, manage data more efficiently, respond

swiftly to market demands, and meet evolving consumer expectations. At the same time, a skilled workforce is essential to utilize ICT, enabling process optimization and fostering innovation. This section examines the key constraints affecting firms' ability to upgrade skills and adopt ICT solutions.

Access to Finance

Access to finance remains a major obstacle for many Mongolian firms. By facilitating easier access to financial services, online banking can enable more effective financial management and provide avenues for firms to secure funding and invest in advanced technologies. However, systemic risks, weak competition in the banking sector, and ineffective state support measures create a challenging environment for securing funding. According to the WBES (2019), 36.8% of respondents identified access to finance as a major or severe constraint for doing business, a significantly higher proportion than the global average.

Interestingly, in 2018, Mongolia's banking sector had a dense branch network, with 1,516 branches nationwide and a penetration rate of 60 branches per 100,000 adults, one of the highest in the world. However, in terms of geographic coverage, Mongolia ranks among the lowest, with only 0.87 branches per thousand square kilometers. This disparity reflects the high cost of delivering traditional banking services in rural and sparsely populated regions (Giacomo, et al., 2019).

Digital solutions such as online and mobile banking have emerged as a viable alternative for businesses to overcome financial and transactional barriers. In recent years, the number of people using traditional banking services has declined, while the use of smart devices and Internet banking has grown steadily. Compared to 2019, the number of Internet banking users had tripled in 2022, while the number of mobile banking users had increased sevenfold. The introduction of new technology-based financial products and services for consumers will ensure that account holders engage more regularly with the bank.

Safety of Transactions

The Bank of Mongolia's strategic focus on modernizing the financial infrastructure for safe, reliable, and efficient payment systems has significantly boosted the adoption of innovative payment platforms and services. As a result, a wide range of payment instruments and channels are now in use across the country. These include traditional methods such as cash, payment orders, and invoices, as well as digital options like Internet banking, mobile banking, and payment cards. Additionally, remittances, e-money, and billing systems have become integral components of Mongolia's evolving payment ecosystem (Bank of Mongolia, 2024).

The underdevelopment of financial infrastructure in rural areas limits banking access due to long travel distances and time-consuming processes. This not only hinders financial inclusion but also increases security risks associated with cash dependency and fraud. To improve transaction convenience, banks must provide fast and reliable services for payment and money transfers. In addition, customers need assurance of transaction security and successful completion. Convenience, both during and after the use of banking services, plays a significant role in the adoption of digital banking technologies. Banks should, therefore, ensure that mobile banking users can easily access prompt support if they encounter issues while using the app. This can be facilitated through AI-based chatbots, live online chats, or 24/7 call centers, all of which can assist in enhancing "possession and post-possession convenience" (Ivanova, A. Noh, G., 2022).

To enable the systematic adoption of digital services, banks must improve the accessibility of mobile and online banking by using data-driven insights into the factors influencing customer experience. These efforts foster technology acceptance and sustained usage while also ensuring security protocols and uninterrupted cross-platform availability across all time zones.

Access to the Global Market

Due to its landlocked geography, Mongolia's export routes are largely dependent on transit through its two neighboring countries, China and Russia, to access seaports and international trade networks. To mitigate this geographical constraint, Mongolian authorities have actively pursued trade diversification strategies aimed at expanding trade partnerships beyond these two nations. This strategic shift led to the development of the Transit Mongolia Program, a national initiative focused on constructing and upgrading major transport corridors and developing a single electronic window system to streamline cross-border trade.

In parallel, the government is working to diversify its export portfolio beyond mining to enhance the overall value of exports. It also introduced SME support programs designed to help businesses enter and compete in the international market.

Another critical obstacle for Mongolian firms in accessing global markets is the low level of compliance with management standards. According to the WBES (2019), only 4.3% of firms in Mongolia reported having an internationally recognized quality certification in management practice, while a mere 1.7% reported using technology licensed from foreign companies.

Access to Skilled Human Capital

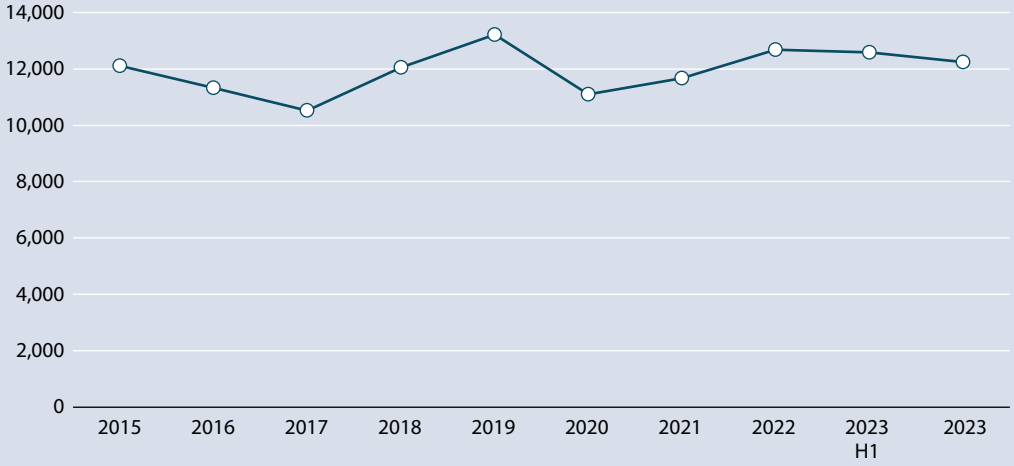
The WBES (2019) data indicates that only 5.5% of respondents in Mongolia identified access to skilled workers as a major or severe constraint to doing business. The proportion of skilled workers among permanent employees stood at 88.7%, which is comparably higher than the regional average. Additionally, 74.3% of permanent full-time workers had completed high school. However, 11.2% of firms still cited an inadequately educated workforce as a major or very severe constraint (Bank of Mongolia, 2024). The core issue regarding access to skills lies in the quality of higher education, as many graduates from colleges and universities leave without acquiring the skills required by the labor market. This indicates that educational institutions in Mongolia need to improve their curriculum and programs to meet the needs of the labor market.

Another significant barrier to accessing skilled labor is Mongolia's low population density, which contributes to widespread workforce shortages. To address this, the government's Vision 2050 emphasizes the promotion of Technical and Vocational Education and Training (TVET). This initiative aims to tackle the shortage of skilled workers, particularly in the ICT sector, which is crucial for industrial growth. Skilled IT professionals are consistently in short supply in Mongolia, as illustrated in Figure 1.

Implementing targeted training programs and forging strong partnerships with educational institutions is essential for developing a competent workforce capable of meeting the evolving demands of the ICT industry. Basic digital literacy is also fundamental to the growth of the ICT sector, as it drives user engagement and expands the market through increased everyday Internet usage. The public must be equipped with the necessary skills to use digital technologies effectively.

FIGURE 1

WORKFORCE WITH ICT SKILLS IN MONGOLIA.



Source: Communications Regulatory Commission (2023).

In addition, the lack of competency in management systems presents a key challenge for firms attempting to upgrade their skills and adopt ICT technologies. Larger companies and those with foreign investment are often better positioned to address human resource constraints by providing on-the-job training, increasing salaries and compensation to retain employees, and recruiting skilled foreign workers. However, most SMEs face challenges due to inadequate and poor management practices, which hinder their ability to implement digital solutions within their business operations.

Background Statistics of ICT

Mongolia's telecommunication sector has experienced rapid growth since the 1990s and holds strong potential to attract significant FDI to facilitate new activities to deliver faster and better services. According to the National Statistical Office (NSO), the total revenue of the telecommunications sector reached MNT1.7 trillion in 2024, representing an 8% increase compared to 2023. This growth is primarily due to the rise in wireless telecommunications revenue. As total ICT revenues continue to grow rapidly, foreign investors are increasingly showing interest in developing high-speed networks and building a competitive digital infrastructure.

One of Mongolia's key advantages in digital access is its high mobile penetration rate. In 2022, there were 117.6 mobile-cellular and active mobile-broadband subscriptions per 100 inhabitants (ITU, 2023). Mobile phones are widely used in Mongolia, and all provincial capitals have access to 4G networks. In terms of mobile usage, Mongolia is almost at par with countries that have well-developed digital infrastructure. This makes mobile Internet a convenient option for populations in rural areas, where fixed ICT infrastructure remains limited.

However, Mongolia lags behind the global average in terms of fixed broadband subscriptions, households with Internet access, and the percentage of individuals using the Internet. These gaps are primarily due to geographic, economic, and social factors. Statistical data highlights significant disparities in digital infrastructure and Internet connectivity between urban and rural areas. For

instance, as of 2016, 38% of households with electricity access in Ulaanbaatar were connected to fixed broadband, but this number was only 7% among rural households.

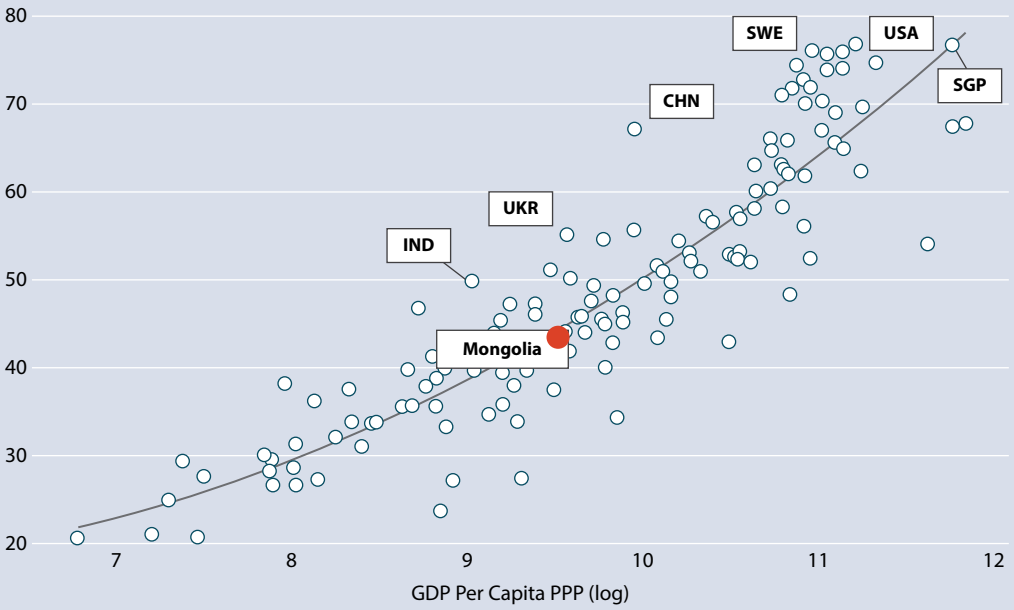
The Agency of Information, Communication, and Technology, the Coordination Agency of the Government of Mongolia provide policy guidance and support to the Cabinet in making decisions and implementing the government's ICT Development policies and laws. In 2022, the Government of Mongolia designated ICT as a leading sector of the economy and called for its support in transforming the country into an "E-Nation".

Infrastructure of Broadband Internet

Figure 2 illustrates Mongolia's position in terms of both the NRI score and GDP per capita (PPP).

FIGURE 2

NETWORK READINESS INDEX SCORE VS. GDP PER CAPITA (PPP).



Source: OEC (2023).

The trend line in Figure 2 represents the expected NRI score relative to a country's income level. As can be seen, Mongolia is slightly below the trend line, indicating that its network readiness is broadly in line with what would be expected given its income level (Observatory of Economic Complexity, 2023).

Mongolia demonstrates above-average Internet penetration rates, surpassing the global and regional benchmarks. Urban areas, in particular, benefit from high-speed, affordable Internet access through fiber optic and mobile networks. However, significant accessibility challenges remain in rural areas and ger districts due to a lack of basic quality infrastructure. To address these gaps, the government needs to adopt alternative strategies to enhance infrastructure in these areas to increase digital access. Notably, Internet services are generally affordable for the public. The household income statistics indicate that Mongolians spend slightly over 2% of their monthly income on mobile data.

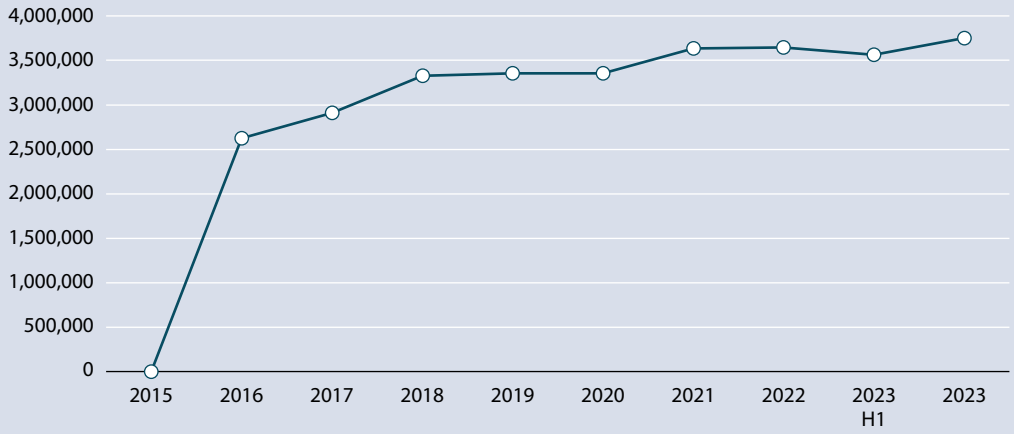
Household Usage of Internet and Mobile Phone

The Internet penetration in Mongolia stood at 68% in January 2020, including 2.20 million Internet users and over 19,000 organizations. Mongolia's vast land area of 1.56 million square km presents fundamental challenges in achieving digital equity. It leads to the significant gap in digital infrastructure and connectivity between rural and urban areas. For instance, as of 2016, 38% of households with electricity access in Ulaanbaatar were connected to fixed broadband, whereas this number was only 7% among rural households.

Following the introduction of 4G in 2015, Internet penetration in Mongolia has increased rapidly, especially over the last two years. Conversely, the percentage of households with fixed broadband subscriptions and individuals using the Internet has lagged behind the global average due to geographic, economic, and social factors (CRC, 2024) (see Figure 3).

FIGURE 3

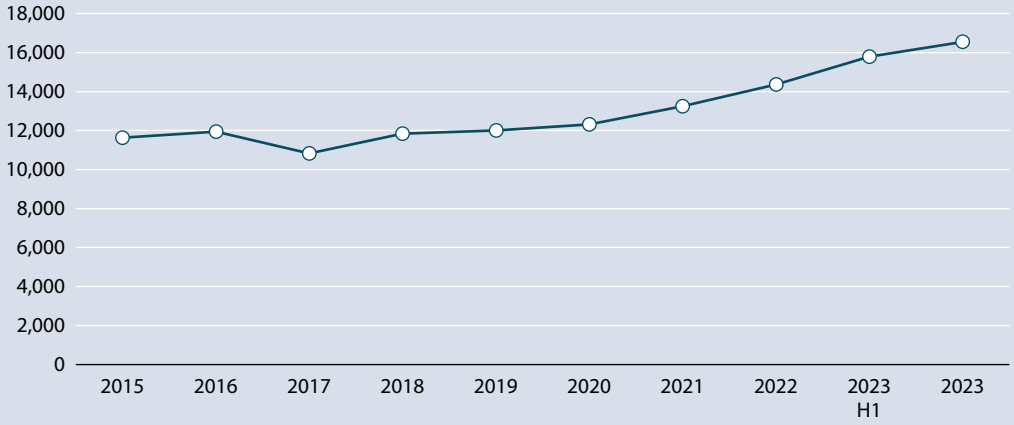
NUMBER OF ACTIVE MOBILE-BROADBAND SUBSCRIBERS IN MONGOLIA.



Source: CRC (2024).

FIGURE 4

AVERAGE SPENDING PER USER (IN MNT).

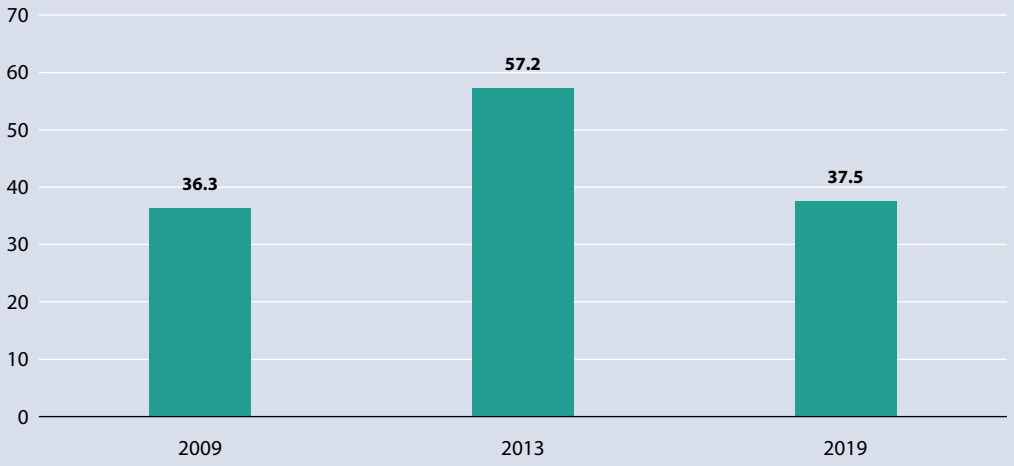


Source: CRC (2024).

According to Figure 5, the proportion of firms that have their own websites is low, especially among MSMEs. The inability to connect to local and global markets digitally affects the business performance of enterprises. Therefore, small and medium-sized manufacturing and service business owners must identify the opportunities and risks of digital transformation and adapt ICT to improve their connectivity as well as productivity.

FIGURE 5

PERCENTAGE OF FIRMS HAVING A WEBSITE IN MONGOLIA.



Source: Agency of SMEs (2022).

According to the 2022 Digital Transformation Readiness Survey of SMEs by the Agency of SMEs, the Implementing Agency of the Government of Mongolia, and MPO, investing in ICT and hiring IT professionals is a vital challenge for MSMEs.

Electronic Payment Systems

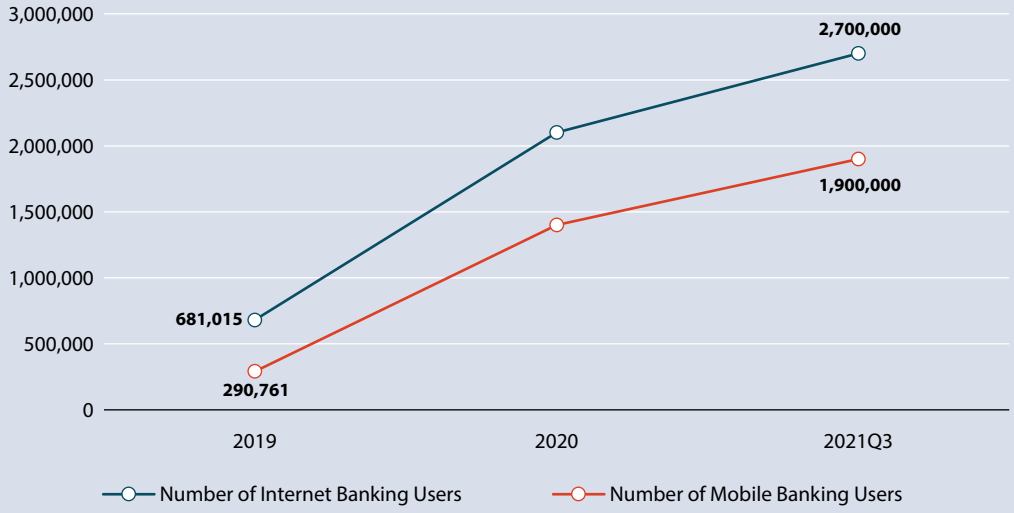
In recent years, the number of people using traditional banking services has been decreasing, while the use of smart devices and Internet banking has been steadily increasing. Compared to 2019, the number of Internet banking users tripled by 2021, and the number of mobile banking users increased sixfold, as shown in Figure 6. Ninety-four percent of the adult population in Mongolia has a bank account, indicating that financial access is at a reasonable level. Ninety-seven percent of bank account holders have enjoyed electronic banking.

Additionally, consumers are more interested in accessing e-financial products and services through mobile phones and smart devices. Banks are eager to enhance their digital services for a better customer experience, as illustrated in Figure 7. A primary catalyst for the increase in e-payments is the substantial expansion of e-commerce, the digital marketplace for goods and services. As consumers shift their purchasing activities to online platforms, this growth in internet-based transactions directly drives demand for e-payment systems.

The rise of smartphones has also contributed to the increase in mobile payments. Likewise, it is indicated that transaction convenience significantly impacts mobile banking adoption among consumers. This implies that consumers can be motivated to adopt mobile banking due to the

FIGURE 6

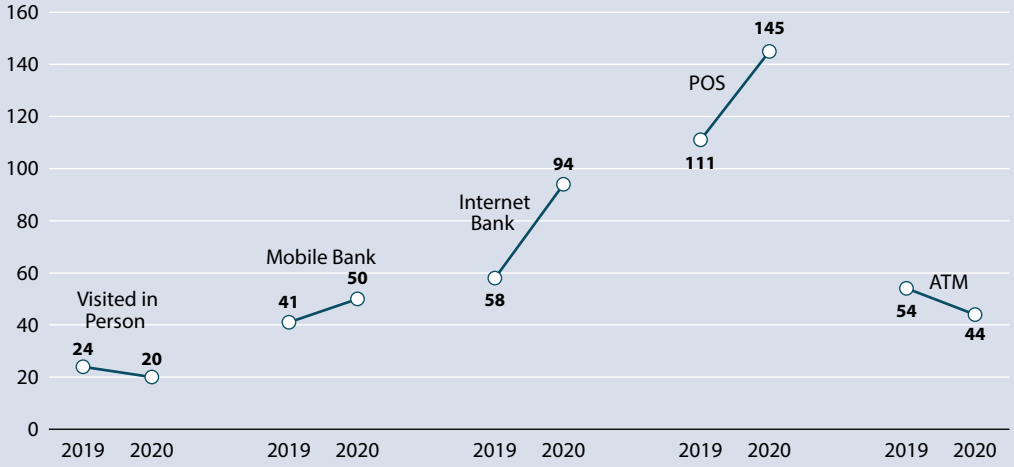
INTERNET BANK USERS VS. MOBILE BANK USERS.



Source: BOM (2024).

FIGURE 7

BANK ACCOUNT TRANSACTION BY HOLDER PER YEAR,



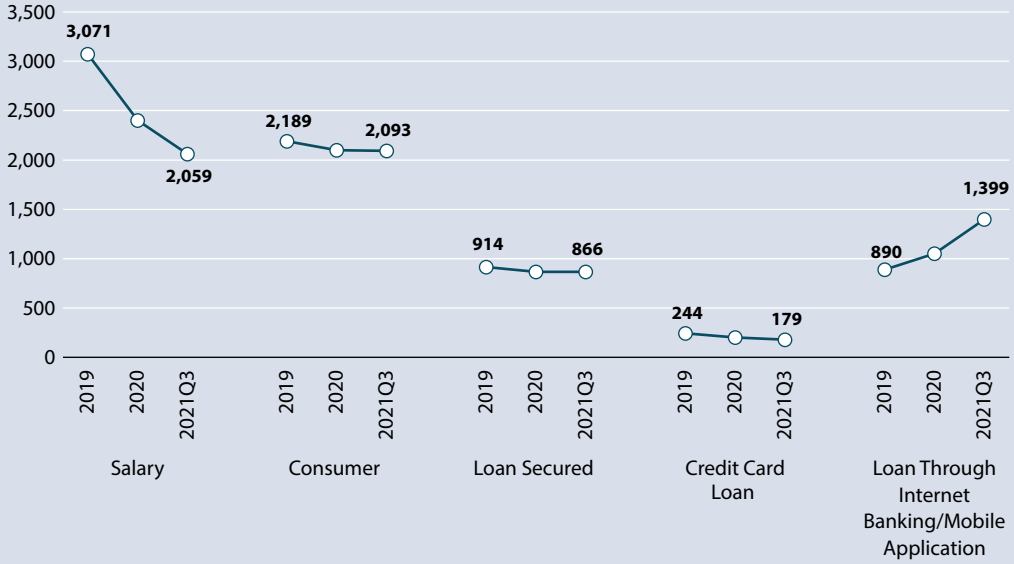
Source: Mongolian Bankers Association (2024).

ease of banking (Banking & Finance Academy of Mongolia, 2022). At the same time, the declining use of cash is evident as Internet connectivity becomes more widely available. Consumers now perceive digital payment as offering superior convenience as compared to traditional payment methods.

Banks are investing considerable effort in expanding electronic services for clearance and are eager to enhance other banking services, such as loans, by making them available electronically. As shown in Figure 8, more customer loans are being issued electronically.

FIGURE 8

CUSTOMER LOANS (IN MNT BILLION).



Source: Mongolian Bankers Association (2024).

Obstacles to ICT-Driven Growth

Mongolia's electricity infrastructure is critical for digital transformation, but faces challenges due to its nomadic lifestyle, harsh climate, and sparse population. While 80% of the population is connected to the central grid, the remaining 20%, primarily herders in remote areas, still lack reliable electricity.

Currently, 304 out of 331 administrative units have been connected to the central electricity system, where most of the consumption occurs. Twelve out of the remaining 27 soums are provided with renewable energy resources, and the 13 border soums are connected to the electricity systems of the neighboring countries, China and Russia (CRC, 2024).

The biggest hindrance to electronic money transactions for banks in Mongolia is a lack of customer trust, especially among businesses. Implementing secure payment solutions with advanced encryption, fraud detection systems, and adherence to security standards is vital to safeguard sensitive financial data from cyber threats. A robust security framework not only builds stakeholder confidence but also enables banks and businesses to mitigate the risk of financial losses.

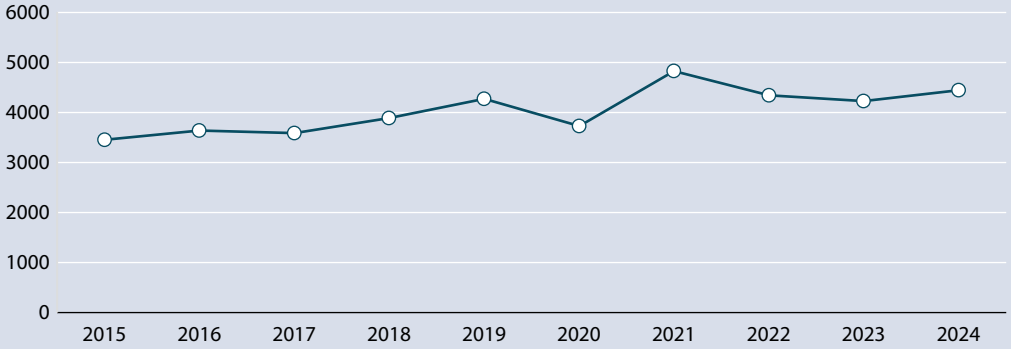
When selecting an e-payment system for their business, SMEs tend to prefer solutions that integrate with their existing systems. This helps avoid operational disruptions and ensures smooth cross-platform communication. However, difficulties in achieving smooth transactions often discourage businesses from adopting e-payment methods.

Data Analysis and Interpretation

Over the past five years, both the number of enterprises and labor productivity in Mongolia have increased steadily, with a particularly sharp increase in labor productivity observed in 2021. This significant rise in GDP per employed person can be attributed mainly to the surge in global commodity prices.

FIGURE 9

LABOR PRODUCTIVITY IN MONGOLIA.

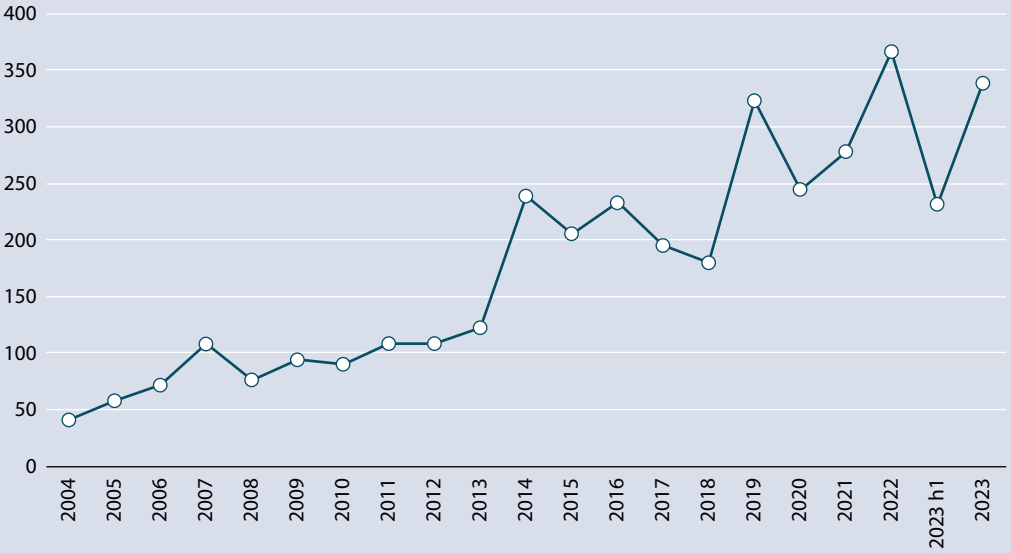


Source: NSO (2024).

In parallel, investment in the ICT sector has remained strong, with total investment reaching MNT338.06 billion in 2023, the second-highest level ever (Figure 10).

FIGURE 10

TOTAL INVESTMENT IN THE ICT SECTOR IN 2023 (IN MNT BILLION).



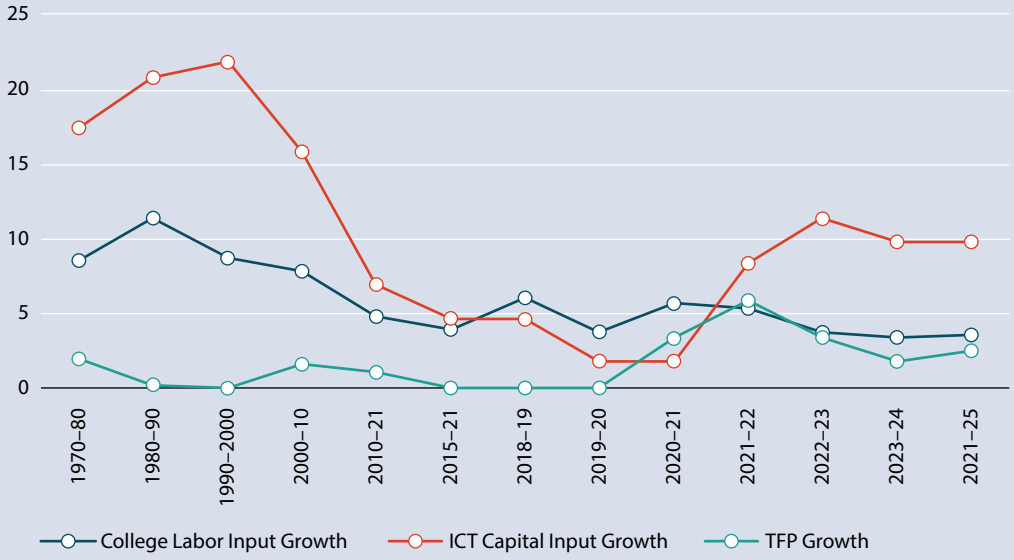
Source: NSO (2024).

Mongolia's labor productivity has shown an upward trend, as illustrated in Figure 11, although it remains relatively low by international standards.

According to Figure 11, the growth trends of ICT investments and TFP have shown a strong correlation over the past years. However, ICT input growth quickly surpassed in 2011. This deviation can be attributed to the dramatic increase in national output—Mongolia's GDP grew by 17.3% in 2011—driven by significant investments in the mining sector, particularly the Oyu-Tolgoi project.

FIGURE 11

LABOR AND ICT INPUT GROWTH/TFP GROWTH.



Source: APO Databook, 2022.

This section investigates the relationship between ICT investment and labor productivity using a dataset spanning 13 years. However, due to the limited sample size, the analysis faces significant statistical constraints. With only 13 observations and multiple variables, the degrees of freedom are limited, which affects the robustness of inference. As a result, the analysis relies on descriptive statistics and correlation analysis rather than time-series regression models, which would be less reliable under such constraints.

To address potential non-stationarity in the time-series data and ensure the validity of the analysis, the study uses differentiated variables. These include the differentiated logarithm of labor productivity (measured in constant 2015 USD), ICT investment, inflation, unemployment rate, population growth rate, and labor force participation rate. Table 1 provides definitions of these variables.

TABLE 1

DEFINITIONS OF VARIABLES.

Variable	Definition
dlnlbprd	Differentiated logarithm of labor productivity, constant 2015 USD
dlnictinv	Differentiated logarithm of the ICT investment
dinf	Differentiated inflation
unemp	Unemployment rate
dpopgr	Differentiated population growth rate
dlnlbf	Differentiated logarithm of labor force participation rate

Source: National expert.

Table 2 presents the descriptive statistics for the differentiated variables used in the analysis. It includes critical metrics, such as the number of observations (Obs.), mean, standard deviation (Std. dev.), minimum (Min), and maximum (Max) values for each variable, providing a snapshot of the data's central tendencies and dispersion.

TABLE 2

DESCRIPTIVE STATISTICS.

Variable	Obs.	Mean	Std.dev.	Min	Max
dlnlbprd	13	0.0413	0.0439	–0.0191	0.1152
dlnictinv	13	0.1594	0.2731	–0.1957	0.7915
dinf	13	0.0231	4.5700	–6.2000	7.9000
unemp	13	7.9231	1.2404	5.4000	10.0000
dpopgr	13	–0.0296	0.1185	–0.2214	0.1745
dlnlbf	13	–0.0052	0.0191	–0.0328	0.0294

Source: National expert.

Table 2 reveals that, on average, ICT investment (*dlnictinv*) has shown positive growth with a mean of 0.1594. However, the relatively large standard deviation (0.2731) and the negative minimum value (-0.1957) suggest significant fluctuations in investment levels over the observed period.

Inflation (*dinf*) also exhibits high volatility, with a standard deviation of 4.57 and a wide range between the minimum of -6.20 and the maximum of 7.90. This highlights the economic instability during the period under review, which may have influenced both ICT investments and productivity.

Conversely, the unemployment rate (*unemp*) appears more stable, with a mean of 7.92% and a standard deviation of 1.24, indicating relatively moderate fluctuations in labor market conditions. Population growth (*dpopgr*) and labor force participation (*dlnlbf*) display even lower variability, suggesting that these factors remained comparatively stable over time.

In summary, Table 2 provides a foundational understanding of the variability and distribution of the key variables used in the analysis. These insights offer essential context for interpreting the correlation results, highlighting the dynamic nature of ICT investment and macroeconomic factors in shaping labor productivity.

Table 3 presents the correlation matrix for the selected variables, showcasing the strength and direction of linear relationships between pairs of variables. Pearson correlation coefficients are reported, with significance levels indicated by stars as follows: ***–$p<0.01$, **–$p<0.05$, *–$p<0.1$.

TABLE 3

CORRELATION MATRIX.

	dlnlbprd	*dlnictinv*	*dinf*	*unemp*	*dpopgr*
dlnictinv	0.5428 *				
dinf	–0.0288	–0.1905			

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	dlnlbprd	*dlnictinv*	*dinf*	*unemp*	*dpopgr*
unemp	−0.1882	0.4646 *	−0.6495 ***		
dpopgr	0.7189 ***	−0.1621	−0.0480	−0.0598	
dlnlbf	0.1371	0.4591 *	0.4995 **	−0.1158	−0.2562

Note: *, **, *** present statistical significance at the levels of 10, 5, and 1%, respectively.
Source: National expert.

Several key relationships emerge from this analysis:

- ICT investment (*dlnictinv*) shows a positive and statistically significant correlation with labor productivity (*dlnlbprd*) (0.5428, $p<0.1$). This suggests that higher ICT investment is associated with gains in labor productivity, underscoring the critical role ICT plays in enhancing firm productivity.

- Population growth rate (*dpopgr*) exhibits a strong positive correlation with labor productivity (0.7189, $p<0.01$), indicating that an expanding population may contribute to productivity gains. This may be due to the potential for a larger labor force or rising market demand, which supports economic output.

- Unemployment (*unemp*) shows a moderate positive correlation with ICT investment (0.4646, $p<0.1$), implying that ICT investment may initially correlate with temporary adjustments in the labor market before its productivity benefits are fully realized. This could reflect the need for workforce reskilling or short-term disruptions as new technologies are integrated.

- A negative and statistically significant correlation is observed between inflation (*dinf*) and unemployment (*unemp*) (-0.6495, $p<0.01$), consistent with the Phillips Curve theory, which posits an inverse relationship between these two variables. This suggests that inflationary pressures may reduce unemployment, a pattern often observed in tight labor markets.

- The labor force participation rate (*dlnlbf*) shows moderate positive correlations with both inflation (*dinf*) (0.4995, $p<0.05$) and ICT investment (*dlnictinv*) (0.4591, $p<0.1$). This suggests that rising inflation and increased ICT investments may encourage greater workforce participation, possibly due to higher economic activity and better job opportunities associated with technological advancements.

It is important to note that this analysis is constrained by a small sample size (13 years), which severely limits statistical inference and the reliability of regression results. While the correlation analysis provides meaningful insights, the findings should be interpreted with caution. Larger datasets would be essential to validate these results and strengthen the empirical evidence.

ICT Utilization

This section examines the relationship between ICT utilization and labor productivity, specifically the effects of the number of Internet users and mobile banking users on GDP per employee.

The logarithm of the number of Internet users (*lnusrint*) and the logarithm of the number of mobile banking users (*lnusrmob*) are used as independent variables. The dependent variable is GDP per employer, while control variables include GDP growth rate, inflation rate, and unemployment rate. Table 4 provides the descriptive statistics for the variables.

TABLE 4

DESCRIPTIVE STATISTICS.

Variable	Obs	Mean	Std. dev.	Min	Max
lngdppe	10	9.8415	0.2172	9.4274	10.0424
lnusrint	10	13.8291	1.1603	11.7440	15.0683
lnusrmob	10	13.9651	0.3843	13.4737	14.5148
gdpgrth	10	4.4477	4.4691	–4.5578	11.6489
inflation	10	7.5200	4.3292	0.7000	15.2000
unemp	10	8.1700	1.1235	6.7000	10.0000

Source: National expert.

Table 5 presents the Pearson correlation matrix. A strong positive correlation is observed between *lnusrint* and *lngdppe* (0.7129, significant at the 5% level), indicating that increased Internet usage is associated with a higher GDP per employer. Similarly, *lnusrmob* shows a positive correlation with *lngdppe* (0.5796), significant at the 10% level, suggesting that mobile banking services also contribute to productivity gains. However, these results do not imply causality and must be validated with larger sample sizes.

TABLE 5

CORRELATION MATRIX.

	lngdppe	*lnusrint*	*lnusrmob*	*gdpgrth*	*inflation*
lnusrint	0.7129 **				
lnusrmob	0.5796 *	0.7030 **			
gdpgrth	–0.2419	–0.4319	–0.3233		
inflation	–0.4842 **	–0.1486	0.0349	0.4277 *	
unemp	0.2944	0.0165	–0.4423	–0.3284	–0.5693 **

Note: * and ** denote statistical significance at the 10% and 5% levels, respectively.
Source: National expert.

The small sample size limits the robustness of statistical inference. The limited observations restrict the analysis to descriptive statistics and correlations, as the dataset lacks sufficient robustness for regression analyses. Future studies with larger datasets must confirm these relationships and assess causality more rigorously.

Despite these limitations, the results highlight the potential of ICT in driving labor productivity. Key takeaways include:

- **Increased productivity:** ICT tools, such as Internet access and mobile banking, enable firms to automate operations, reduce costs, and enhance efficiency.
- **Enhanced decision-making:** IT platforms improve communication and facilitate data-driven decision-making.
- **Market expansion:** ICT investment allows firms to access global markets and respond to risks in real-time.
- **Remote work capabilities:** The adoption of ICT facilitates remote work environments, boosting employee satisfaction and productivity

Firm Productivity

This section investigates the relationship between ICT utilization and labor productivity at the firm level. ICT utilization is measured by whether a company maintains its website, serving as a proxy for digital engagement. The analysis draws on data from 358 companies for the FY 2018. Table 6 provides the definitions for the variables used in this analysis.

TABLE 6

THE DEFINITION OF VARIABLES.

Variable	Definition	Source
Lbpr	Labor productivity is the logarithm of sales divided by the number of employees	World Bank Enterprise Surveys
Web	Dummy variable: 1 if the company has its website, 0 otherwise	
Domestic	Percentage owned by domestic individuals, companies, or organizations	
Exptop	The top manager's years of experience working in this sector	
Fmtop	Dummy variable: 1 if the top manager is female, 0 otherwise	
Tech	Dummy variable: 1 if the company uses technology licensed from a foreign-owned company, 0 otherwise	
Strategy	Dummy variable: 1 if the company has a formalized written business strategy, 0 otherwise	
Member	Dummy variable: 1 if the company is part of a business membership organization or trade association, 0 otherwise	

Source: National expert.

Table 7 presents the descriptive statistics for the variables used in the analysis.

TABLE 7

DEFINITIONS OF VARIABLE.

Variable	Obs.	Mean	Std. dev.	Min	Max
Lbpr	358	17.3695	1.2742	10.3498	20.7316
Web	358	0.4218	0.4945	0.0000	1.0000
Domestic	358	96.9246	15.7303	0.0000	100.0000
Exptop	358	15.9972	8.5079	1.0000	47.0000

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Variable	Obs.	Mean	Std. dev.	Min	Max
Fmtop	358	0.4246	0.4950	0.0000	1.0000
Tech	358	0.0475	0.2130	0.0000	1.0000
Strategy	358	0.4246	0.4950	0.0000	1.0000
Member	358	0.6229	0.4853	0.0000	1.0000

Source: National expert.

About 42.2% of the companies have their website, indicating moderate adoption of basic ICT tools among the firms. On average, 96.9% of the firms' ownership is by domestic individuals, companies, or organizations, showing that the firms in the dataset are primarily locally owned. The top managers have an average of 16 years of experience in their respective sectors, with a maximum of 47 years and a minimum of one year. Approximately 42.5% of the firms have a female as the top manager. Only 4.8% of the firms use technology licensed from a foreign-owned company, indicating limited adoption of foreign technology.

Approximately 42.5% of the firms have a formalized written business strategy, and 62.3% of the firms are members of a business membership organization or trade association, indicating strong participation in collective platforms.

Table 8 presents the correlation matrix for the variables used in the analysis. This matrix shows the strength and direction of the linear relationship between the variables.

TABLE 8

DEFINITIONS OF VARIABLE.

	Lbpr	*Web*	*Domestic*	*Exptop*	*Fmtop*	*Tech*	*Strategy*
Web	0.3076 ***						
Domestic	–0.1701 ***	–0.0460					
Exptop	0.0795	0.2067 ***	0.0056				
Fmtop	–0.0355	–0.0127	0.1304 **	–0.0669			
Tech	0.2256 ***	0.2082 ***	–0.1478 ***	–0.0355	–0.0589		
Strategy	0.2611 ***	0.4565 ***	–0.0664	0.1839 ***	–0.0290	0.2068 ***	
Member	0.1397 ***	0.1277 **	–0.0610	0.1931 ***	–0.0546	0.0382	0.1903 ***

Note: *, **, and *** denote statistical significance at the levels of 10%, 5%, and 1%, respectively.
Source: National expert.

Labor productivity is positively correlated with having a website (0.3076), indicating that firms with websites tend to have higher labor productivity. It is also positively correlated with the use of technology licensed from foreign companies (0.2256), having a formalized business strategy (0.2611), and business membership (0.1397). But it is negatively correlated with the percentage of

ownership by domestic entities (-0.1701). This suggests that companies with a higher share of domestic ownership might have lower labor productivity, potentially due to fewer resources, limited market access, or technology gaps compared to firms with foreign ownership.

Table 9 presents the regression analysis for all companies. The primary independent variable, the *Web*, is positive and statistically significant at the 1% level across all models (coefficient range: 0.5433 to 0.7640). This finding indicates that companies with a website tend to have higher labor productivity. The result underscores the importance of a digital presence in enhancing operational efficiency, expanding market reach, and improving customer engagement, ultimately leading to increased productivity.

TABLE 9

REGRESSION ANALYSIS FOR ALL COMPANIES.

Variable	Model 1	Model 2	Model 3	Model 4
Web	**0.7640** ***	**0.6785** ***	**0.5485** ***	**0.5433** ***
Domestic	-0.0126 ***	-0.0110 ***	-0.0107 ***	-0.0104 **
Exptop	0.0028	0.0046	0.0027	0.0009
Fmtop	-0.0265	-0.0091	-0.0072	-0.0006
Tech		0.9077 ***	0.8185 ***	0.8187 ***
Strategy			0.3179 **	0.2891 **
Member				0.2027
Intercept	18.2331 ***	18.0320 ***	17.9572 ***	17.8436 ***
Observations	358	358	358	358
F statistics (p-value)	11.9716 (0.0000)	11.5410 (0.0000)	10.5308 (0.0000)	9.3908 (0.0000)
Adj.R^2	0.1095	0.1286	0.1381	0.1413

Note: *, **, and *** denote statistical significance at the levels of 10%, 5%, and 1%, respectively.
Source: National expert.

Domestic ownership is negative and statistically significant in all models, suggesting that a higher percentage of domestic ownership is associated with lower labor productivity. This may imply that domestically owned companies face challenges in accessing external resources or lack the professional management practices needed to optimize productivity.

The experience and gender of top managers do not significantly influence labor productivity, suggesting that other factors may have a more substantial impact on firm efficiency than managerial tenure or gender.

Companies that use licensed technology from foreign-owned companies exhibit significantly higher labor productivity. This finding emphasizes the importance of adopting advanced technology to enhance operational efficiency and competitiveness. Additionally, companies with a formalized written business strategy demonstrate higher labor productivity, highlighting the value of strategic planning in guiding operations and optimizing resource allocation.

Lastly, membership in a business organization shows no significant impact on labor productivity, indicating that participation in such groups may not directly influence a company's operational efficiency. Table 10 summarizes the regression analyses across various subgroups of companies, based on size and sector, with the Web serving as the primary explanatory variable.

TABLE 10

REGRESSION ANALYSIS FOR ALL COMPANIES.

	Model 1	Model 2	Model 3	Model 4
Large Companies				
Web	**0.8267** ***	**0.5501** *	**0.5548** *	**0.5596** *
Observations	84	84	84	84
F statistics (p-value)	2.9963 (0.0234)	5.7115 (0.0002)	4.7000 (0.0004)	4.1006 (0.0007)
Adj.R^2	0.0878	0.2211	0.2110	0.2073
Small and Medium Companies				
Web	**0.5305** ***	**0.5347** ***	**0.3975** **	**0.4069** **
Observations	274	274	274	274
F statistics (p-value)	4.5594 (0.0014)	3.6427 (0.0033)	3.7670 (0.0013)	3.7338 (0.0007)
Adj.R^2	0.0496	0.0462	0.0573	0.0655
Manufacturing Companies				
Web	**1.0188** ***	**0.9983** ***	**0.8295** ***	**0.8328** ***
Observations	115	115	115	115
F statistics (p-value)	10.3011 (0.0000)	9.1693 (0.0000)	8.9448 (0.0000)	7.7388 (0.0000)
Adj.R^2	0.2461	0.2638	0.2949	0.2927
Retail Companies				
Web	**0.7365** ***	**0.5765** **	**0.4602**	**0.4044**
Observations	110	110	110	110
F statistics (p-value)	3.1115 (0.0183)	3.1090 (0.0118)	2.7372 (0.0165)	3.7810 (0.0011)
Adj.R^2	0.0719	0.0882	0.0873	0.1515
Service Companies				
Web	**0.6484** ***	**0.5787** ***	**0.4943** **	**0.4959** **
Observations	133	133	133	133
F statistics (p-value)	5.4426 (0.0004)	4.7385 (0.0005)	4.0654 (0.0009)	3.4708 (0.0020)
Adj.R^2	0.1187	0.1240	0.1223	0.1158

Note: *, **, and *** denote statistical significance at the levels of 10%, 5%, and 1%, respectively.
Source: National expert.

Having a website is positively correlated with labor productivity across all company groups, with the most potent effects observed in manufacturing firms. The results suggest that a digital presence is particularly beneficial in sectors where technology and operational efficiencies play a significant role. However, the explanatory power of the models varies, being more robust for manufacturing companies compared to others.

Remaining Obstacles in ICT Utilization

- The implementation costs of ICT are high for small and medium-sized firms. High initial costs and ongoing maintenance can deter firms from fully utilizing ICT, potentially limiting productivity gains.

- Many Mongolian firms expressed that they lack skilled personnel to use ICT tools effectively, which can hinder productivity improvements. Dedicated training and development are crucial in this field.

Policy Discussion

The government of Mongolia has announced ICT as one of the leading sectors of the economy and aims to become a digital nation within the next five years. Major policy and structural changes, as listed, are being made to accelerate Mongolia's digital transformation.

- VISION-2050 Long-term Development Policy of Mongolia, the Parliament of Mongolia, 2020.
- The Standing Committee on Innovation and e-policy was established within the Parliament in 2020.
- E-Mongolia System and Government online platform, October 2020 (More than 660 public services from 61 Government organizations were introduced, since July 2022).
- The government established the Ministry of Digital Development and Communications (MDDC, www.mddc.gov.mn) in January 2022.
- The e-Mongolia Academy was established to digitalize public services, develop the main and sub systems of e-government, improve digital skills of civil servants, as well as for all, in January 2022.

Current Policies to Promote Firms' Skill Upgrading

The government policy documents related to skill development in the ICT sector in Mongolia are:

- **Digital Mongolia 2020:** This policy framework aims to promote the digital economy, enhance ICT infrastructure, and improve digital literacy and skills among the workforce.

- **National Program for the Development of Information Technology:** This program focuses on developing the IT sector, including initiatives for training and upskilling workers in various ICT fields.

- **ICT Skill Development Policy:** This document outlines strategies for enhancing ICT skills through vocational training and education, ensuring alignment with industry needs and requirements.

- **National Education Sector Strategy:** This strategy encompasses components designed to enhance ICT education in schools and universities, as well as promote Science, Technology, Engineering, and Mathematics (STEM) education.

- **Vocational Training Programs:** These programs focus on establishing and funding vocational training centers that provide skills training tailored to the needs of various industries, including IT, mining, and agriculture.

- **E-government Development Policy:** This policy emphasizes the need for training public sector employees in ICT skills to improve service delivery and efficiency.

- **National Cybersecurity Policy:** This document outlines provisions for training professionals in cybersecurity and addressing the growing need for skilled cybersecurity workers.

- **Public-Private Partnership Initiatives:** Various initiatives encourage collaboration between the government and the private sector to develop training programs focused on ICT skills (Tumen-Ulzii, 2022).

Policy documents and frameworks related to skill development and government policies aimed at skill upgradation for firms typically focus on enhancing the workforce's digital literacy and capabilities to meet the demands of a modern economy. Here are some key elements that may be included in such policies:

- **National Program for SMEs:** Provisions for skill development and training, specifically designed to enhance the digital capabilities of SMEs.

- **National Program on ICT HR:** Enhancing the technical skills of ICT professionals to meet global labor market needs.

- **Vocational Education and Training:** Enhancing the vocational education system to ensure that training programs meet industry requirements and promote lifelong learning.

- **Mongolian Education Sector Strategic Plan:** Emphasizes reforming the education sector, including vocational training, to better equip students for the job market.

Current Policies to Promote ICT Infrastructure

Over the last three years, the Parliament of Mongolia has ratified several new laws to support digital transformation and advance the Digital Nation-Mongolia initiative. Basic sector legislations are the Law on Communications Sector (1995, 2001), the Radio Wave Law (1999), and the Postal Service Law (2003), all of which were amended by the Parliament in 2019 to reflect evolving technological and regulatory needs. In 2020, the Parliament also passed a new legislation for radio and TV broadcasting, the Law on Broadcasting.

To accelerate the country's digital transformation and ensure effective implementation of the Digital Nation, Mongolia has further strengthened its IT-related legal environment. In the past year alone, four new laws were approved by the Parliament and came into effect in May 2022. These laws are as listed:

- Law on Public Information and Transparency

- Law on Digital Signatures
- Law on Cyber Security
- Law on Personal Data Protection

To achieve the Digital Nation initiative, the Government of Mongolia has approved the ICT Sector Medium-Term Development Policy, which will be implemented from 2022 to 2027. This policy document includes:

- **Digital infrastructure:** Ensuring the availability of the main infrastructure to meet the growing needs of ICT
- **E-governance:** To create a bureaucratic and transparent e-government
- **Cybersecurity:** Establish a national security system in the cyber environment
- **Digital literacy:** To improve digital skills for all
- **Innovation and production:** Develop IT, big data, AI, blockchain-based platforms, national digital content, and support to increase the share of the economy;
- **National development accelerator:** Introduce ICT products and services to increase competitiveness and efficiency

Policy Recommendations for Firms' Skill Upgrading Through ICT Vs. R&D

The government and its institutions should promote policies that encourage ICT investment and training, recognizing their potential to drive productivity growth across the economy. Enhancing public digital literacy and reducing the digital divide can significantly contribute to GDP growth. Moreover, introducing new sectors to the economy through the development of IT, big data, AI, blockchain-based platforms, software, and national digital content can increase value-added across most economic sectors.

To achieve this, Mongolia must launch a national development program focused on improving public digital literacy and ICT skills. At the same time, upgrading the country's ICT infrastructure is essential to ensure accessibility for firms of all sizes. This will also help promote incremental progress in financial inclusion.

As service providers increasingly adopt electronic services, they must consider a range of regulatory requirements, including data protection and privacy laws, anti-money laundering regulations, consumer protection laws, electronic signature laws, and cybersecurity regulations.

Firms, in turn, must maintain a robust management system to address data and technological risks. This includes establishing effective internal controls and audit processes to ensure compliance with relevant regulations, an essential step to mitigate risks associated with electronic services.

Firms can ensure their management system competency is up-to-date by implementing the following strategies:

- **Continuous training and development:** Provide regular training programs to enhance employees' skills and knowledge about the latest management practices and technologies.
- **Adopting best practices:** Stay informed about industry best practices and benchmarks, and incorporate them into the management system.
- **Technology integration:** Utilize modern management software and tools that facilitate efficient processes and data management.
- **Networking and community involvement:** Participate in industry conferences, workshops, and forums to share knowledge and learn from peers.
- **Adaptability and flexibility:** Foster a culture that encourages adaptability to change, enabling the firm to respond quickly to new challenges and opportunities.
- **Investing in R&D:** Allocate resources for R&D to explore innovative management practices and technologies that can enhance competency.

Conclusion

Mongolia has significant potential to advance its digital strategies, supported by its strong mobile subscription base and mobile broadband penetration, both of which exceed the global average.

Following the pandemic, government interventions have accelerated the adoption of electronic services among both consumers and businesses. This has led to increased use of digital banking and e-commerce platforms. With the development of IT, labor productivity in the banking sector has improved, expanding opportunities to engage customers and enhancing firms' access to financial services.

Overall, research findings indicate a positive association between ICT utilization and firm productivity. However, the strength of this relationship may vary based on factors such as industry, firm size, and the scale of ICT investment.

To support broader economic upgrading, the government must establish cross-institutional partnerships that foster collaboration among stakeholders, including education, industry, and science and technology sectors. The partnerships should jointly develop and implement policies and plans for digital transformation. Decision-makers should also regularly review ICT performance and take proactive steps to leverage ICT investment, particularly to support SME development and increased labor productivity.

Improved ICT infrastructure and skills contribute to greater equity and competitiveness, drive productivity and quality gains, help firms meet international standards, and enable them to access and compete in the global markets.

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NEPAL

Summary

Infrastructural limitations, high trading costs, and a lack of skilled labor hinder Nepal's integration into GVCs. This study explores the current position of Nepalese firms within GVCs, emphasizing the need for skill upgradation and the transformative potential of ICT. While government initiatives like the Digital Nepal Framework (DNF) (2019) and the Nepal Trade Integration Strategy (NTIS) (2023) have encouraged ICT adoption, several barriers exist. These include weak infrastructure, limited technical expertise, and financial constraints. Data analysis from the WBES 2023 highlights low levels of innovation, minimal international certification, and challenges in digital adoption, particularly in areas such as e-payment systems.

Regression analysis of the WBES 2023 survey data indicates that Internet access has a positive impact on labor productivity. However, standalone digital factors, such as e-payments and online presence, do not show a significant impact. The study underscores the need for strategic investments in digital infrastructure, targeted training, and policy support to enhance Nepal's competitiveness. Key recommendations include strengthening ICT infrastructure via government undertakings and providing incentives to the private sector, improving infrastructure resilience, fostering digital literacy, and encouraging SMEs to establish and improve their digital presence. These measures aim to address current limitations and harness the potential of ICT in advancing Nepal's economy and integration into the GVC.

Introduction

Current Position of Firms in the GVC

GVCs have emerged as a critical aspect of international trade, enabling countries to specialize in specific segments of production. This changing context of international trade has essential implications for least developed and developing countries like Nepal to participate in GVCs to generate productive activities, eventually increasing entrepreneurship and employment opportunities for the country. Active engagement in GVC is also expected to lead to dynamic benefits such as

- Investment and upgrading of productive capacity, contributing to economic diversification and resilience,
- Backward linkages leading to broad-based economic growth, and
- Knowledge creation that helps in increasing skills.

Nepal's engagement in GVCs remains limited due to geographical, infrastructural, and economic factors. Geographically landlocked, Nepal has limited access to international markets. This geographical complexity also causes issues in regional markets. In the FY 2023–24, Nepal's export value of trade with India was 67.71% of the total export value, while the sum of export value of trade

with eight other nearby countries[1] amounted to 2.76% (GoN, 2024). The landlocked situation also necessitates enhanced diplomatic trade facilitation through India, requiring more robust foreign relations and trade policies. Similarly, it also adds to the cost of trading at a time when the cost of trading matters more for GVC participation (Basnet and Pandey, 2014). Past studies have shown Nepal is one of the least integrated regions globally, with limited regional supply chains.

The WBES 2023 survey highlights significant challenges faced by firms in Nepal in integrating into the GVC. The survey showed that out of 582 firms, only 65 firms have acquired quality certifications that are internationally recognized, limiting access to global markets. In comparison, only 29 firms are engaged in export activities, and 53 are focused on international markets. It has also been observed that logistical delays further hinder international trade, with customs clearance taking an average of 4.5 days and border controls 8.75 days, including the high export compliance costs amounting to 3.67% of the product value. Furthermore, the survey shows that the 475 firms have not developed new products or features in the last three years, indicating a low innovation level. Given that competition in global markets is intensifying, further challenges await Nepali firms that intend to expand into the international market. This underscores the need for improved innovation, certification, and streamlined export processes to enhance Nepal's participation in the GVC.

As a land-locked country, factors beyond Nepal's borders also have important implications for production and trade competitiveness, which can influence Nepal's participation in GVCs. Thus, firms in Nepal will need to assess linkages and location within GVCs, as well as the productive capacities needed to move up the value chain. To address the challenges and to engage in GVC, the Government of Nepal (GoN) has also prioritized the need for Nepal's participation in GVC at the policy and institutional level. For instance, Nepal's NTIS 2023 recognizes the importance of GVCs for export development (Ministry of Industry, Commerce and Supplies, 2023). The GoN has also formulated the DNF in 2019, which serves as a roadmap for the digital economic future in eight different categories, which are further divided into eighty different digital initiatives. In addition to the policy and institutional efforts, developing countries like Nepal need help building appropriate capacity, especially in the ICT sector, to participate effectively in GVCs and benefit from them (Basnett & Pandey, 2014). Businesses in Nepal are also gradually adopting technological advancements in production and innovations while embracing digitalization and new technologies such as generative AI, cloud computing, virtual reality, and others.

Importance and Necessity of Skill Upgrading

As developing and least-developed countries like Nepal deepen their engagement with the global economy, human capital emerges as a critical driver for competitiveness. This necessitates a concerted effort to upgrade skills, particularly in ICT, to align workforce capabilities with the demands of GVCs. Participation in GVCs offers opportunities for economic growth. However, it also requires countries to enhance their workforce's technological and digital competencies, to sustain and upgrade their positions in these chains, as domestic supply chains are influenced by the international standards of the global chains (Stark et al., 2012). Effective integration into GVCs has been shown to spur innovation within firms, compelling them to meet international efficiency, quality, and digital connectivity standards.

Nepal's ambition to participate in GVCs presents unique opportunities and challenges for its firms. These challenges include a lack of trained human capital, inadequate infrastructure, limited

[1] These countries include Afghanistan, Bangladesh, Bhutan, China, the Maldives, Myanmar, Pakistan, and Sri Lanka.

financial access, and weak integration into global markets. Such obstacles hinder various forms of economic upgrading, including process, product, functional, and cross-sectoral advancements. Addressing these constraints requires significant investment in skill upgradation, with ICT at the forefront of these efforts. Strengthening digital capabilities enables firms to adopt higher-value-added processes, improve transparency, and meet global standards, thereby enhancing their competitiveness in international markets.

For instance, introducing a digital traceability system for Nepal's orthodox tea processors has showcased the transformative potential of ICT in promoting transparency and quality assurance (Republica, 2023). This system ensures compliance with international standards by leveraging ICT to document and track every stage of tea production—from cultivation and harvesting to processing, packaging, and distribution. It provides verifiable data about the origin of Nepali tea, instilling confidence among GVC actors and enhancing the product's competitiveness. Such examples highlight how digital technologies can create avenues for market integration and economic upgrading.

The GoN has also recognized the critical role of ICT and skills development in addressing these challenges and has introduced various job training and vocational programs, particularly targeting youth. These programs aim to build a digitally proficient workforce capable of meeting the demands of both domestic and global markets. While evaluations show that skill-enhancement programs have improved employment outcomes, skepticism remains regarding their long-term impact. Firms face resource-based and capability-related barriers to innovation, such as limited access to skilled labor, market information, finance, robust ICT infrastructure, and intellectual property protection.

Constraints on Firms' Skill Upgrading and ICT's Potential

Despite the growing recognition of the importance of skill development, businesses in the country encounter numerous barriers to workforce enhancement. Macroeconomic instability, limited access to financial services, low capital formation, and inadequate investment are persistent issues that undermine the capacity of firms to invest in skill development. Firms in Nepal also face issues such as low savings and restricted access to credit, further compounding the difficulty of upgrading the skills of their workforce (Panda, 2016). Another critical issue is the lack of robust industrial policies and their implementation to address these constraints. Weak public infrastructure, such as unreliable energy supplies and poor transport systems, creates additional hurdles. Furthermore, the absence of strong educational and vocational training systems limits the availability of skilled labor, leaving firms unable to meet the demands of a competitive global market (World Bank, 2020). The result is a vicious cycle where firms struggle to upgrade their operations, improve efficiency, and participate meaningfully in GVCs.

For least developed countries like Nepal, ICT adoption presents a significant opportunity to overcome many barriers hindering skill upgradation and firm growth. By improving operational efficiency, facilitating access to global markets, and fostering innovation, ICT enables firms to enhance their productivity and competitiveness. ICT provides firms with real-time access to market information, streamlines communication between suppliers and customers, and enables the adoption of advanced technologies (Chong et al., 2001). These capabilities help break the traditional barriers of geographical isolation and high transaction costs, and secondly, help SMEs compete with larger and more established global players. For example, the introduction of digital traceability systems in Nepal's orthodox tea industry demonstrates the transformative potential of

ICT. These systems allowed firms to document and track every stage of tea production, from cultivation to distribution. By ensuring transparency and compliance with international standards, ICT enhanced the competitiveness of Nepali tea in global markets (Republica, 2023). Such innovations underscore how digital tools can empower firms to improve their operations and achieve greater integration with GVCs.

While ICT offers immense potential, several obstacles hinder its effective adoption by firms in Nepal. Many firms lack the technical expertise to implement and manage ICT solutions, highlighting the need for targeted training programs. Furthermore, the trend of migrating IT graduates, mainly to study or work abroad, has also led to a shortage of experienced workers in the market (Lemma et al., 2017). Moreover, regulatory and legal barriers, including inadequate intellectual property protection and weak enforcement of digital policies, discourage investment in ICT. Limited access to ICT infrastructure, such as reliable Internet and affordable digital tools, remains a significant challenge. Chapter III looks into the recent development in the ICT infrastructure sector in Nepal.

Background Statistics of ICT

Infrastructure of Broadband Internet

The price of broadband Internet in Nepal is lower than in other countries, including India, Bangladesh, Afghanistan, and Pakistan, with the average monthly Internet price being USD13.15 (Howdle, 2020). Broadband Internet service, which was launched in Nepal to provide Internet facilities at all local levels to increase access to information and communication, reached all 753 local level offices, including 5,951 ward offices, by mid-March of 2023. Similarly, broadband Internet connection has reached 4,272 health centers and 5,341 community secondary schools (Ministry of Finance, 2023).

Under the construction of the information highway, which connects the mid-hill highway and adjoining district headquarters, 12,238 km of optical fiber have been laid as of mid-March 2023. Free WiFi hotspots are operating at religious and tourist places, including Sagarmatha Base Camp trail, Barah Area, Annapurna trekking route, Muktinath Temple Complex, Janaki Temple Complex, Pathibhara Temple, Halesi Temple, Gurdwara, Gadhimai Temple Complex of Bara, and Panch Kashmiri (Takia Mosque) (Ministry of Finance, 2023).

Furthermore, in the realm of public service, the Government Integrated Data Center has been established as a high-grade data center that provides services such as data storage, sharing of computing resources, and email, Internet, and website hosting at the national level to be used by all entities of the GoN. Likewise, some popular private data centers such as Datahub Nepal, Cloud Himalaya, and Access World have emerged, among others, due to burgeoning Internet usage and data-driven institutions.

These structures are built on the foundation of Nepal's National Broadband Policy of 2015, a landmark policy in the realm of ICT that emphasizes developing broadband infrastructure and expanding access to high-speed Internet services in the rural parts of the country.

Household Usage of Internet and Mobile Phone

Currently, in Nepal, mobile phone services utilizing 2G/GSM, 3G/WCDMA, and 4G/LTE are in commercial use. A survey by the National Statistics Office reveals that 73% of Nepali households now own smartphones, which also reinforces the use of Internet-at-hand and reflects a growing reliance on

digital devices among Nepali households (National Statistics Office, 2023). Furthermore, there are over twenty million mobile banking users and over 1.8 million Internet banking service users in Nepal (Ministry of Finance, 2023). The user base of mobile banking and Internet banking has increased after the pandemic, although at a decreasing rate. In FY 2022–23, the number of mobile banking users increased by 16.7% and reached 21.36 million. Similarly, the number of Internet banking users increased by 10.2% in FY 2022–23 and reached 1.86 million (Nepal Rastra Bank, 2023).

Electronic Payment Systems

Nepal Rastra Bank, the central bank of Nepal, regulates the e-payment systems to ensure security, reliability, and compliance with global standards. The central bank has granted permission to the Nepali payment system operators to simplify and facilitate digital retail payments, both nationally and internationally. The QR Code-based payment system introduced by one of the payment services further initiates a new standard for digital transactions. Commercial banks and FIs have also adopted the QR Code-based payment system, which has opened the doors for convenient transactions for customers, further ensuring a streamlined and accessible financial system. The number and value of QR code-based transactions have increased by 189.53% and 159.67% respectively in FY 2022–23 compared to FY 2021–22. This reflects a significant development in Nepal's digital payments system. Moreover, the use of mobile wallets has increased significantly to 18.94 million transactions, as of mid-July 2023, with a total transaction amount valued at NPR219.81 billion.

This remarkable shift was further enhanced after the pandemic, which prompted people to utilize digital platforms and instruments such as connectIPS, eWallet, mobile banking, Internet banking, QR codes, and cards. Further, e-commerce and POS transactions have also increased after the pandemic. For instance, ConnectIPS has become a key platform in expediting efficient and seamless financial transactions. The number of transactions through ConnectIPS surged by 27.5%, from the FY 2021–22 to FY 2022–23, while the total value of these transactions increased by an impressive 33.5%. Overall, it has been observed that the post-pandemic era has brought a dramatic shift towards digital payment methods (Nepal Rastra Bank, 2023).

Nepal Payments System Development Strategy, 2024 is a key strategy introduced by the Central Monetary Authority, i.e., Nepal Rastra Bank, to achieve a safe and efficient national payments system that effectively contributes to the country's financial stability and economic growth (Nepal Rastra Bank, 2014).

Data Analysis and Interpretation

The empirical analysis for this research is based on the WBES 2023, which includes a comprehensive survey of 582 establishments across Nepal. Although panel data from previous surveys is available, the most recent wave of WBES contains key variables not present in earlier waves, such as 2009 and 2013, which hinders a detailed analysis of Internet adoption and Internet-related services. Consequently, the analysis relies on cross-sectional data from the 2023 survey.

ICT Utilization and Obstacles

Firms and Electricity Use

Table 1 presents the annual cost of electricity as a share of total sales across four sectors. The hotel sector exhibits the highest average burden of electricity costs, with a mean of 5.39%, a median of 4.29%, and a significant maximum of 28.8%, reflecting its energy-intensive nature due to round-the-clock operations and high energy demands for heating, cooling, and lighting. The manufacturing

sector shows the highest maximum share of electricity costs at 32.08%. However, its mean and median values are relatively moderate at 2.49% and 1.25%, respectively, indicating that while some firms face substantial electricity costs, the majority have more manageable shares.

The retail sector has the lowest mean of 0.66% and median of 0.20%, with a maximum of 12.0%, indicating minimal electricity expenses in most firms. Similarly, the other services sector demonstrates a relatively low burden, with a mean of 1.52% and a median of 0.67%, though it has a maximum of 10.78%, showing some variability among firms. Overall, the aggregated statistics reveal that electricity costs account for an average of 2.48% of total sales, with a median of 1.04%, but the maximum of 32.08% highlights significant variation among the firms.

TABLE 1

ANNUAL COST OF ELECTRICITY AS A SHARE OF TOTAL SALES (IN %).

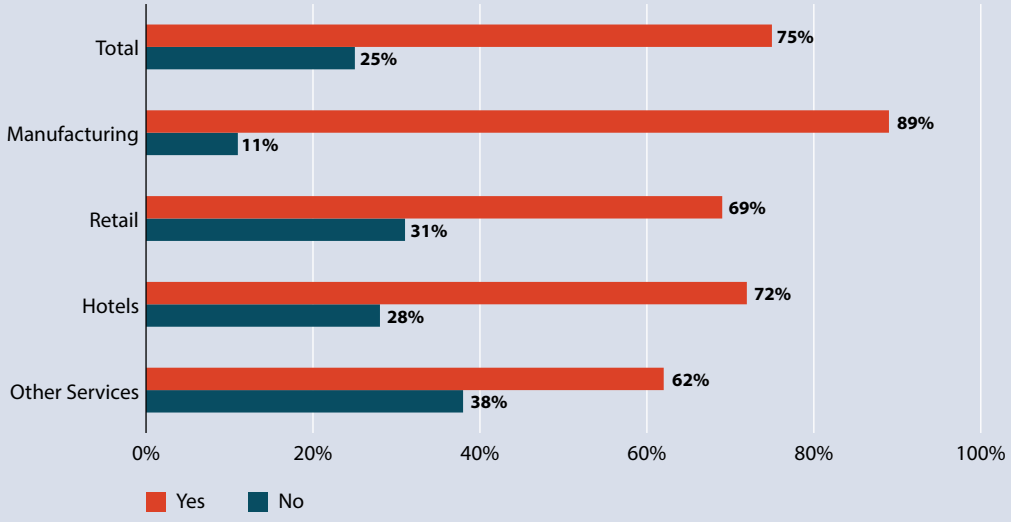
Sector	N	Max	Min	Mean	Median
Hotels	117.000	28.800	0.250	5.392	4.286
Manufacturing	211.000	32.084	0.008	2.489	1.250
Retail	118.000	12.000	0.007	0.661	0.198
Other Services	122.000	10.776	0.005	1.521	0.667
Overall	579.000	32.084	0.005	2.480	1.041

Source: World Bank Enterprise Survey, 2023.

Figure 1 displays the percentage of firms facing power outages in each sector during the last FY. In the retail sector, 69% faced outages, and 62% in other services reported similar issues. Notably, the manufacturing sector is the least affected, with only 11% of the establishments experiencing outages. In contrast, the hotel sector showed a higher prevalence of power outages, with 72% of firms reporting outages.

FIGURE 1

PERCENT OF FIRMS FACING POWER OUTAGES (SECTOR WISE).



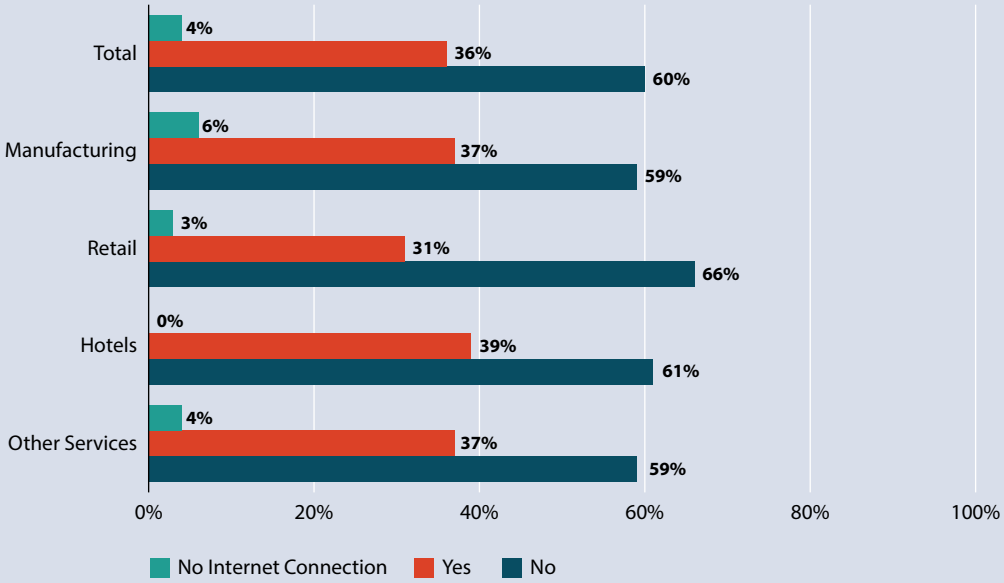
Source: World Bank Enterprise Survey, 2023.

Firms and the Internet

Figure 2 shows the percentage of firms that have faced Internet disruptions in the last FY and the percentage of firms that do not have access to Internet services at all. Only 4% of the establishments have no Internet connection, which shows high Internet adoption. Even though Internet adoption is high, more than 30% of firms in each sector have faced some Internet disruption. This represents a considerable hurdle for adopting ICT services, such as websites, e-payments, and digital marketing.

FIGURE 2

PERCENT OF FIRMS FACING INTERNET DISRUPTIONS (SECTOR WISE).



Source: World Bank Enterprise Survey, 2023.

Table 2 reflects the annual cost of the Internet as a share of total sales across four sectors. In the hotel sector, the cost of Internet is a relatively higher burden than other sectors, with a mean of 0.85% and a median of 0.50%. The maximum value is 5.97%, suggesting that while most hotels incur modest Internet expenses, some experience a significantly higher share of the total sales dedicated to Internet costs. The manufacturing sector shows a very low average Internet cost, with a mean of just 0.005% and a median of 0.012%. The maximum value of 1.05% indicates that while some manufacturing firms may face slightly higher Internet expenses, the majority incur minimal costs as a share of total sales.

The retail sector has a mean of 0.095% and a median of 0.035%, with a maximum value of 1.18%. This suggests that Internet costs represent a small proportion of sales for most retail firms, with a few exceptions experiencing a higher share of sales attributed to Internet expenses. The other services sector reflects a slightly higher cost of Internet than manufacturing and retail, with a mean of 0.242% and a median of 0.119%. The maximum value of 2.57% shows some variability, though most firms still experience relatively low Internet costs as a percentage of sales. Overall, Internet costs account for an average of 0.265% of total sales, with a median of 0.052%. The maximum cost of Internet, at 5.97%, indicates that while Internet expenses are generally low across most sectors, there are instances where firms face notably higher costs than their total sales.

TABLE 2

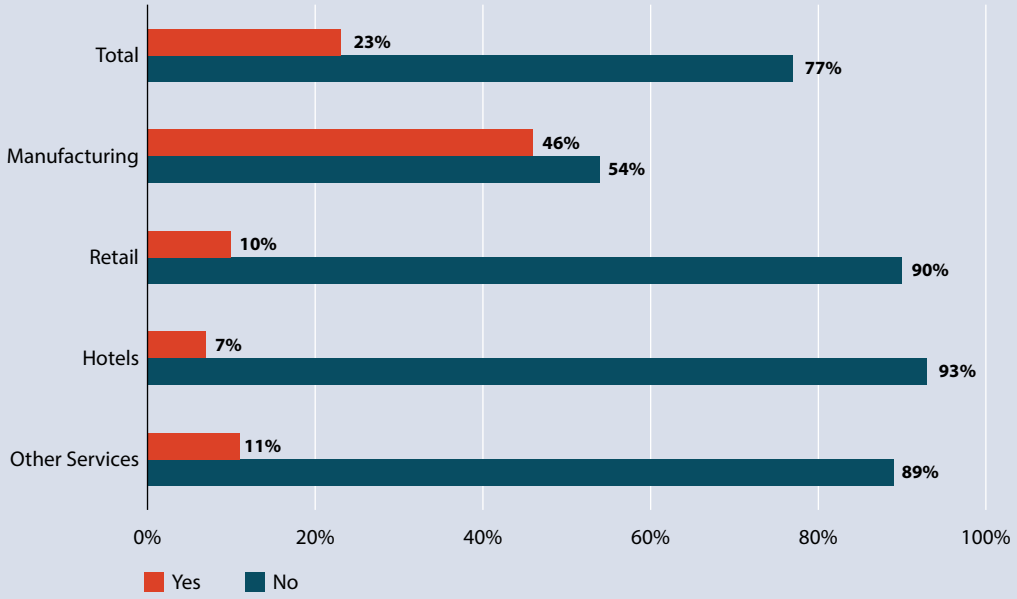
ANNUAL COST OF INTERNET AS A SHARE OF TOTAL SALES (IN %).

Sector	N	Max	Min	Mean	Median
Hotels	118.000	5.972	0.007	0.850	0.500
Manufacturing	211.000	1.050	0.000	0.005	0.012
Retail	118.000	1.180	0.000	0.095	0.035
Other Services	133.000	2.571	0.000	0.242	0.119
Overall	580.000	5.972	0.000	0.265	0.052

Source: World Bank Enterprise Survey, 2023.

FIGURE 3

PERCENT OF FIRMS USING E-PAYMENTS (SECTOR WISE).



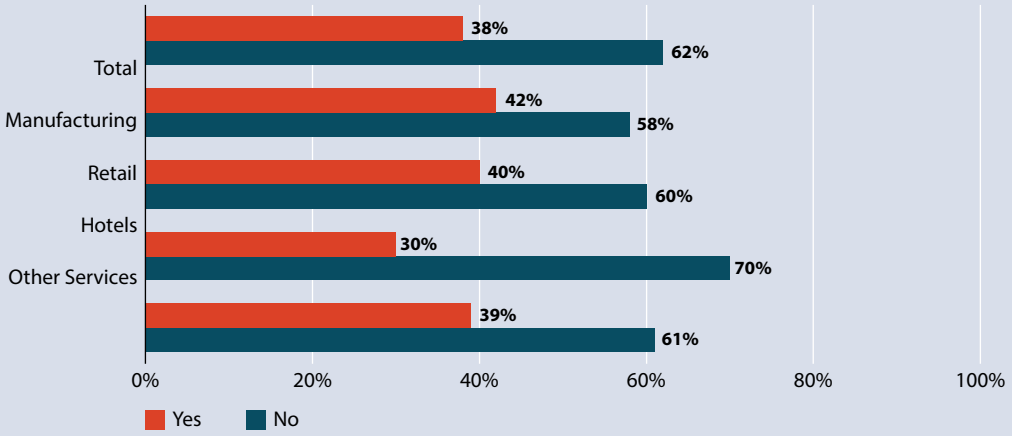
Source: World Bank Enterprise Survey, 2023.

Figure 3 illustrates the percentage of firms, by sector, that use e-payments for financial transactions. Overall, 77% of firms use e-payments as a method of financial transaction, indicating a significant shift towards a cashless environment. Apart from manufacturing, where only 54% of the firms use e-payments, in all other sectors, approximately 90% use e-payment methods.

Similarly, Figure 4 reveals key observations about the online presence of businesses across different sectors. Overall, 62% of businesses have adopted websites or social media, highlighting a significant trend toward digital engagement. Notably, hotels lead the way, with 70% of businesses having an online presence, indicating a strong reliance on digital marketing for customer interaction. The retail sector (60%) and other services (61%) also show considerable engagement, reflecting their effectiveness in utilizing online platforms. In contrast, the manufacturing sector has the lowest online presence at 58%, suggesting a more traditional approach, which may hinder its marketing effectiveness.

FIGURE 4

PERCENTAGE OF FIRMS WITH WEBSITE OR SOCIAL MEDIA PRESENCE (SECTOR WISE).



Source: World Bank Enterprise Survey, 2023.

Firm Productivity

Firm productivity is measured using labor productivity. Labor productivity for each firm can be calculated simply by dividing total profit by the number of workers. Total annual sales data are used as a proxy for profit.

Labor Productivity = total annual sales/number of workers

Labor Productivity and ICT Utilization

The following regression equation measures the effect of ICT utilization on the labor productivity of the firms:

$$(\text{log\_LP})_i = \beta_0 + \beta_1*(\text{log\_annual\_cost\_of\_electricity})_i + \beta_2*(\text{log\_annual\_cost\_of\_Internet})_i + \beta_3*(\text{power\_outages})_i + \beta_4*(\text{websites})_i + \beta_5*(\text{used\_epayments})_i + \beta_6*(\text{Internet\_access})_i + \beta_7*(\text{Internet\_disruption})_i + \beta_8*(\text{control variables})_i + \varepsilon_i$$

The given equation represents a linear regression model where the dependent variable is the natural logarithm of labor productivity (log_LP) for firm i.

The independent variables in the model capture various ICT-related factors that influence labor productivity. The annual cost of electricity refers to the total expenditure incurred by the firm on electricity during the last FY. This variable reflects the financial burden of energy consumption, which can significantly impact operational costs, especially in energy-intensive sectors. Similarly, the annual cost of the Internet represents the total expenditure on Internet services in the last FY. The logarithmic form of the annual cost of electricity and Internet is used for regression.

Power outage is a binary variable indicating whether the firm experienced any disruptions in electricity supply during the last FY (1 if yes, 0 if no). Power outages can disrupt production schedules, reduce efficiency, and lead to higher costs due to reliance on alternative energy sources. Internet access captures whether the firm has a functional Internet connection (1 if yes, 0 if no), serving as a fundamental infrastructure for digital operations.

Likewise, Internet disruption is a binary variable indicating whether the firm faced interruptions in Internet connectivity (1 if yes, 0 if no). Frequent Internet outages can impede communication, online transactions, and digital operations, which are essential for maintaining productivity in a connected economy.

The website indicates whether the firm maintains a website or social media handle (1 if yes, 0 if no). An online presence can enhance visibility, customer engagement, and operational efficiency. The use of e-payments measures whether the firm has completed any financial transactions using e-payment systems (1 if yes, 0 if no). The use of e-payments reflects the firm's integration into digital financial ecosystems, which can streamline operations and reduce transaction costs.

Analysis and Discussion

TABLE 3

REGRESSION RESULTS.

Variables	(1) Log of Labor Productivity
Log of annual cost of electricity	0.192*** (0.0380)
Log of annual cost of Internet	0.0403 (0.0422)
Firm faced power outages (=1 if firm faced power outages)	0.0684 (0.120)
Firm has a website (=1 if firm has a website)	0.0855 (0.110)
Firm used e–payments (=1 if firm used e–payments)	–0.218 (0.133)
Firm faced Internet disruptions (=1 if firm faced Internet disruptions)	–0.00327 (0.105)
Firm has Internet access (=1 if firm has Internet access)	0.898* (0.481)
Firm size is small (=1 if firm size is small)	0.0321 (0.209)
Firm size is medium (=1 if firm size is medium)	0.0513 (0.177)
Firm belongs to manufacturing sector (=1 if firm belongs to manufacturing sector	0.190 (0.165)
Firm belongs to hotel sector (=1 if firm belongs to hotel sector)	–1.226*** (0.160)
Firm belongs to retail sector (=1 if firm belongs to retail sector)	0.998*** (0.150)
Constant	10.98*** (0.586)
Observations	579
R–squared	0.366

Note: Standard errors in parentheses, *** p<0.01; ** p<0.05; * p<0.1.
Source: World Bank Enterprise Survey, 2023.

The regression results reveal several important relationships between the characteristics of the firms and labor productivity. The log of annual electricity cost demonstrates a strong and highly significant positive relationship with productivity ($p < 0.01$), suggesting that firms investing more in electricity experience enhanced operational efficiency. This may indicate that electricity is a critical input for productive activities, enabling firms to sustain energy-intensive processes and infrastructure. In contrast, the log of annual Internet cost shows a positive but statistically insignificant effect. While Internet services likely support productivity indirectly, their isolated impact becomes less pronounced when other factors are controlled for.

Internet access plays a vital role in enhancing productivity, as evidenced by its weakly significant and positive relationship ($p<0.1$). The large coefficient size underscores the transformative potential of connectivity, facilitating digital integration and operational efficiency. However, having a website, while positively associated with productivity, does not yield statistically significant results. This suggests that while an online presence may offer advantages, its standalone impact on productivity might depend on complementary factors, such as effective utilization or integration into broader business strategies.

Interestingly, firms using e-payment systems show a negative, though statistically insignificant, relationship with productivity. This could indicate transitional inefficiencies or challenges in adapting digital payment technologies, which might outweigh their potential benefits in the short term. Similarly, power outages and Internet interruptions do not significantly affect productivity. This resilience suggests that firms might have adopted adaptive measures to mitigate the impact of such disruptions on their operations. Overall, the findings emphasize the importance of strategic investments in digital and energy infrastructure. While spending on electricity remains a critical driver of productivity, Internet access is emerging as another key enabler of operational success.

Policy Discussion

Current Policies to Promote Firms' Skill Upgrading

To address the increasing need for skill upgradation in industrial firms, the Government of Nepal formulated the Industrial Policy 2011, aiming to bring about positive changes in the country's economic and social sectors through rapid industrial development. The Industrial Policy 2011 analyzes current challenges, the present situation of the industrial sector, and the desirable policies. The most relevant provisions include the promotion of industrial entrepreneurship through the use of the latest technology and the development of human resources and managerial capacity (Kharel & Dahal, 2021). The highest level of priority has been given to developing and achieving new technology in national and industrial units to increase the competitive capacity of industrial products and services, quality, and productivity. Furthermore, the National Startup Enterprise Policy 2023 explicitly stated that concessions should be provided on the use and development of IT by startups of Nepal, as well as the reintegration of returning labor migrants by reskilling and upskilling such employees.

Current Policies to Promote ICT Infrastructure

Nepal's ICT development journey began with the IT Policy 2000, the country's first e-government-friendly policy. This policy focused on establishing a nationwide telecenter network, IT parks, and knowledge-based industries. It highlighted the legalization and promotion of e-commerce, encouraged both domestic and foreign investment in the IT industry, and provided the necessary infrastructure and resources for the e-government, including an information superhighway and IT

services for rural areas. The policy also emphasized human resource development and compulsory computer education in schools. The Electronic Transaction Act, 2008, was introduced to strengthen the ICT infrastructure further and regulate and legitimize electronic transactions. Similarly, the E-Communication Standardization Directives, 2010, established regulatory frameworks for electronic transactions and e-commerce.

In 2010, a revised IT Policy addressed the digital divide by incorporating intellectual property rights and anti-dumping provisions, prioritizing domestic products, information security, and data protection. This policy encouraged industry-academia collaboration and public-private partnerships to establish electronic hardware technology parks and attract stakeholders. The current Information Communication Policy, 2015, reflects a comprehensive approach to ICT development. It aims to position ICT as a driver of sustainable development and poverty reduction. Key priorities include promoting e-learning systems, adopting IT-enabled educational management systems, and facilitating e-commerce adoption, particularly by SMEs in agriculture, tourism, and manufacturing. It also emphasizes productivity and growth in non-traditional export sectors (Acharya, 2016).

The government took a major step towards digitalizing its services by introducing the DNF in 2019. This initiative aims to harness disruptive technologies for socioeconomic growth across eight key sectors: digital foundation, agriculture, health, education, energy, tourism, finance, and urban infrastructure. Additionally, the "National Strategy on the Development and Use of E-commerce in Nepal, 2019" emphasizes upgrading ICT infrastructure, enhancing data security, and improving e-payment systems (MOICS, 2019).

Conclusion

This research report highlights the importance and issues of ICT adoption in Nepali firms to enhance the integration of the Nepali economy in GVC. The empirical analysis illustrates that Internet access positively impacts labor productivity. However, Nepali firms have not been able to harness the potential of having a website. Similarly, Nepali firms are also having difficulty in adopting e-payment systems. This calls for strategic investments in digital and energy infrastructure. From the policy lens, the government has made strides through various policies to foster skill upgradation and ICT development, focusing on leveraging technology for economic growth and global competitiveness. Policies such as the Industrial Policy, 2011, and the DNF, 2019, provide a foundation for addressing Nepal's digital and infrastructural challenges. However, continued investment in human capital, digital infrastructure, and innovation is essential for Nepal to fully capitalize on the opportunities presented by ICT and integrate effectively into GVCs.

Nepal faces significant challenges in participating effectively in GVCs due to infrastructure limitations, high trading costs, and a lack of skilled labor. While the government has introduced several policies to improve ICT capabilities, such as the NTIS 2023 and the DNF 2019, the country's integration into GVCs remains constrained by macroeconomic instability, financial barriers, and inadequate industrial policies. Nevertheless, ICT adoption offers considerable potential to overcome these challenges by enhancing operational efficiency, innovation, and access to global markets, as seen in sectors like the tea industry. Progress in ICT infrastructure, including widespread broadband Internet, mobile connectivity, and the development of digital payment systems, has improved digital accessibility across Nepal. The increase in mobile and Internet banking usage and the substantial growth of e-payment systems reflect a positive shift towards a

digital economy. Despite these advancements, challenges such as limited technical expertise, migration of skilled workers, and insufficient infrastructure continue to impede full ICT adoption.

Recommendations for Future Prospects

- The negative impact of e-payments on labor productivity suggests that businesses face challenges integrating such sophisticated systems into their simple business models. To address this, the government should provide targeted support for adopting e-payment technologies, such as organizing workshops and certification programs in partnership with technology providers and FIs to train employees on e-payment system integration and management. Similarly, standardizing e-payment platforms and ensuring compatibility across different systems can reduce integration difficulties and remove the need to reorient employees using multiple platforms.

- SMEs must be encouraged to establish and maintain a digital presence through websites, mobile apps, and social media platforms. Governments could offer incentives, such as tax breaks or grants, to businesses, especially startups, to help them expand their online presence and operational efficiency.

- Nepal still faces unforeseen power outages, resulting in a decline in industrial productivity. Policymakers should implement measures to improve the resilience of ICT infrastructure. One such measure is investing in backup power solutions, such as generators or solar power, to ensure business continuity during outages. Likewise, the government should collaborate with the private sector to expand and enhance reliable Internet infrastructure and accessibility in remote areas, as the Internet is critical for skill upgradation and improving labor productivity. Such collaboration models can be explored through Public Private Partnerships.

- The Government of Nepal should subsidize and cost-share international certifications (e.g., ISO, HACCP) to enhance product quality and market access. It should also provide technical assistance for certification readiness through training and advisory services. To foster innovation, establish innovation grants and sector-specific incubation centers with testing facilities and mentorship for product development aligned with global standards. Additionally, certified products should be promoted through trade fairs and a "Certified in Nepal" branding program to connect businesses with international markets, and buyers can be introduced. These measures will strengthen competitiveness and boost exports for Nepali products.

- The Government of Nepal should improve partnerships with fintech companies, including payment providers, to offer cashback, discounts, or loyalty rewards to both businesses and customers engaging in e-payment transactions. This can also be supplemented by introducing policies that encourage digital invoicing to promote financial transparency and simplify the adoption of e-payments.

- Nepal should ratify the plurilateral agreement on IT, which would foster a conducive environment for the development and accessibility of IT products and services. By eliminating tariffs and reducing trade barriers on IT products covered under the agreement, Nepal can facilitate the import of advanced technologies at more competitive prices, making ICT tools and devices more affordable for MSMEs, educational institutions, and individual users, promoting digital transformation across various sectors.

- Scale up vocational and ICT training programs, especially for youth and SMEs. Integrate digital skills, including digital marketing, e-commerce, cloud computing basics, and social media management, into secondary and post-secondary education curricula to promote digital orientation among young people.

- Introduce "Connectivity Bonds" as a specialized government-guaranteed financial instrument for local investors, particularly in remote locations. These bonds would serve a dual purpose: to channel funds into critical connectivity projects, such as high-speed Internet connectivity, while fostering greater local citizen participation in national development efforts by leveraging domestic resources.

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PAKISTAN

Summary

This study examines the role of ICT in boosting productivity at the firm level and driving economic growth in Pakistan. Despite recent policy initiatives and improvements in the digital landscape, Pakistan's productivity growth remains slow. This stagnation is primarily due to structural challenges, infrastructure gaps, and limited access to ICT. This study evaluates the current ICT environment, the stages of ICT adoption at the firm level, and its overall impact on productivity in Pakistan. The findings indicate that ICT adoption significantly enhances productivity, particularly for larger firms. In contrast, firms in the manufacturing and service sectors exhibit lower productivity, implying that they face significant operational and technological challenges. The study also highlights the critical role of workforce education in boosting TFP. The study concludes with recommendations that the government should ease regulations, foster a competitive environment, and encourage firms to adopt digital technologies by promoting digital literacy. These, in turn, will help SMEs gain better access to capital for sustainable business development.

Introduction

Productivity at the firm level is crucial for economic development, particularly in developing countries like Pakistan, where enhancing industrial performance can drive national prosperity. At the firm level, productivity goes beyond just using resources efficiently. It also involves adopting innovative practices and technologies that enable companies to remain competitive in an increasingly globalized market. Economic upgradation, where firms improve their capabilities and transition into higher-value activities, has become a central policy objective in Pakistan. A key element in this process is the integration of ICT, which can drive innovation, improve productivity, and streamline operations across various sectors.

Pakistani firms face systemic barriers in achieving productivity gains, despite the recognized importance of ICT. Studies highlight critical infrastructural and institutional challenges, including poor Internet connectivity, underdeveloped digital infrastructure, and low levels of digital literacy (Jamil, 2021). Many firms also grapple with outdated training frameworks, misalignment between industrial needs and educational curriculum, and financial constraints that limit investments in modern technologies. Broader institutional gaps, such as inconsistent policy support for digital transformation and resistance to organizational change, compound these issues. For instance, SMEs, which form the backbone of Pakistan's economy, often lack the resources to adopt advanced technologies or retrain employees, leaving them trapped in low-productivity cycles (Archer et al., 2020).

Studies have consistently shown that adopting ICT is vital for boosting productivity (Aghion et al., 2005; Brynjolfsson & Hitt, 2003). In Pakistan, the growing digitalization of firms, often measured by the ratio of intangible to tangible capital, has become a key factor in enhancing productivity. Intangible capital, including software, data, patents, and intellectual property, is now viewed as a critical driver of competitiveness in the digital age. Unlike physical capital, intangible assets such as ICT systems and digital platforms can be scaled quickly and relatively cheaply, making them especially beneficial for firms in developing economies (Zareie et al., 2024). For example, in

agriculture, ICT-enabled solutions like precision farming tools can optimize resource use, while in manufacturing, automation and cloud computing can streamline supply chains and reduce production costs (Arif, 2018). Similarly, service-sector firms can leverage e-commerce platforms to access global markets and diversify revenue streams.

The transformative role of ICT is particularly evident as Pakistan seeks to diversify its industries and transition into high-value sectors. Empirical studies underscore a strong positive correlation between ICT adoption, R&D, and TFP (Kahn et al., 2022). Furthermore, ICT opens doors to the global digital economy, allowing Pakistani firms to participate in cross-border trade and attract foreign investment. For Pakistan, prioritizing ICT-driven strategies could thus catalyze sustainable industrial growth, bridging the gap between current challenges and future economic aspirations (Acemoglu & Restrepo, 2020).

This study examines the impact of ICT adoption on firm-level productivity and economic outcomes in Pakistan, with a focus on its role in economic upgrading. It also identifies the need and significance of ICT in reducing the productivity gap in Pakistan. The potential of ICT adoption in improving economic performance in Pakistan is examined by comparing firm-level productivity indicators in the country with those of other regional countries, using a set of ICT facility and infrastructure indicators.

Major ICT indicators that form targets for analysis include ICT-fixed investment as a percentage of GDP, secure Internet server growth, and mobile cellular subscriptions between 2010–23. ICT adoption, particularly mobile banking platforms, could alleviate these constraints by improving access to digital financial services and enabling alternative credit assessment mechanisms. The goal is to offer valuable insights for policymakers, business leaders, and researchers seeking to harness ICT to drive Pakistan's economic growth and industrial transformation.

The report's structure is as follows: The section titled *"ICT Investment and Economic Productivity: Comparative Analysis of Pakistan and APO Economies"* outlines the analytical framework, methodology, and data sources used in the study. The section on *"Empirical Analysis of the Impact of ICT on Firms' Productivity"* compares Pakistan's ICT indicators with those of Bangladesh, China, and India, providing a regional perspective on productivity dynamics. It also analyses the impact of ICT adoption on firm-level productivity in Pakistan. The final section presents the conclusion and offers recommendations for improving Pakistan's productivity through increased ICT adoption.

ICT Investment and Economic Productivity: Comparative Analysis of Pakistan and APO Economies

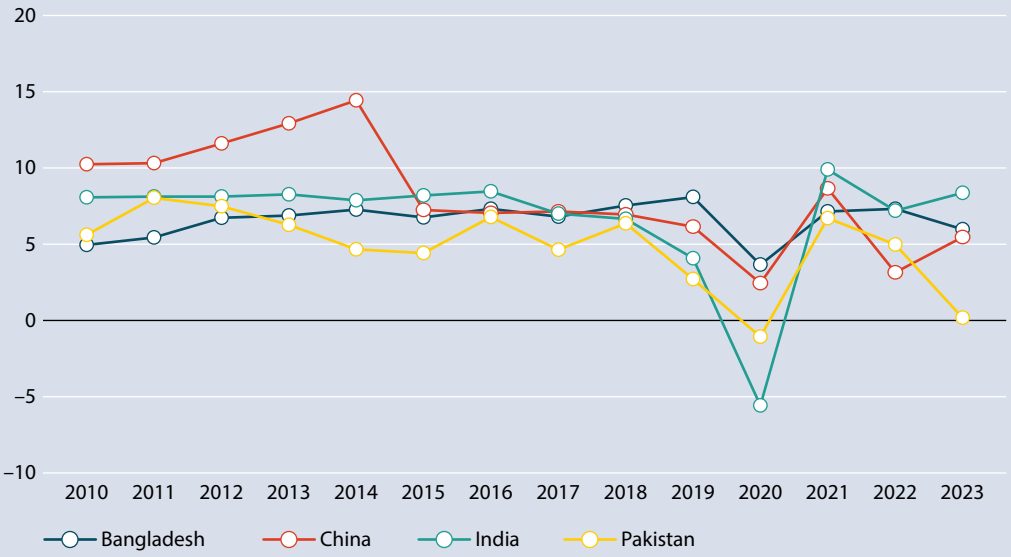
This section compares ICT investment, measured in current US dollars, secure Internet servers, and mobile cellular subscriptions, among Pakistan, Bangladesh, China, and India during the period 2010–23. This study mainly assesses the impact of ICTs on economic growth and firm-level performance in these economies.

The analysis intends to describe the dynamics of the main ICT-related factors before and during technology transitions. The study analyses how investments in ICT, secure Internet service, and mobile cellular subscriptions have evolved in each country. These factors are pertinent as they determine the state of digital development of economies and how the former can harness the latter for growth.

Besides, this study intends to discuss the findings to compare the country's performance with its neighbors, such as Bangladesh, China, and India. The study focuses on the impact of each country's investment in ICT on its economic processes. For instance, enhanced secure Internet servers in China are proportionate to higher economic development. The fast-growing mobile subscriptions in India indicate an attempt to increase Internet connectivity for all. It is important to note that, compared to other countries, Pakistan's relatively low progress in these fields demonstrates that it faces several challenges in applying ICT for economic development and achieving competitive advantage. Based on these ICT indicators, this section explains how crucial ICT has been and continues to be in forming the economic character of the selected APO countries.

FIGURE 1

GDP GROWTH RATE IN SELECTED APO COUNTRIES.



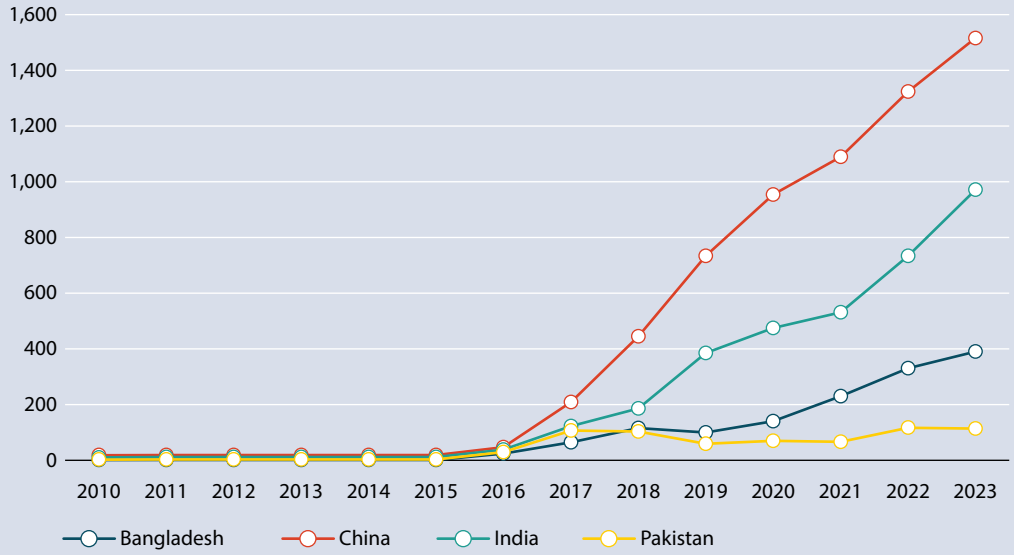
Source: World Development Indicators, World Bank (2023).

Figure 1 illustrates the GDP growth rates in Bangladesh, China, India, and Pakistan during the period 2010–23. In GDP terms, the growth is expressed in actual values at constant prices determined in the Local Currency Units of the respective countries. Noticeably, the figure shows that GDP declined across all economies in 2020 during the pandemic. However, only India and Pakistan recorded negative growth that year. Although China's growth rate dropped significantly compared to the previous year, it remained positive. In contrast, Bangladesh maintained a comparatively stable growth trajectory despite global challenges.

The study reveals that Pakistan's GDP has consistently lagged behind that of its regional neighbors during the period under review. Although economies such as China and Bangladesh demonstrated resilience and recovered relatively quickly, especially in the postpandemic phase, Pakistan's recovery remained sluggish, hindered by persistent structural issues. India, too, rebounded with strong growth in the immediate aftermath of the pandemic. In contrast, Pakistan's growth rate stagnated. These trends indicate that, despite periods of significant growth in recent decades, Pakistan's economic structure remains inefficient, particularly in areas such as investment in ICT and innovation, factors known to drive TFP and support firms' economic upgrading.

FIGURE 2

SECURE INTERNET SERVERS PER MILLION PEOPLE.



Source: World Development Indicators, World Bank (2023).

Figure 2 illustrates the trends in the number of secure Internet servers across selected Asian economies during the period 2010–23. Secure Internet servers are a key indicator of digital infrastructure necessary for economic upgradation and productivity growth, since they support secure online transactions and the broader adoption of digital technologies.

The figure reveals significant disparities in the adoption of secure Internet servers across the four countries. China demonstrates a remarkable surge in secure servers during the period, reflecting its substantial investment in ICT infrastructure and digital transformation initiatives. India also shows a steady upward trend, indicating progress in building its digital economy in line with its position as a global IT hub. While exhibiting a slower growth than China and India, Bangladesh has steadily increased its number of secure Internet servers, highlighting its gradual adoption of digital technologies.

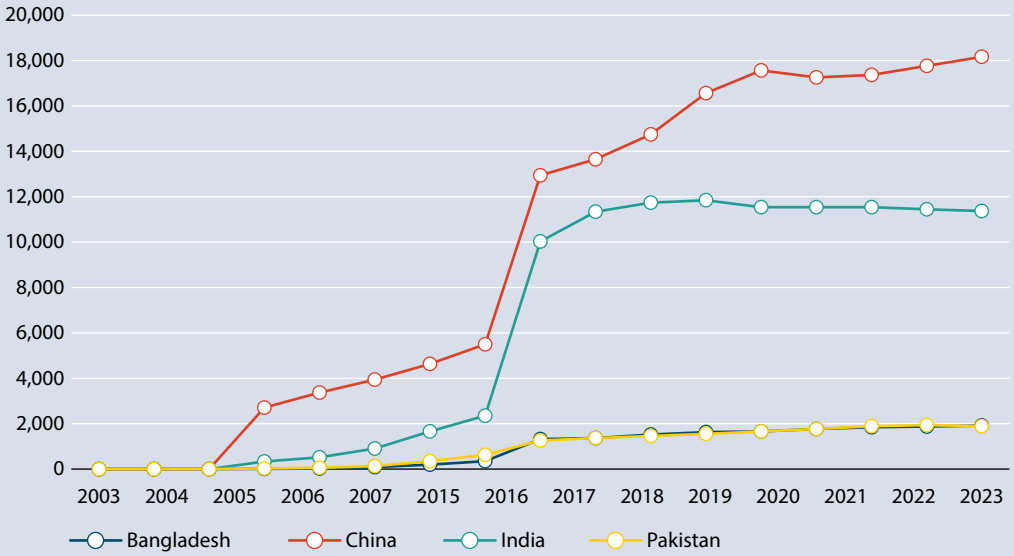
In contrast, Pakistan's progress in expanding the number of secure Internet servers has been limited, lagging significantly behind its regional peers. This slow growth underscores persistent challenges in ICT adoption, which adversely affect firm-level productivity and economic upgradation. The country's underdeveloped digital infrastructure restricts firms' ability to leverage ICT to improve efficiency, reduce operational costs, and integrate into GVCs.

These trends underscore the urgent need for Pakistan to invest in digital infrastructure and foster ICT adoption to unlock productivity gains and drive economic growth. The stark differences between Pakistan and its neighbors highlight the pivotal role of secure Internet servers in enabling digitalization and enhancing firm-level competitiveness in the modern economy. Addressing these gaps should be a policy priority to ensure Pakistan remains competitive and aligned with the digital progress in the region.

Figure 3 presents the trends in mobile cellular subscriptions across Bangladesh, China, India, and Pakistan from 2010–23. Mobile cellular subscriptions serve as a key indicator of ICT penetration and

FIGURE 3

NUMBER OF MOBILE CELLULAR SUBSCRIPTIONS PER 100 PEOPLE.



Source: World Development Indicators, World Bank (2023).

digital connectivity, which are critical in driving firm-level productivity and economic growth. The figure shows that China leads by a significant margin, with both the highest number of subscriptions and the steepest, most consistent growth throughout the observed period. This is in line with China's increased development of digital buildings and extensive use of cellular technologies within the nation and globally to enhance effectiveness and, therefore, promote economic advancement.

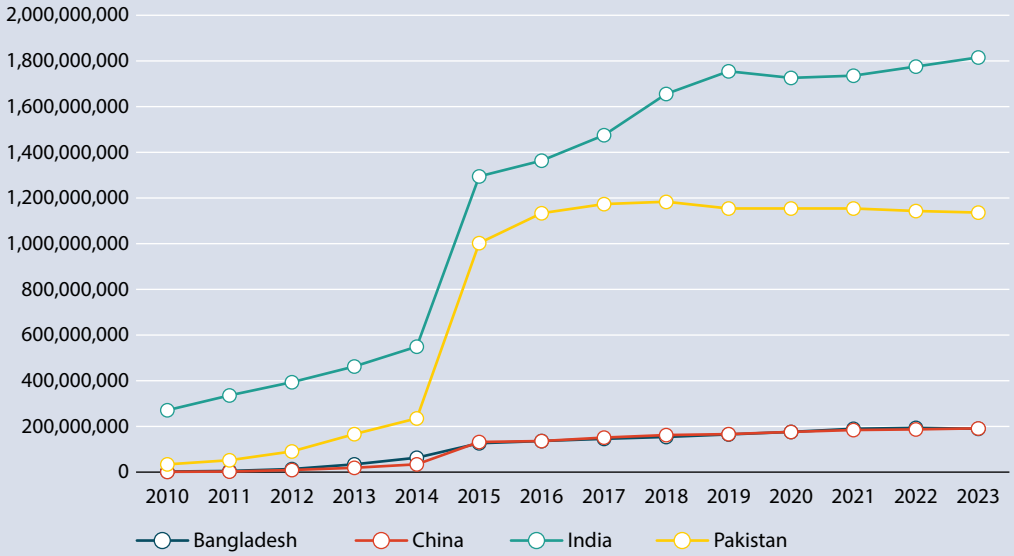
India also demonstrates a strong trajectory, with a sharp rise in subscriptions by 2010, followed by a modest growth. This emerging trend aligns well with India's rapid development and efforts to expand mobile infrastructure, supporting digital transformation. Bangladesh, while exhibiting moderate growth in overall Internet usage, has steadily increased mobile phone adoption, which is a positive sign regarding the rise in ICT usage and the inclusion of more people. In contrast, Pakistan's growth in mobile cellular subscriptions remains significantly lower than that of other countries in the region. This slower growth indicates potential constraints in attaining universal mobile phone adoption, which may limit firms' ability to leverage mobile technologies for productivity gains and competitiveness.

The disparities in mobile cellular adoption among these economies underscore the critical role of ICT for growth. Pakistan's relatively low mobile phone density indicates a missed opportunity to improve firm-level productivity and economic upgrading through digitalization. Addressing these shortcomings through increased investment in mobile infrastructure and proactive promotion of mobile adoption is essential to realize the full productive potential of ICT in Pakistan.

Figure 4 charts the trajectories of ICT investment (in current USD) across selected countries in the region during the period 2010–23, with a particular emphasis on the pivotal trends emerging around 2014. The data highlights sharp disparities in national approaches: China stands out as a significant outlier, with its ICT investments surging due to state-driven initiatives like the "Digital China" framework, 5G deployment, and AI development.

FIGURE 4

INVESTMENT IN ICT WITH PRIVATE SECTOR PARTICIPATION (CURRENT USD).

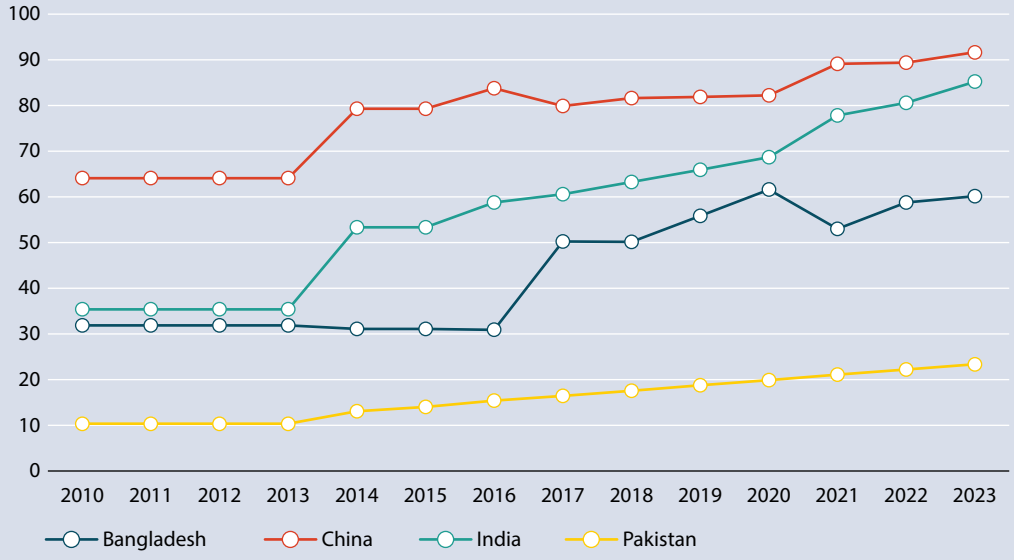


Source: World Development Indicators, World Bank (2023).

Pakistan's ICT investment remains critically low, trailing significantly behind regional peers such as Bangladesh, China, and India, and amounting to only a fraction of the regional average. Systemic barriers include inadequate public funding and minimal private-sector incentives. This underinvestment stifles socioeconomic progress, while the lagging ICT infrastructure limits productivity gains and employment, as well as curtails technological innovation due to inadequate R&D support.

FIGURE 5

MOBILE BANKING USERS AS A PERCENTAGE OF THE POPULATION.



Source: World Development Indicators, World Bank (2023).

Figure 5 illustrates the development of mobile banking usage across Bangladesh, China, India, and Pakistan during the period 2010–23. Mobile banking plays a pivotal role in information transformation and financial inclusion by expanding access to financial services, particularly in developing economies. The adoption levels in the four countries vary significantly, shaped by differences in digital infrastructure, financial regulations, and the financial literacy of their populations.

China consistently recorded the highest uptake of mobile banking throughout the period, with its adoption rates continuously rising from around 70% in 2010, experiencing a rapid expansion till 2013, and achieving nearly 100% adoption by 2023. This rapid growth was driven by the emergence and widespread adoption of fintech platforms such as Alipay and WeChat Pay, along with the government-funded digital financial programs. China's leadership in mobile banking stems from high mobile phone penetration, robust Internet infrastructure, and enabling policy frameworks.

India experienced a sharp acceleration in mobile banking adoption after 2013, overtaking Bangladesh in 2016 and reaching approximately 90% by 2023. The rise in mobile banking usage is directly linked to India's digital transformation initiatives, including the launch of the Unified Payments Interface, Aadhaar-linked financial services, and government-led campaigns promoting digital transactions. The combination of increased smartphone ownership, a thriving fintech industry, and robust policy support for digital transactions has significantly boosted mobile banking usage in India.

Mobile banking usage in Bangladesh has experienced a gradual growth surge over the years, albeit at a slower pace than in China and India. Mobile banking adoption in this country operated steadily until 2014 and has expanded progressively to reach about 60% by 2023. The growth has been primarily driven by mobile money services provided by platforms such as bKash, which have made digital financial services more accessible, especially in rural areas.

Current statistics indicate that Bangladesh lags behind its Asian neighbors, China and India, in terms of digital financial service adoption rates and Internet infrastructure. Therefore, additional investments would accelerate the adoption of digital financial services in the country. Pakistan, in contrast, exhibits the slowest growth in mobile banking adoption among the four countries.

The data indicates a rising trend during the period 2010–23, yet the adoption levels remain below what other countries in the region have achieved. Slow mobile banking adoption suggests considerable obstacles, including insufficient smartphone devices, limited financial knowledge, bureaucratic barriers, and a lack of adoption of fintech solutions within the region. The insufficient digital infrastructure in Pakistan restricts the expansion of financial access through mobile banking, preventing the economic benefits of this technology from being realized.

Collaborative efforts among policy reforms, infrastructure investments, and public awareness campaigns would enable Pakistan to reach standards comparable to those of its neighbors. Mobile banking, as used by these countries, follows more prominent developments in the digital economy and financial inclusion advances. China and India lead the way in digital financial service integration, but Bangladesh and Pakistan still have opportunities for future development. The widespread adoption of mobile banking and its maximum economic benefits require investments in digital resources, programs that teach financial skills, and favorable government regulations.

Empirical Analysis of the Impact of ICT on Firms' Productivity

The following section provides information about the analytical framework used to understand the impacts of ICT on improving the productivity of Pakistan's economic operations and those of other APO countries. It describes the nature, origin, and approach of the data used to measure ICT capital investment, Internet-secured sites, and mobile cellular subscriptions as symbols of digital infrastructure and economic progress. Also, this section deliberates on the data employed to examine the differences in productivity and economic growth for the countries under analysis.

Analysis Framework

This study comprehensively analyzes ICT investment, secure Internet servers, and mobile cellular subscriptions in Pakistan and three APO countries during 2010–23, and the data were collected from World Development Indicators, a database of the World Bank. The purpose is to assess the given economies' potential in utilizing ICT to reconstruct their economic productivity change, comparing the performance of Pakistan's economy to that of those in the region. First, the study compares the ICT indices for capturing the digital channels of the involved countries. It reviews economic avails concerning insight into the ICT adoption and impacts on related economic activities. Second, based on this theoretical structure, the study discusses changes in socioeconomic factors in Pakistan and their relevance to digitalization. Further, it also discusses the power supply problems, rates of power failure, and Internet accessibility measures that form the basis of the study within the infrastructure and policy of Pakistan. Third, the study explores trends in ICT-related productivity metrics over the specified period, assessing how advancements in digital infrastructure have influenced long-term productivity. Finally, the study discusses strategies and recommendations to enhance long-term productivity and economic growth in Pakistan through further development and integration of ICT.

Data

The dataset includes balance sheet and income statement information for all 410 publicly listed firms during this period, as well as export flow data. The firms are categorized into 13 sectors based on the Pakistan Bureau of Statistics' sector classification system, which follows the 2-digit ISIC code. However, in alignment with prior studies, the study excludes firms operating in the coke and petroleum sectors, services, and state-owned companies, resulting in a total of 370 firms under analysis. Among these 370 firms, 323 were continuously tracked from the start to the end of the study period. However, 38 firms were excluded at various points during the research, and nine firms were added to the sample after 2012.

Additionally, 48 firms were omitted due to missing data for calculating productivity. Consequently, the final sample for this study comprises 322 firms across 11 sectors, with the textiles sector being particularly well-represented in terms of the number of firms. Definitions of variables and their sources are provided in Appendix Table A-1.

This study employs a binary variable to measure a firm's digital transformation, coded as 1 if the firm has adopted ICT tools such as the Internet, email, or computer systems for operational use and 0 otherwise. It examines the relationship between ICT adoption and firm productivity while accounting for endowment variables, including workforce skill levels. Additionally, it investigates barriers to ICT adoption, including power supply issues, power failure rates, and Internet access constraints, which are particularly pertinent within Pakistan's infrastructure and policy frameworks.

The firms selected in this study are among the largest entities in the Pakistani economy, contributing nearly 13% of Pakistan's GDP in 2017. On average, the sample firms have approximately 380 employees, and around 16% of the firms are MSEs.

Methodology

The methods used in this study are as follows:

Labor Productivity

Labor productivity at the firm level is calculated using two primary approaches: one based on the total hours worked by employees and the other based on the total number of employees within a firm. The following equations are used to estimate labor productivity at the firm level.

$$LP_i = \frac{Y_i}{H_i} \tag{1}$$

$$LP_i = \frac{Y_i}{ELF_i} \tag{2}$$

Y represents the firm's total output, ***H*** denotes the total hours worked by all employees within the firm, ***ELF*** stands for the employed labor force or the total number of employees in the firm.

Equations 1 and 2 allow for the estimation of labor productivity at the firm level across different Hours Worked. Firm-level data on hours worked is collected to calculate the average working hours per employee within each firm. Total weekly working hours are calculated for each firm, and these figures are then annualized by multiplying by the number of work weeks in a year.

Total Factor Productivity

Siddique (2022) describes the approach to estimating TFP by utilizing the neoclassical production function, a standard method in growth theory. Following the Siddique approach, this study regresses log sales for each year on firm-level labor (measured as log headcount), log capital, and fixed effects for the firm's country, sector, and year. TFP is then defined as the residual from this regression.

$$\log(Sales_{it}) = \alpha + \beta_1 \log(K_i) + \beta_2 \log(Labour_i) + \theta_i + \vartheta_i + \varepsilon_{it} \tag{3}$$

$$TFP = \log(Sale_{it}) - \log(\hat{S}ales_{it}) \tag{4}$$

This method raises concerns about potential biases in elasticity estimates and whether it accurately represents TFP at the firm level. To address these concerns, this residual-based TFP measure is compared with the TFP derived using the Ackerberg et al. (2015) methodology, commonly applied in the Orbis dataset. The study comparison shows that, except for the extreme values of the residual-TFP measure, it correlates very strongly with the control function TFP measure. This strong correlation reinforces the credibility of the findings regarding productivity in the ORBIS database.

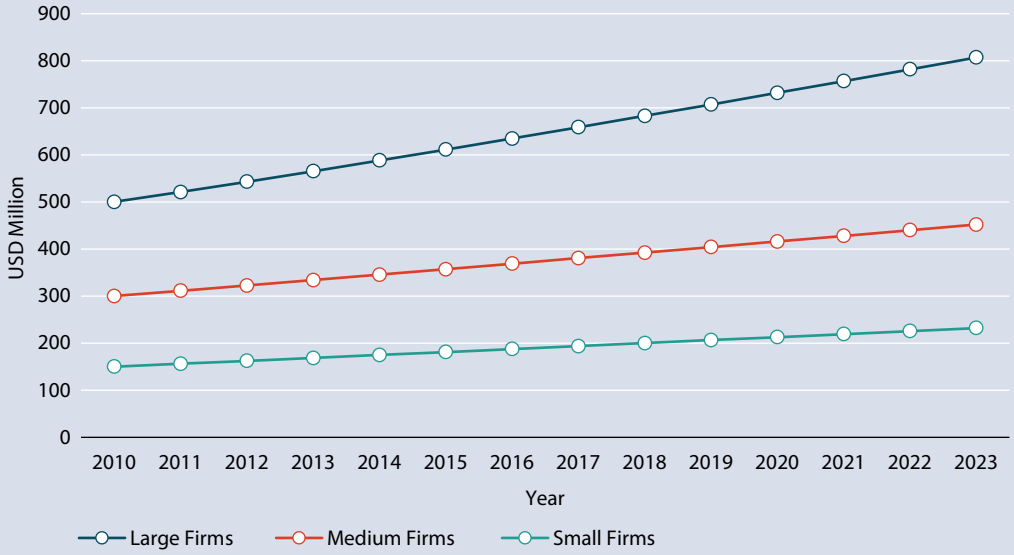
By utilizing this methodology, the study ensures that the TFP estimates are robust and provide a reliable measure of firm-level productivity in Pakistan, even without more detailed firm-level price and employment data.

Descriptive Statistics

Figure 6 illustrates employment trends by firm size in Pakistan during the period 2010–23, covering overall employment and disaggregated data for large, medium, and small firms. The vertical axis

FIGURE 6

REVENUES BY FIRM SIZE (2010–23).



Source: Data retrieval basics, London Stock Exchange Group (2023).

represents the total number of employees, while the horizontal axis shows the years. The data indicates that large firms experienced steady employment growth over the period, reflecting the efficiency of large-scale operations, often supported by access to capital, better technologies, and resources. In emerging economies like Pakistan, large firms are better positioned to weather economic volatilities than smaller firms.

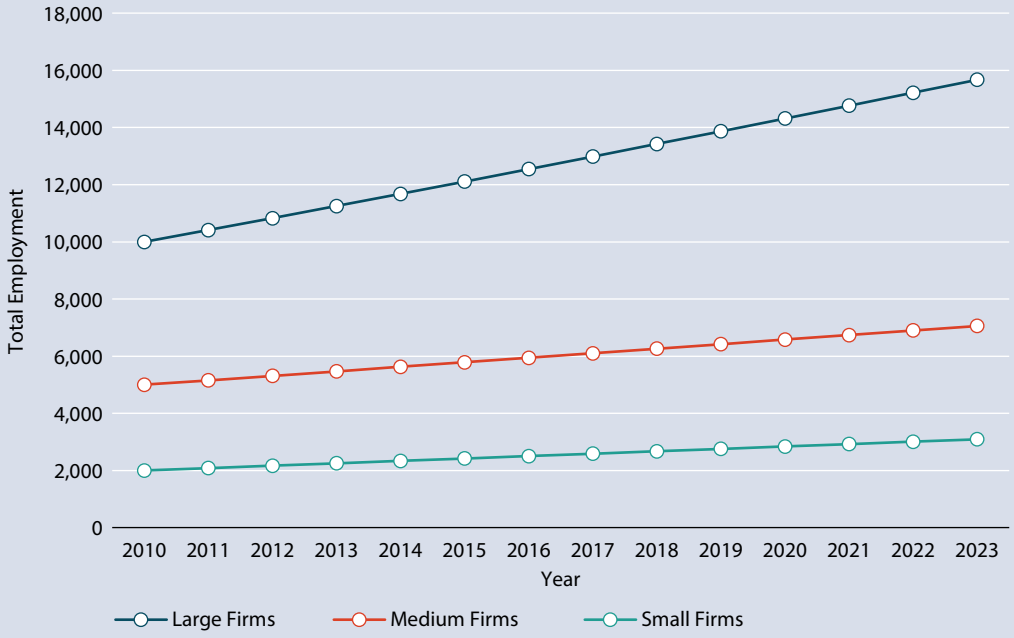
The employment data of medium-sized firms is not as consistent as that of large firms; employment is observed to increase in some periods and decline in others. This inconsistency can be attributed to factors specific to medium-sized firms, which generally face constraints such as limited funding, reliance on political factors, and greater responsiveness to economic cycles.

Small firms exhibit higher cyclical volatility, with employment increasing during periods of growth, followed by drastic declines. These swings are linked to the challenges that hinder Pakistani small businesses: inadequate infrastructure, energy shortages, and a shortage of skilled human resources. The fluctuations evident in 2013, 2016, and 2019 indicate rapid economic shifts in Pakistan, including energy shocks and fluctuations in the macroeconomy. Thus, small and medium-sized firms may have experienced low demand and operational problems during these periods, which could have reduced their employment.

Figure 7 illustrates the changes in total employment in Pakistan. The vertical axis represents employment, and the horizontal axis indicates the period during the period 2010–23. This timeline probably describes the fundamental changes in the country's labor market as influenced by economic and structural conditions. Employment in Pakistan may have also experienced cyclical fluctuations during the period 2010–23 due to internal and external factors, including growth rates, policy changes, political stability, and other disturbances, such as the pandemic in 2020.

FIGURE 7

TOTAL EMPLOYMENT BY FIRM SIZE (2010–23).



Source: Data retrieval basics, London Stock Exchange Group (2023).

Employment trends were unpredictable between 2013–16 due to regime changes, a fragile economy, energy crises, and rising inflation throughout Pakistan. Although the trend is slightly low, it improves somewhat as 2023 approaches in the graph, which could depict the so-called post-pandemic recovery period, along with the economic measures taken by the government to address the unemployment issue. In Pakistan, the government has started the Kamayab Jawan Program and Ehsaas Program to establish employment and youth leadership. Such programs may impact employment generation in select sectors, as well as strategically reduce unemployment.

Results and Interpretation

TABLE 1

DETERMINANTS OF TFP ACROSS FIRM SIZES.

Variable	Full Sample	Large	Medium	Small
ICT	0.0033*** (0.0004)	0.0035*** (0.0003)	0.0016* (0.0008)	0.0012 (0.0012)
Capital	0.0040*** (0.0003)	0.0051*** (0.0008)	0.0033*** (0.0002)	0.0045*** (0.0004)
Firm Age	0.0022** (0.0010)	−0.0001 (0.0021)	0.0029*** (0.0010)	0.0018* (0.0011)
Number of Observations	4160	2730	1040	390
R^2	0.867	0.556	0.401	0.250

Note: *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.
Source: Based on calculations by the national expert.

The regression analysis of productivity in relation to firm-level characteristics in Pakistan is presented in Table 1. The results suggest that ICT use has a positive influence on productivity enhancement, especially among large firms. Firms that have adopted digital technologies, such as cloud and ERP systems, have shown a high level of organizational efficiency and competitiveness. In other words, the coefficient of ICT is very high and statistically significant. Such statistics encourage the adoption of ICT in larger organizations that can leverage ICT to improve their efficiency.

While ICT adoption and productivity have a strong positive correlation in large firms, this correlation is relatively lower for SMEs. These remain barriers to their optimal exploitation of ICT benefits. It is worth noting that smaller firms often face challenges in investing in ICT and implementing digital transformation due to inadequate support systems (Chen et al., 2024). Addressing these challenges requires targeted policy interventions that aim to improve access to finance, build digital infrastructure, and provide skills development programs. Policies can help SMEs leverage ICT more effectively by reducing these barriers and enhancing productivity (Brynjolfsson et al., 2018).

The regression results also confirm a highly significant relationship between capital investment and productivity, with firm size being a significant influencing factor. The statistically significant coefficients for capital investment show that firms that invest in better machinery, equipment, technology, and human capital experience enhanced productivity.

The result, as depicted below, indicates that the impact of capital investment on medium and small firms is negligible, likely due to the firms' limited capital investments. Older firms may face challenges related to organizational inertia and resistance to change, which can hinder their ability to adopt new technologies and adapt to market shifts.

TABLE 2

DETERMINANTS OF PRODUCTIVITY.

Variables	TFP	Sales/Worker
ICT Adoption	0.085*** (0.030)	0.095*** (0.025)
Size: Medium (20–99)	–0.010 (0.028)	0.060** (0.022)
Size: Large (100 and over)	0.115** (0.040)	0.275*** (0.028)
Manufacturing	–0.480*** (0.048)	–0.020 (0.095)
Services	–0.620*** (0.180)	0.020 (0.092)
Education Workforce	0.013*** (0.002)	0.011*** (0.002)
Credit constrained	–0.079*** (0.028)	–0.125*** (0.020)
Number of Observations	3770	3770
R^2	0.441	0.593

Note: *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.
Source: Based on calculations by the national expert.

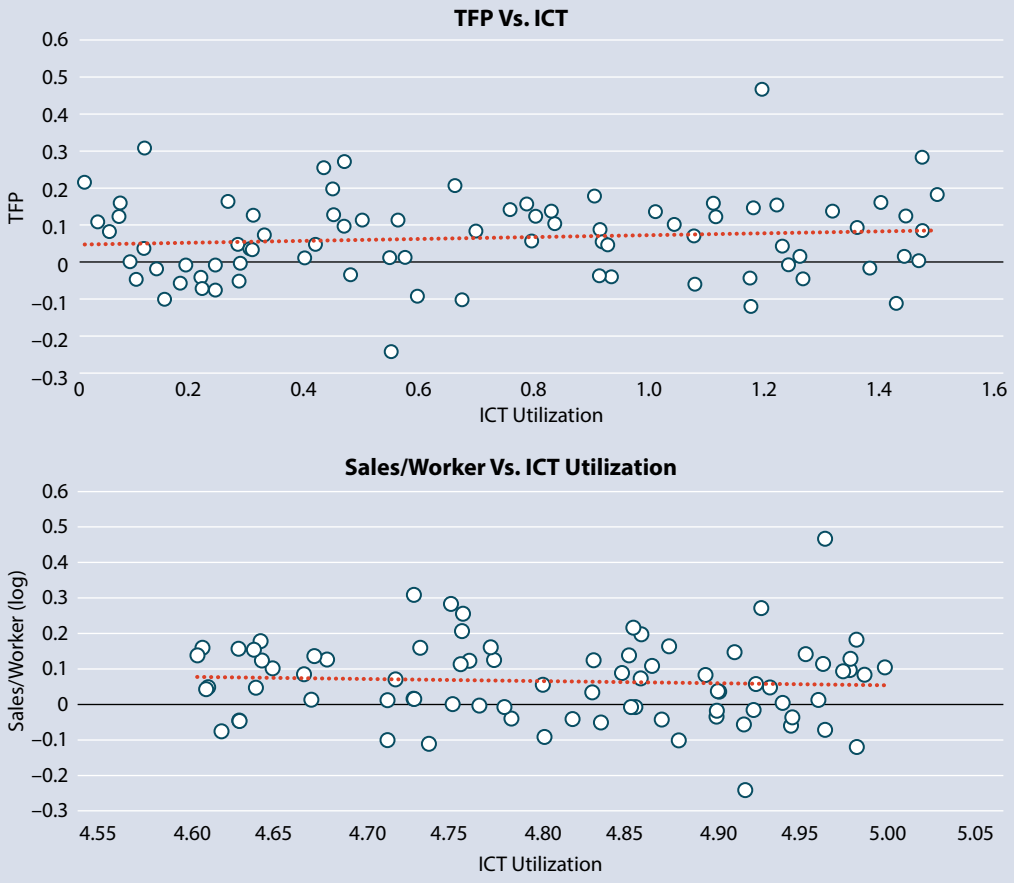
Table 2 presents the results examining the impact of key firm-level characteristics on TFP and sales per worker in Pakistan. The analysis reveals that ICT adoption significantly enhances productivity, particularly for large firms. Larger firms are better positioned to integrate advanced technologies, improving efficiency and competitiveness. Conversely, firms in the manufacturing and service sectors exhibit negative coefficients, indicating that sector-specific challenges, such as limited technological advancements and operational inefficiencies, may impede productivity growth. Additionally, the workforce's education level is positively associated with TFP, underscoring the importance of a skilled labor force in driving productivity. On the other hand, credit constraints have a significantly negative impact on productivity, highlighting that limited access to finance restricts firms from investing in productivity-enhancing technologies and resources.

In the sales per worker regression, larger firms demonstrate higher sales per worker, consistent with economies of scale, where larger firms achieve greater efficiency through better resource utilization. The positive correlation between workforce education and sales per worker further emphasizes that a well-educated workforce contributes significantly to the firm-level efficiency.

These findings underscore the significance of ICT adoption, firm size, workforce education, and access to credit in influencing productivity and efficiency among Pakistan's firms.

FIGURE 8

TFP AND ICT UTILIZATION.



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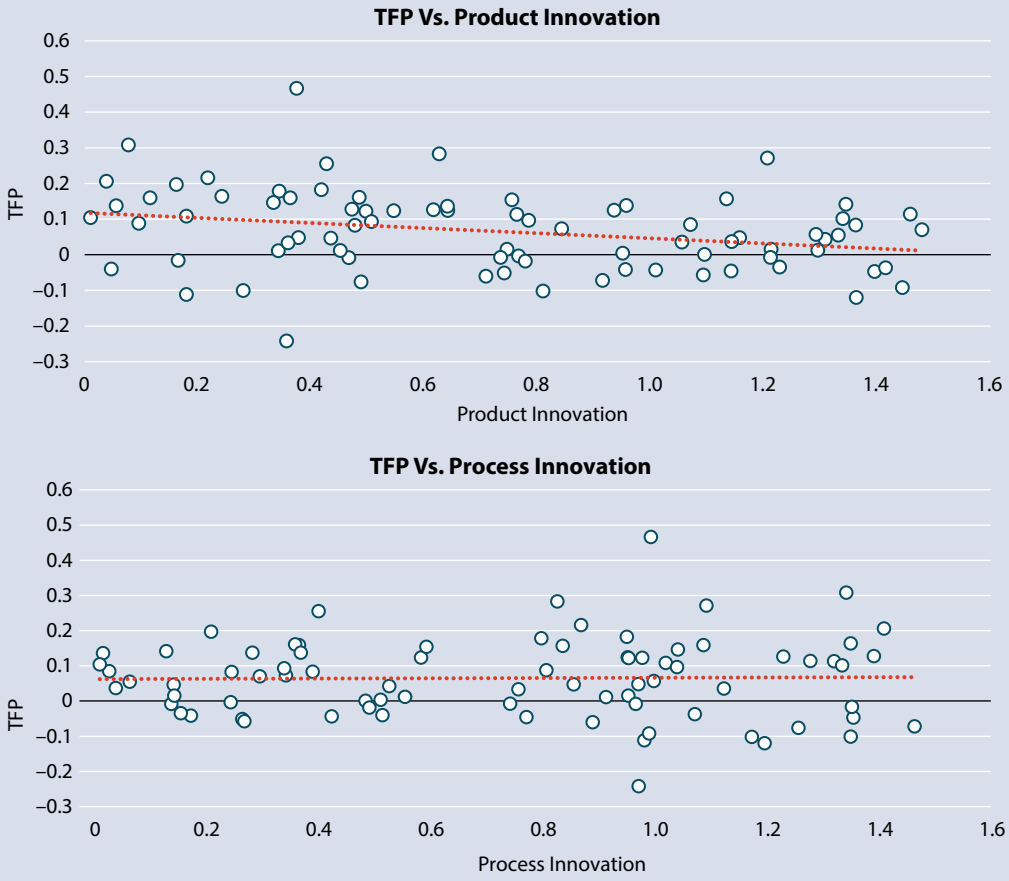

Source: Data retrieval basics, London Stock Exchange Group (2023).

The findings depicted in Figure 8 are Ordinary Least Squares regressions of TFP as the endogenous variable and ICT usage, product innovation, and process innovation as the exogenous variables. The study utilized Pakistani firm-level data from DataStream during the period 2010–23, including firm-level variables such as firm age, size, geographical location, R&D investment, and the proportion of employees with advanced skills. Results further show that the direct relationship between ICT utilization and worker productivity is weak, as captured by sales per worker. However, the disaggregated ICT use suggests that the direct contribution of ICT to TFP appears to be relatively modest if analyzed in isolation.

Process innovation, on the other hand, appears to be a more critical input that affects TFP with a moderate, positive effect. Alternatively, product innovation has a mildly negative impact on TFP, but the results continue to act in the opposite direction. Indeed, this result rejects the assumption made in the literature that product innovation unambiguously results in higher productivity. Nonetheless, one should note that this criterion's application can also be multidimensional and dependent on the context in which the product innovation will be launched.

The modest link between ICT use and TFP implies that while ICT is necessary, it is insufficient for increasing productivity, provided appropriate conditions, including personnel skills, managerial

techniques, and other structural changes, are not in place. Results also show that process innovation positively affects TFP, meaning efficiency improvements are crucial for productivity changes. Since process innovation seems to exert a more significant and direct impact on TFP compared to ICT, companies should devote more effort to internal processes, for instance, by increasing production efficiency.

Conclusion

The comparative analysis of ICT investment and economic productivity among Pakistan, India, China, and Bangladesh reveals stark disparities in digital readiness and growth outcomes. Pakistan consistently lags behind its regional peers in critical ICT indicators such as secure Internet servers (Figure 2), mobile cellular subscriptions (Figure 3), and ICT investment (Figure 4), which correlate with its sluggish GDP growth (Figure 1) and lower firm-level productivity. While China and India have leveraged robust ICT infrastructure, mobile connectivity, and digital financial services (Figure 5) to drive economic resilience and innovation, Pakistan's underdeveloped digital ecosystem limits productivity gains, particularly for SMEs.

The firm-level analysis underscores that ICT adoption significantly boosts productivity, especially in large firms. However, SMEs face barriers such as limited access to finance, skills gaps, and inadequate infrastructure. Process innovation emerges as a more potent driver of TFP than ICT alone (Figure 8), emphasizing the need for complementary investments in workforce education and operational efficiency. Determined credit constraints, sectoral inefficiencies in manufacturing and services, and cyclical employment volatility (Figures 6–7) further hinder Pakistan's economic upgrading.

These findings highlight that Pakistan's slow ICT integration and structural challenges limit its ability to harness digitalization for inclusive growth. Addressing these gaps is critical for closing the regional competitiveness divide and achieving a sustainable economic transformation.

Overview of Pakistan's ICT Policies

Pakistan's ICT policies have aimed to promote digital inclusion and drive economic growth, exemplified by programs such as the Digital Pakistan Initiative launched in 2019. This initiative emphasizes expanding broadband infrastructure, promoting e-governance, enhancing digital literacy through platforms like DigiSkills.pk, and fostering tech startups via innovation hubs like NIC Lahore.

Building on this framework, the National Digital Policy of 2021 set forth ambitious goals, including increasing IT exports to USD15 billion by 2025, strengthening cybersecurity frameworks, and reducing urban-rural digital disparities. To improve connectivity, the Universal Service Fund (USF) increased 4G access to 80% of the population by 2023, while the National Cybersecurity Policy 2021 was introduced to safeguard data and strengthen critical infrastructure.

Evidence-Based Recommendations

To support Pakistan's digital network, scaling public-private partnerships for skills development (e.g., collaborating with firms like Microsoft to expand DigiSkills.pk) is critical, particularly for rural women, who account for 25% of mobile Internet usage. Accelerating broadband infrastructure via USF-funded fiber-optic networks and community models can address rural gaps. Enhancing cybersecurity through a national emergency response team and enforcing data laws will mitigate risks.

Reasonable device access requires tariff reductions and subsidies to boost smartphone ownership, currently at 54%. Centralized oversight of ICT policies can improve federal-provincial coordination (e.g., PTA, Igsnite), while gender-inclusive campaigns, in collaboration with organizations like UN Women, can bridge participation gaps. These steps align with the SDGs, fostering equitable, tech-driven growth.

Policy Recommendations

This report presents the following policy recommendations based on the results from the study above.

- Prioritize public and private funding for secure Internet servers, 5G networks, and broadband expansion to match regional benchmarks (Figures 2–4).
- Launch a "Digital Pakistan Fund" to promote the adoption of ICT in underserved areas and incentivize private-sector participation through tax breaks.
- Fixing targeted grants, low-interest loans, and digital toolkits to help SMEs adopt cloud computing, ERP systems, and e-commerce platforms (Table 1).
- Integrate ICT and financial literacy programs into the nationwide education curriculum and vocational training.
- Partner with tech firms to offer certifications in emerging technologies such as AI and fintech to bridge skills gaps (Table 2).
- Reform regulations to promote fintech innovation and reduce bureaucratic hurdles for mobile banking (Figure 5).
- Introduce tax incentives for firms investing in R&D and process innovation, which showed more substantial TFP impacts than ICT alone (Figure 8).
- Encourage digital lending platforms to leverage alternative data (e.g., mobile transaction histories) for risk assessment.
- Develop tailored ICT roadmaps for manufacturing and services to address sectoral productivity gaps (Table 2).
- Streamline policies to attract foreign ICT investments and ensure cybersecurity frameworks align with global standards.
- Establish a cross-ministerial task force to coordinate digital transformation initiatives and monitor progress.

By prioritizing these measures, Pakistan can unlock the productivity potential of ICT, reduce regional disparities, and build a resilient, innovation-driven economy.

Appendix

TABLE A-1

DEFINITION OF VARIABLES AND DATA SOURCES.

Variable Name	Definition	Details	Source
ICT Adoption	ICT Adoption	A binary variable (1 if the firm has adopted ICT tools such as the Internet, email, or computer systems for operations; 0 otherwise). This captures the firm's digital transformation level.	DataStream (2010–23)
Capital	Capital Investment	Capital refers to the firm's physical assets, such as machinery, buildings, and equipment. If applicable, fixed capital should be deflated using the Consumer Price Index (CPI) to account for inflation. If capital is log-transformed, it is done to normalize the variable and control for scale differences.	DataStream (2010–23)
Firm Age	Firm's Operational Age	This represents a firm's years in operation, not its listing age. It can be calculated as the difference between the current year and the year the firm started operations.	DataStream, (2010–23)
Firm Size	Firm Size (Small, Medium, Large)	Firms are classified based on their number of employees and annual revenue, as defined by industry standards: small (less than 50 employees), Medium (50–250 employees), and large (more than 250 employees).	DataStream, (2010–23)
Productivity (TFP)	Total Factor Productivity	Measures the firm's productivity by considering the outputs relative to the combined labor and capital inputs. TFP is calculated using the Solow residual/ similar approach.	ORBIS database, (2010–23)
Revenue	Annual Revenue	The firm's total revenue over the past year, adjusted for inflation (CPI), can provide insights into its scale and financial health.	ORBIS database, (2010–23)
GDP	GDP Growth	Annual percentage growth rate of GDP at market prices based on constant local currency	WDI, (2010–23)
ICT	ICT Investment	Investment in ICT projects refers to commitments to projects in ICT backbone infrastructure (including land-based and submarine cables) that have reached financial closure and directly or indirectly serve the public.	WDI, (2010–23)
Mobile Cellular Subscriptions	Mobile Cellular	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service.	WDI, (2010–23)
Secure Internet Servers	Secure Internet servers (per 1 million people)	The number of distinct, publicly-trusted TLS/SSL certificates found in the Netcraft Secure Server Survey	WDI, (2010–23)

Source: The table has been compiled based on the following databases: DataStream (https://www.refinitiv.com/en/products/datastream); World Development Indicators (WDI) (https://data.worldbank.org/indicator); ORBIS database (https://orbis.bvdinfo.com).

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PHILIPPINES

Summary

Digital technologies offer developing economies like the Philippines a significant opportunity to enhance their participation in GVC, drive labor productivity, and improve overall economic competitiveness. However, the country continues to face significant disparities in ICT access and usage. Digital divides are evident across regions, age groups, and education levels. Businesses in the Philippines face persistent challenges, such as inadequate infrastructure, digital skills, financial constraints, and regulatory barriers, preventing them from fully capitalizing on digitalization.

The study analyzes empirical data to identify the critical role of ICT utilization, skills upgradation, and infrastructure in improving a firm's labor productivity. Firms that utilize digital tools and employ upskilling programs experience substantial productivity increases, whereas those facing infrastructure deficiencies, such as power outages, are associated with productivity losses. Addressing gaps in digital infrastructure, investment, and skills development and upgradation is crucial to fully leverage the opportunities created by GVC integration and the rapidly advancing digital economy.

Introduction

Overview of Trade and GVC Trends in the Philippines

The Philippine trade landscape underwent significant and critical transformations in recent decades. Import growth outpaced exports, widening the country's trade deficit (see Table 1). From an average of PHP397,000 during the 2000–09 period, the trade deficit almost tripled to PHP1.17 million in the next decade, and further climbed to PHP1.91 million since the pandemic. The average share of merchandise imports to domestic output in the Philippines rose by more than six percentage points from 24.1% in 2000–09 to 30.5% in 2020–23. Conversely, the share of merchandise exports in the country has remained below the 20% level since 2001. Trade in services exports largely outpace merchandise exports growth, increasing services' contribution to domestic output. The share of services exports in the Philippines rose by more than three percentage points, up from 8.21% in 2000–09 to 11.3% in 2010–19 and 11.5% in the current decade.

TABLE 1

PHILIPPINES' TRADE STATISTICS.

	Merchandise			Services		
	2000–09	2010–19	2020–23	2000–09	2010–19	2020–23
	Value (PHP Million)					
Export	1.48	2.23	3.12	0.729	1.71	2.22
Import	2.07	4.10	5.89	0.538	1.04	1.36
Balance	(0.588)	(1.84)	(2.77)	0.191	0.674	0.856

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	Merchandise			Services		
	2000–09	2010–19	2020–23	2000–09	2010–19	2020–23
Share (%)						
Export	17.3	15.1	16.2	8.21	11.3	11.5
Import	30.4	33.8	37.5	6.28	6.88	6.99
Growth (%)						
Export	2.34	5.24	3.17	14.8	5.67	12.3
Import	5.09	7.19	7.31	5.77	5.02	20.2

Note: All numbers in the parentheses are negative.
Source: Calculated by the National Expert based on data from Philippine Statistics Authority.

To increase the volume of export from the country and its trade competitiveness, the Philippine Export Development Plan (PEDP) 2023–28 identified several strategic measures such as diversifying exports, positioning the Philippines as supplier of tradeable intermediate services, and prioritizing the development of key industry clusters to support and strengthen GVC participation (Department of Trade and Industry, 2024). The four GVC clusters are as listed:

- Industrial, machinery, and transport
- Technology, media, and telecommunications
- Health and life sciences
- Modern basic needs and a resilient economy

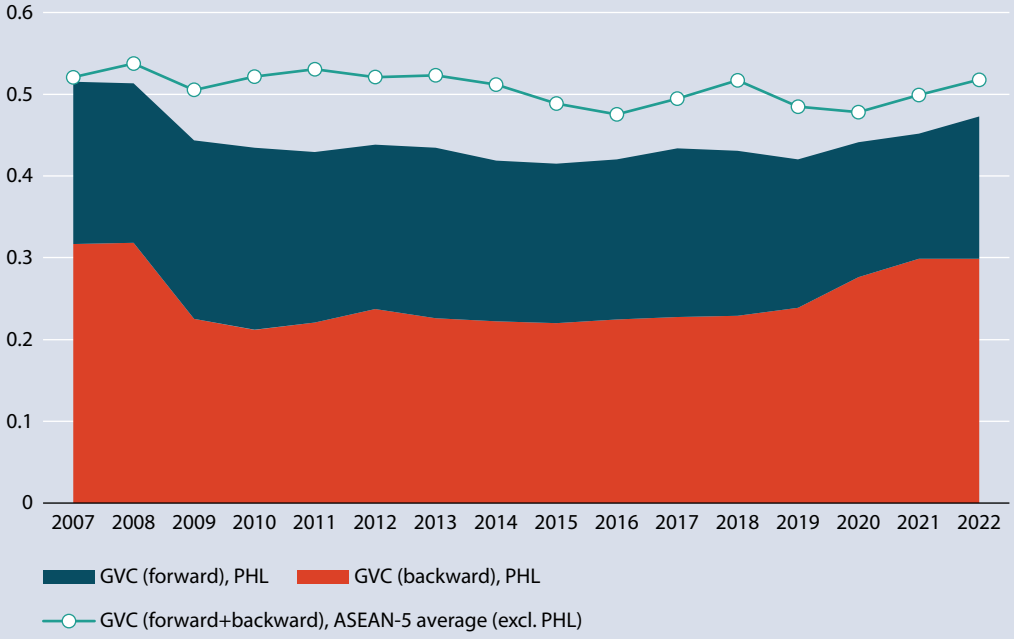
In the 1990s, until the advent of the 2008–09 global financial crisis (GFC), the world witnessed a global acceleration in GVC participation. Increased production fragmentation during this period was attributed to a confluence of factors, as listed:

- Improvements in transport and logistics infrastructure facilitated trade and lowered costs.
- Rapid evolution and increased accessibility of ICT revolutionized business operations, enabling MNCs to offshore and outsource services to developing economies.
- Substantial trade integration and liberalization, such as through participation in preferential and regional trade agreements, reduced trade barriers, fostering cross-border transactions (Mendoza & Villafuerte, 2023).

The Philippines' GVC participation rate failed to surpass its pre-GFC levels, averaging 42.9% during the 2009–19 period (see Figure 1). An upward trend was observed since the pandemic, rising by more than three percentage points from 44.1% in 2020 to 47.3% in 2022, the highest since 2008. Recent trends further indicate that a majority of the Philippines' GVC trade happened through backward participation, characterized by the reliance on foreign imports for producing exports. Thus, the country's GVC merchandise and services exports have relatively higher imported value added.

FIGURE 1

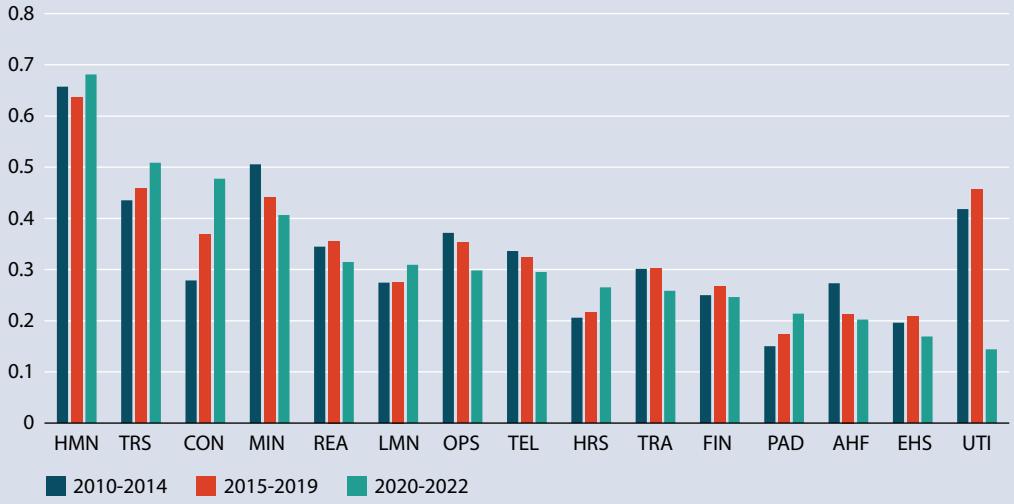
GVC PARTICIPATION RATE OF THE PHILIPPINES.



Note:
1. ASEAN-5 refers to Indonesia, Malaysia, the Philippines, Singapore, and Thailand; PHL represents the Philippines.
2. Participation rates are calculated using the trade-based approach, which divides GVC-related flows by total exports.
Source: ADB (2024).

FIGURE 2

GVC PARTICIPATION RATE BY SECTOR IN THE PHILIPPINES.



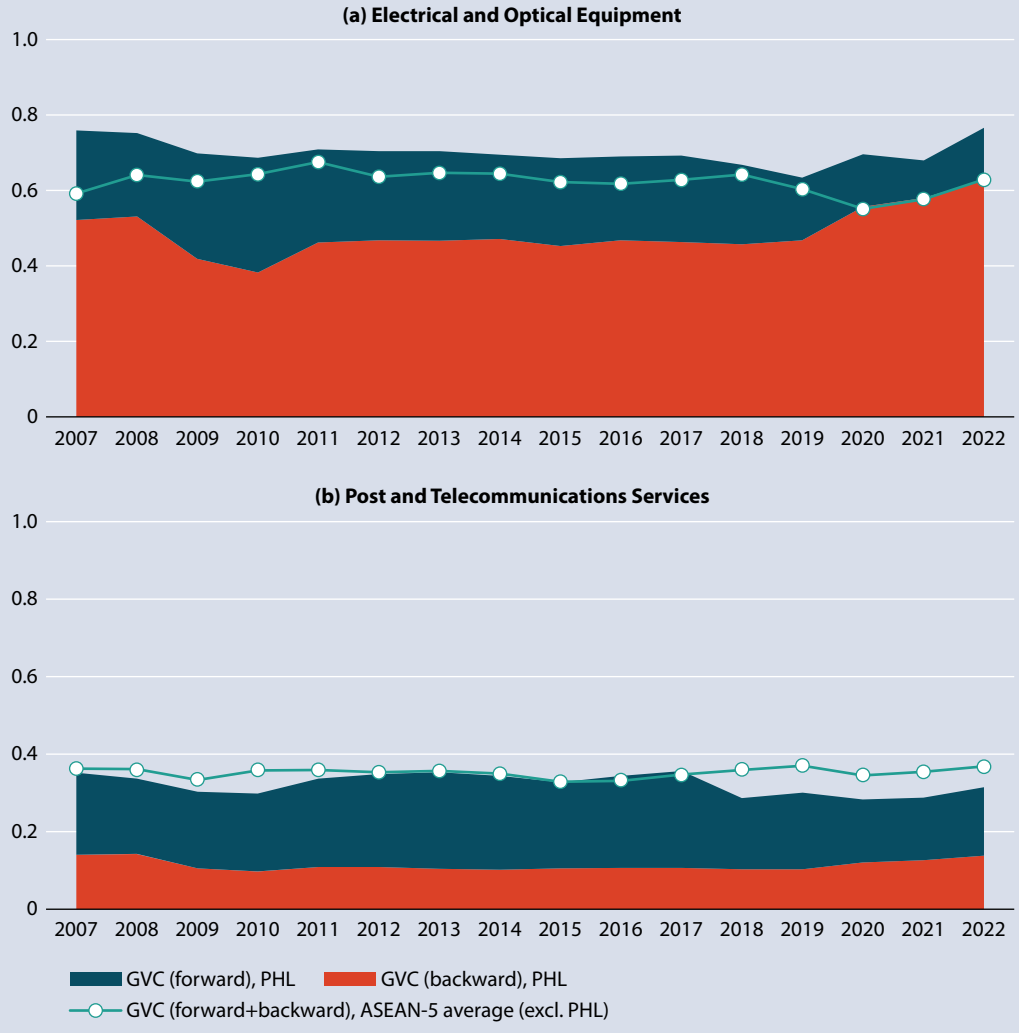
Note:
1. AHF, Agriculture, hunting, forestry, and fishing; CON, Construction; EHS, Education, health, and social work services; FIN, Financial intermediation services; HMN, Heavy manufacturing; HRS, Hotels and restaurants services; LMN, Light manufacturing; MIN, Mining and quarrying; OPS, Other personal services; PAD, Public administration and defense; REA, Real estate, renting, and business activities; TEL, Telecommunications services; TRA, Trade Services; TRS, Transport services; UTI, Utilities.
2. Participation rates are calculated using the trade-based approach that divides GVC-related flows by total exports.
Source: ADB (2024).

Disaggregated data reveal heterogeneity in GVC participation across sectors, especially during the pandemic (see Figure 2). The primary sectors observed a general decrease in GVC participation over the past decade. Compared to 2010–14 levels, the share of intermediate trade in agriculture and mining sectors dropped by about 7% and 10% since the pandemic, respectively. Several service sectors, including telecommunications, finance, real estate, and public services such as education, health, and social work, likewise contracted. On the other hand, GVC trade in construction services surged to 47.7% from an average of 36.8% in 2015–19.

Transport, as well as hotel and restaurant services, also exhibited resilience, growing by about 7% and 6%, respectively, compared to the averages of the 2015–19 time period. Heavy manufacturing sector exports continued to be traded mainly in intermediates. From an average of 65.7% in 2010–14, this share decreased to 63.6% in 2015–19, and jumped to 68.1% notwithstanding the pandemic. Light manufacturing sector's GVC participation was at 30.9% during 2020–22, likewise exceeding average pre-pandemic levels.

FIGURE 3

GLOBAL VALUE CHAIN PARTICIPATION RATE BY SECTOR IN THE PHILIPPINES.



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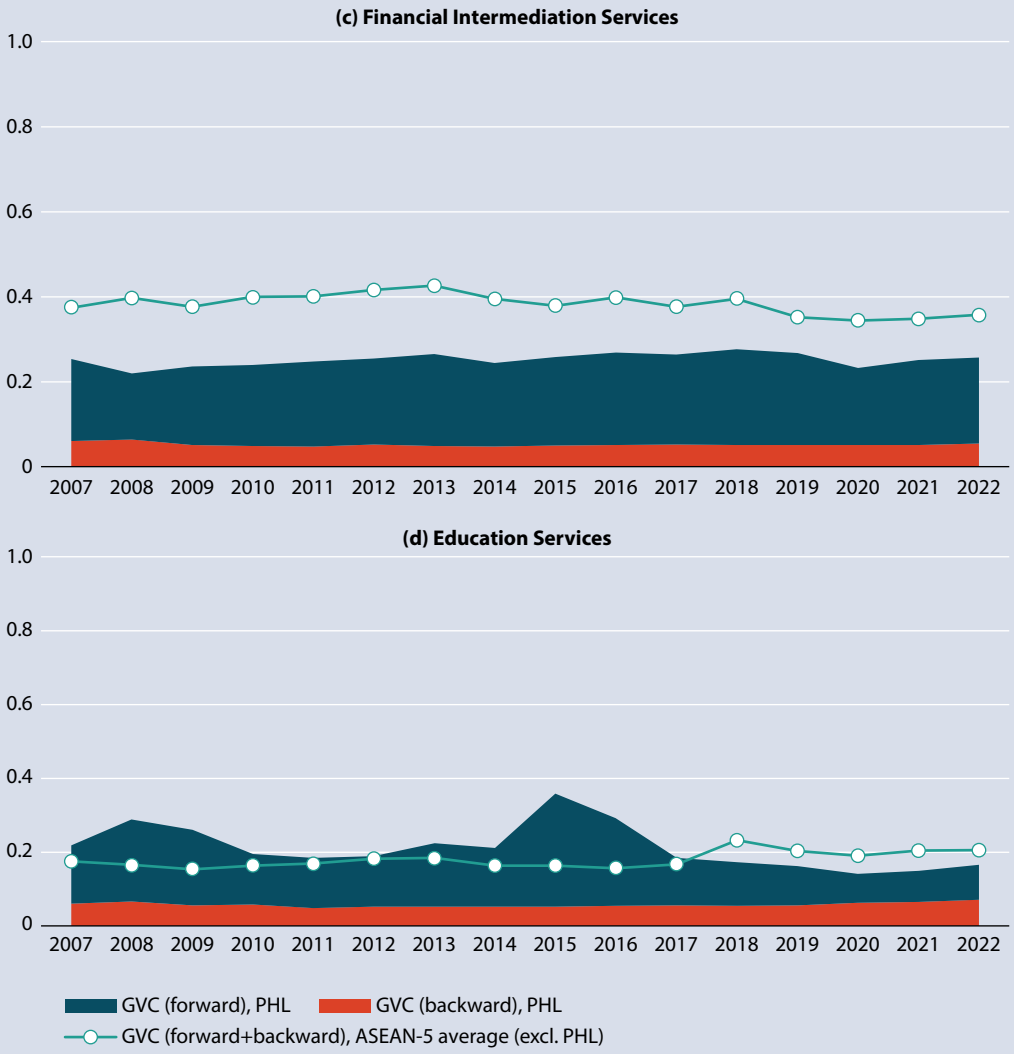

Note:
1. ASEAN-5 refers to Indonesia, Malaysia, Philippines, Singapore, and Thailand; PHL represents the Philippines.
2. Participation rates are computed using the trade-based approach that divides GVC-related flows by total exports.
Source: ADB (2024).

Further analysis of the key sectors indicates that the majority of the Philippines' exports in electrical and optical equipment were traded as intermediate inputs (see Figure 3, Panel A). The country's GVC participation rate in the sector, averaging 68.7% of exports in the previous decade, was among the highest compared to major Southeast Asian economies. This share has further increased since the pandemic, reaching 76.6% in 2022, exceeding the levels of 2007–08. The Philippines' GVC trade in electrical and optical equipment was largely through backward linkages, implying a relatively downstream position in production chains. The Department of Trade and Industry reported that the Philippines primarily participates in the component stages of the electronics and electrical GVCs, such as the assembly of electronic components and integrated circuits (ICs), as well as assembly and test activities for analog semiconductors. Several IC global companies have locations in the Philippines, including Texas Instruments, STMicroelectronics, NXP, ON Semiconductor, Analog Devices, and Maxim, among others (Department of Trade and Industry, 2017).

Close to a third of the country's post and telecommunication services exports were traded as intermediates, peaking at 35.7% in 2017 (see Figure 3, Panel B). This share dropped to 28.3% during the first year of the pandemic, but a gradual recovery appeared underway as the participation rate climbed to 31.4% in 2022. The majority of the sector's GVC trade was through forward participation, characterized by exports of domestically produced services to partners. The Philippines is among the world's leading markets for Information Technology and Business Process Management (IT-BPM) sourcing services, particularly voice-related services (Department of Trade and Industry, 2022a). The industry is among the country's top revenue sectors, earning USD29.5 billion in revenues in 2021 (Information Technology and Business Process Association of the Philippines, n.d.). The Annual Survey of Philippine Business and Industry reported a total of 2,205 formal establishments engaged in IT-BPM activities in 2021, of which more than 20% dealt with customer relationship management activities (Philippine Statistics Authority, 2023).

The share of GVC exports in financial intermediation services, averaging 25.8% in the 2010–19 period, was low as compared to major Southeast Asian economies (see Figure 3, Panel C). After decreasing to 23.2% in 2020, the share bounced back to 25.1% the following year. About 70–80% of the sector's GVC trade was through forward participation, peaking at 81.6% in 2018. Meanwhile, GVC trade participation in education services peaked at 38.8% in 2015 and had been on a downward trajectory until the onset of the pandemic (see Figure 3, Panel D). Similar to the previously discussed sectors, indications of a post-pandemic bounce back were observed as the share gradually increased to 15% in 2021 and 16.6% in 2022. However, since 2018, the Philippines' GVC participation rate in this sector has lagged behind that of its regional peers.

Digitalization, Productivity, Trade, and Overall Economic Competitiveness

Driven by the rise of digital technologies, developing economies such as the Philippines can leverage stronger GVC participation to advance trade and other cross-cutting economic competitiveness objectives. Apart from the growth and maturation of GVCs, the rise of the digital economy can be considered another crucial game changer in the international trade landscape. The COVID-19 global pandemic further accelerated the shift toward a more digital-based economy. The unprecedented rise of e-commerce and digital platforms for online purchases, marketing, and communication has created new marketplaces to transact goods and services (Lanzona & Pascua, 2023). Reports indicate that global e-commerce sales reached USD26.7 trillion in 2019, approximately 30% of the global GDP (UNCTAD, 2021a). Despite the onset of the pandemic, global exports and imports of ICT-related merchandise grew by 4% and 1%, respectively. While services trade experienced historic declines, ICT services exports defied the trend, growing by 6% in 2020 (UNCTAD, 2021b).

Technological advancements and digital trends bear profound effects on global production networks by enabling easier GVC participation. For example, digital platforms provide more cost-effective and efficient linkages across buyers and sellers who are physically far apart. Li et al (2024) observed that the adoption of digital technology improves productivity, drives exports of higher value-added products, and helps increase GVC participation. Furthermore, the authors found that trade openness positively correlated with higher digital technology integration and enhanced GVC participation. Ladrière et al. (2022) found that nearly 34% of e-commerce marketplace listings serve as intermediate inputs to downstream GVC activities. With some statistical indication that MSMEs are among the main users of these marketplaces, the authors conjectured that e-commerce could increase MSME participation in GVCs.

Against this backdrop, an integrated GVC and digital trade strategy can help the Philippines upgrade to more sophisticated, higher value-added goods and services. The combined elements of GVC development and digitalization, both of which are fostered by innovations in ICT, likewise bear huge potential to make trade inclusive, resilient, and sustainable (Lundquist & Kang, 2021). Aligning with the goals and strategic measures articulated in the PEDP 2023–28, the following discussion demonstrates how a coordinated GVC and digital trade strategy can help enhance SME participation in GVCs, revitalize trade in services, and advance domestic productivity.

- **Enhancing SME participation in GVCs:** The unbundling of production stages across borders enabled economies to participate in international trade without the need to specialize in the entire production process. This further encouraged local firms with relatively limited resources and capabilities, including SMEs, to reap the benefits of engaging in international trade by working on specialized tasks or components within the value chain that were aligned with their comparative advantage. The 2022 List of Establishments of the Philippine Statistics Authority (PSA) reported that SMEs comprised about 9% of business enterprises operating in the country, contributing to about 32.4% of total employment (Department of Trade and Industry, 2022b).

  While analyzing the firm-level data of the Philippines, Mendoza (2020) observed that manufacturing SMEs were weakly connected to GVCs, trading fewer products, and linked to a smaller set of foreign partners compared to large manufacturers. Internationalizing SMEs through GVCs could help in addressing productivity constraints faced by Philippine SMEs, such as the lack of access to markets, technology, finance, and human capital, among others (Francisco et al., 2018). Digitalization and digital platforms provide network effects for SMEs, facilitating wider access to suppliers and customers, and opportunities that will enhance their global competitiveness. Evidence from the literature suggests that firms' digitalization and the use of e-commerce platforms, aided by developments in ICT infrastructure, improve their productivity and positively influence the probability of SMEs engaging in import and export activities (Higón & Bonvin, 2023; Sun, 2021).

- **Revitalizing services trade competitiveness:** The growing importance of services trade in regional and GVCs aligns with the Philippines' goal to become a major player in intermediate services trade. The World Trade Organization (WTO) estimated the value-added in services at USD3.95 trillion in 2021, more than double the value of final services exports. The share of services value-added on global trade had substantially increased from 30% in 1980, 45% in 2005, and 50% in 2018 (WB & WTO, 2023). Serafica (2019) pointed out that while the Philippines has gained an international foothold in business process outsourcing services, the country's services exports have grown at a slower pace in recent years.

  Meanwhile, trade in services has also become more digital. The country's digitally delivered services exports in 2022 were estimated at USD3.82 trillion, accounting for 54% of the total services exports (WB & WTO, 2023). Between 2005 and 2009, the Philippines contributed about 13% of Southeast Asia's digital services exports and remains one of the top exporters in the region (Avendano & Helbe, 2022). To build on this momentum, the Philippine Development Plan (PDP) 2023–28 aims to reinvigorate the country's services sector by expanding and diversifying trade, utilizing digital technologies to enhance productivity, and facilitating the shift to higher-value-adding segments (National Economic and Development Authority, 2023).

Analyzing GVC participation among Asia-Pacific economies, Shepherd (2022) found that digitally delivered services exhibit substantial forward and backward linkages, making them an important part of the region's GVC landscape. The author further concludes that reducing trade costs generates spillover effects when digitally-delivered services serve as inputs in the production and export of other goods and services.

An inclusive approach to GVC integration, coupled with a pivot towards a more digital and liberal services trade regime, is crucial for enhancing labor productivity and upgrading skill structures. Participating in GVCs increases the productivity of workers and increases the supply of skilled labor.

A firm-level empirical analysis by Ehab and Zaki (2020) found that enhanced GVC integration results in skill-upgradation, and the effects are more pronounced when services are liberalized. Additionally, firms that aim to move up the value chain must invest in innovation and continuous learning to stay competitive. This necessitates investments in human capital development by providing opportunities for training and upskilling. However, the expected productivity benefits of GVC integration and (digital) services trade are inhibited by the lack of digital infrastructure, human capital and digital skills, and affordability.

The diverse levels of digital readiness and capabilities may worsen the existing digital divide across economies and may cause the potential gains to be unevenly distributed (Crivelli et al., 2022; UNCTAD, 2021b). The succeeding section analyzes the prevalence of ICT in the Philippines.

Adoption of ICT in the Philippines

Insights from the 2019 National ICT Household Survey

Significant disparities in the access and use of ICT are observed across geographical areas, age, and education, indicating the existence of digital divides among the sectors of society. The 2019 National ICT Household Survey (NICTHS) is the first nationwide baseline household and individual survey in the Philippines that aims to gather baseline data to assess the country's ICT status and development. A total of 43,838 sample households, comprising individuals aged 10–74, were surveyed on their knowledge, access, and usage of ICT devices and services (Department of Information and Communications Technology, n.d.). Some of the key results and analyses conducted by Albert et. al. (2021) using the 2019 NICTHS are highlighted below:

- **Mobile phone ownership and use:** Around 75% of individuals in the Philippines own at least one mobile phone, and 79% reported using one in the last three months. These numbers are significantly higher than those for computer ownership and use, which stand at around 24% and 34%, respectively, including desktops, laptops, and tablets. Mobile phone ownership and usage exceed 60% across all age groups, with the highest rate observed among individuals aged 18–34. Furthermore, both ownership and usage are positively correlated with educational attainment, reaching about 90% among those who have completed secondary education.

- **Internet use:** Nearly half of the individuals in the Philippines (46.9%) have used the Internet in the past three months. Among the different age groups, the share of Internet usage is highest among those aged 18–24 (61.4%), closely followed by the 10-17 age group at 59.7%. In contrast, Internet usage is significantly lower among the older population—37.7% for those aged 35–54, and just 18.1% for individuals aged 55 and

above. Internet use still positively correlates with educational attainment, where the share is highest among those who completed secondary education (66.1%) and lowest among those with little to no schooling (6.1%).

Geographical disparities also persist: 57.3% of urban residents reported using the Internet, compared to only 36.1% in rural areas. Notably, only around half of the students surveyed reported using the Internet, while usage among persons with disabilities remains exceptionally low at around 10%.

- **Home and mobile connectivity:** The majority of households (68.2%) received standard wireless data transmission through 4G and long-term evolution (LTE) cellular network signal in their community (see Table 2). However, this level of mobile connectivity is concentrated mainly in urban areas. Fewer than half of rural households (49.6%) reported access to a 4G/LTE signal, often relying on lower-speed network connections instead.

  Compared to mobile connectivity, the proportion of households with a home Internet connection is substantially lower, especially in rural households. The share of households in the National Capital Region (NCR) with an Internet connection is nearly double the national average. According to the 2019 NICTHS, key reasons cited by households without home Internet connections included the high cost of Internet subscriptions (52.5%), high cost of equipment (33.8%), unavailability of Internet access in the area (19.4%), lack of knowledge on how to use the Internet (16.2%), poor Internet quality and speed (7.2%), and lack of information on what the Internet is (6%). On average, households spend PHP1,281 monthly on a home Internet subscription. The cost is highest among households in the NCR.

TABLE 2

HOME AND MOBILE CONNECTIVITY INDICATORS IN THE PHILIPPINES.

	Share of Households with Home Internet Connection (%)	Average Monthly Spending on Home Internet Connection (PHP)	Highest Mobile Network Signal Available at the Barangay (%)		
			2G	3G	4G
National	17.7	1,280.59	7.3	24.5	68.2
NCR	33.2	1,505.08	0.0	4.2	95.8
Area					
Urban	23.6	1,406.99	2.0	13.8	84.2
Rural	11.4	1,008.33	13.4	37.0	49.6

Note: Barangay is the smallest local government unit in the Philippines. NCR, National Capital Region.
Source: Department of Information and Communications Technology (n.d.); Albert et al. (2021).

- **Online activities:** Among Internet users in the Philippines, social media use and communicating with family and friends remain the top online activities, reported by 94.2% of users. Accessing information is the second most preferred activity (44%), which includes using search engines, reading general content, and downloading files. Leisure and lifestyle activities—such as online gaming, music downloading, and streaming—rank third with 14.7% engagement. Other notable online activities include learning (14.7%), accessing government websites and services (13%), conducting online transactions (6.7%), and online transportation and navigation (4.7%).

- **E-commerce transactions:** Only a minority of Internet users (26%) reported participating in e-commerce activities in the past year. Internet users in urban areas appear relatively more engaged in e-commerce activities as compared to those in rural areas (see Table 3). Purchasing goods and services online is the most frequently performed e-commerce activity. However, despite the rise in online shopping, cash-on-delivery remains the dominant mode of payment. About 80.4% of online buyers pay in cash, followed by over-the-counter payments, such as through remittance centers (9%). Digital methods, such as electronic and mobile wallets (4.3%) and online banking, including card payments (4.5%), are the least preferred options. Security concerns, particularly sharing personal details, were cited by 42% of respondents as the primary reason for reluctance to use e-payment methods.

TABLE 3

SHARE OF INTERNET USE BY TYPE OF E-COMMERCE TRANSACTIONS (IN %).

Type of E-commerce Transactions Done in the Last 12 Months	Urban	Rural	Total
Bill payments (utilities, credit card, etc.)	7.7	3.7	6.2
Banking (checking account balance, fund transfers, etc.)	6.8	4.6	5.9
Delivery services (food, packages, etc.)	6.0	3.2	4.9
Transportation services (flights, ride-hailing, etc.)	3.7	1.3	2.8
Accommodation services (e.g., hotels)	1.8	1.4	1.6
Purchase of goods and services	23.5	15.9	20.6
Sale of goods and services	3.9	3.4	3.7
Stock trading and online investments	0.3	0.2	0.3

Source: Department of Information and Communications Technology (n.d.); Albert et al. (2021).

- **ICT skills:** The 2019 NICTHS captures six of the nine ICT skills identified for monitoring under Sustainable Development Goals (SDG) Indicator 4.4.1: *Proportion of youth and adults with ICT skills*. For each of the six measured skills, only a minority of youth and adults reported proficiency. The highest proportions were observed in basic tasks such as sending e-mails with attached files, using copy and paste tools, and transferring files (see Table 4). The survey further revealed that 39.8% of youth and adults possess at least one of the six ICT skills identified under SDG Indicator 4.4.1. The highest share was recorded among individuals aged 15–24 (46.7%), followed by those aged 25–64 (40.3%). The lowest shares were found among children aged 10–13 (23.1%) and those aged 65 and above (18.0%).

TABLE 4

PROPORTION OF YOUTH AND ADULTS WITH ICT SKILLS IN DIFFERENT COUNTRIES (IN %).

ICT Skill	BRN (2022)	IDN (2017)	MYS (2022)	SGP (2022)	THA (2020)	VNM (2021)	PHL (2019)
Ability to use basic arithmetic formulas in a spreadsheet	17.0	25.2	53.8	36.1	14.8	15.8	7.2
Ability to use copy-and-paste tools to replicate or reposition content within a document	52.0	59.6	77.2	54.3	22.6	26.1	24.5

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ICT Skill	BRN (2022)	IDN (2017)	MYS (2022)	SGP (2022)	THA (2020)	VNM (2021)	PHL (2019)
Ability to send e-mails with attachments	38.0	26.2	71.7	75.6	17.2	20.6	25.8
Ability to create electronic presentations with presentation software	10.0	30.2	50.4	37.1	8.9	18.7	9.1
Ability to find, download, install, and configure software	38.0	25.5	58.2	55.6	5.1	9.5	10.5
Ability to transfer files between a computer and other devices	23.0	50.7	66.6	52.6	11.5	10.6	22.2

Note:
1. BRN, Brunei Darussalam; IDN, Indonesia; MYS, Malaysia; PHL, Philippines; SGP, Singapore; THA, Thailand; VNM, Vietnam.
2. Data covers all ages.
3. Three ICT skills listed in SDG 4.4.1 are not included in this table as data is not available for the Philippines.
Source: Department of Information and Communications Technology (n.d.); Albert et al. (2021); United Nations Statistics Division (n.d.).

- **Digital infrastructure:** Near-universal access to electricity has been achieved across the Philippines, with more than 90% of surveyed barangays (the smallest local government unit in the country) reporting uninterrupted electricity availability to support digital infrastructure. The majority of these barangays also have mobile phone reception and 4G signal coverage. However, only 36% of barangays have a telecommunications tower, and 95% of these are privately owned. The absence or a limited number of such towers may contribute to sub-par mobile service quality.

  Among major ISPs in the country, Globe is present in 65% of surveyed barangays, Smart in 52%, and Philippine Long Distance Telephone Company in 31%. In contrast, free Wi-Fi connectivity is available in just 12% of barangays, with about 70% of these services provided by public institutions. While fiber optic cables offer the highest Internet bandwidth and reliability, their availability remains concentrated in urban areas. Notably, only 5% of the surveyed barangays reported access to the full range of broadband infrastructure and services—namely ISPs, fiber optic connectivity, free wireless Internet access through Wi-Fi, and telecommunications towers. Among these, about 89% are located in urban barangays.

TABLE 5

PROPORTION OF SURVEYED BARANGAYS WITH ACCESS TO DIGITAL AND RELATED INFRASTRUCTURE (IN %).

Infrastructure	Urban	Rural	Total
Electricity	99.6	97.7	98.5
Free-to-air digital television signal	50.6	34.2	40.9
Mobile phone signal	97.8	88.1	92.0
Fourth-generation network (4G) signal	82.6	43.8	60.6
Third-generation network (3G) signal	15.2	40.6	29.6
Telecommunications tower	61.3	18.9	36.3

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Infrastructure	Urban	Rural	Total
Internet Service Provider	92.1	71.1	79.6
Free wireless Internet access through Wi-Fi	23.9	4.1	12.2
Fiber optic connectivity	53.3	11.9	28.8

Note: Barangay is the smallest local government unit in the Philippines.
Source: Department of Information and Communications Technology (n.d.); Albert et al. (2021).

ICT Utilization and Firm Productivity

There is significant potential to expand ICT adoption among establishments within the Philippines' ICT sector, particularly in e-commerce. The Survey on ICT (SICT), routinely conducted by the PSA, measures key ICT indicators and levels of utilization among firms in the ICT, content, and media sectors. The ICT sector, as defined in the survey, includes industries such as software publishing, telecommunication services, computer programming, consultancy, and related services, data processing, and hosting services, as well as repair of computers and communication equipment (Philippine Statistics Authority, n.d.b.) .

TABLE 6

ICT INDICATORS AMONG FIRMS IN THE INFORMATION AND COMMUNICATION TECHNOLOGY SECTOR.

Indicators	2013	2015	2017	2019	2021
Number of ICT establishments	3,434	2,979	2,782	4,595	2,977
Number of employed (thousands)	372	387	367	334	429
Share of ICT establishments (%)					
Owning and using computers	98.5	98.4	99.6	99.8	99.6
With Internet	96.3	96.5	97.6	97.4	98.7
With website	25.9	30.2	41.4	36.5	41.8
With e–commerce via the Internet	12.8	13.2	22.9	22.7	29.7
With business transactions via mobile	15.9	17.3	27.2	41.5	48.6
With social media	–	–	34.7	47.4	57.1
With the Internet for staff training	29.7	33.8	63.5	22.0	46.6

Source: Philippine Statistics Authority (n.d.).

In the ICT sector, both employment levels and the percentage of establishments using ICT tools, such as mobile communication, the Internet, and social media, reached historic highs during the COVID-19 pandemic (see Table 6). By 2021, nearly 60% of ICT establishments had a presence on social media. However, less than 30% engaged in e-commerce via the Internet.

Businesses that embrace digital technologies can unlock significant growth opportunities and gain a competitive edge in the market. For example, by leveraging e-commerce, establishments can expand their market reach, reduce overhead costs associated with physical storefronts, and enhance overall productivity, among other benefits.

Despite these opportunities, many firms continue to face constraints, including infrastructural gaps, financial limitations, a shortage of human capital, and regulatory challenges, which hinder their ability to fully benefit from digitalization. The WBES provides firm-level data to benchmark the quality of the business environment. In the Philippines, three surveys have been conducted, with the most recent survey completed in 2023 (see Table 7).

TABLE 7

WBES FOR THE PHILIPPINES: FIRM COMPOSITION.

	2009		2015		2023	
Size	Number	Share	Number	Share	Number	Share
Small	522	39.4	474	35.5	423	42.2
Medium	468	35.3	475	35.6	323	32.2
Large	336	25.3	386	28.9	256	25.5
All	1326	100.0	1335	100.0	1002	100.3

Note: Percentages may not add up due to rounding.
Source: Calculated by the National Expert based on data from WB (n.d.).

Electricity, transport, and an inadequately educated workforce have increasingly been ranked among the biggest obstacles affecting business operations in the Philippines (see Table 8). Energy security, in particular, has risen from being the fourth-highest ranked obstacle in 2009 to the top concern for the establishments in 2023. Similarly, concerns over workforce education have steadily grown, with its ranking increasing from 13th in 2009 to 9th in 2023. This trend underscores the growing urgency for investments in both reliable energy sources and workforce skill development. Other consistently cited barriers affecting business operations in the Philippines include electricity supply issues, the impact of competitive practices of the informal sector, limited access to finance, and burdensome tax rates, all of which have remained among the top five obstacles across the three surveys.

TABLE 8

BIGGEST OBSTACLES AFFECTING BUSINESS OPERATIONS IN THE PHILIPPINES (SHARE OF RESPONDENTS).

	2009		2015			2023		
Obstacle	Rank	%	Rank	Change	%	Rank	Change	%
Electricity	4	8.7	3	↑ (+1)	10.7	1	↑ (+2)	20.2
Practices of competitors in the informal sector	1	22.3	1	No change	16.5	2	↓ (−2)	12.7
Access to finance	2	13.0	4	↓ (−2)	9.2	3	↓ (+1)	9.9
Business licensing and permits	7	3.2	12	↓ (−5)	3.1	4	↑ (+8)	8.4
Tax rates	3	10.6	2	↑ (+1)	11.2	5	↓ (−3)	7.7
Transport	9	3.0	7	↑ (+2)	7.0	6	↑ (+1)	6.4
Crime, theft, and disorder	11	2.4	11	No change	3.2	7	↑ (+7)	5.9
Corruption	5	6.7	5	No change	7.9	8	↓ (−3)	5.2
Inadequately educated workforce	13	1.7	10	↑ (+3)	3.5	9	↑ (+1)	4.1

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Obstacle	2009		2015			2023		
	Rank	%	Rank	Change	%	Rank	Change	%
Labor regulations	10	2.6	8	↑ (+2)	4.0	10	↓ (−2)	4.0
Tax administration	12	2.0	9	↑ (+3)	3.9	11	↓ (−2)	3.0
Customs and trade regulations	8	3.2	6	↑ (+2)	7.8	12	↓ (−6)	2.4

Note: 'Change' refers to the change in rank order of the obstacles compared to the previous survey year. Responses marked as 'Does not apply' and 'Do not know' were excluded from the rankings.
Source: Calculated by the National Expert based on data from WB (n.d.).

The WBES 2023 indicates that inadequate electricity supply is the most significant obstacle, with 20.2% of firms surveyed in the Philippines highlighting it as their primary operational challenge. More than 29% of respondents considered power interruptions as a significant or severe obstacle hampering their operations, while 42.9% of firms reported experiencing power outages during the previous FY. Notably, 41.6% of firms experienced power outages more than once.

Practices of competitors in the informal sector (12.7%) ranked as the second most significant obstacle, with 22.7% of firms reporting that they faced competition from unregistered or informal firms. Access to finance followed in third place, with 9.9% of firms identifying it as their top obstacle. Around 12.3% of respondents classified access to finance as a major to severe obstacle, and more than 69.1% of firms reported having no line of credit or loan from a financial institution. Access to finance is a significant challenge for MSMEs, startups, and cooperatives, largely due to their lack of collateral and difficulty meeting the documentation requirements of formal lenders. This problem is worsened by the absence of a credit risk database that includes information on the creditworthiness of micro and small businesses. Additionally, seed funds and grants for incubation and startup development are still limited, and venture capitalists remain scarce (National Economic and Development Authority, 2023).

In line with findings from the 2019 NICTHS, the utilization of e-payment remains unpopular among establishments, likely due to cybersecurity concerns. Around 37% of firms did not use electronic means to pay, while 26% did not receive payments using electronic means. The 2019 NICTHS also revealed that fewer than half of the population are aware of cybersecurity and data privacy issues. Scams and fraudulent text messages are the most frequently reported cyber incidents, yet only about 24% of victims report these incidents (Albert et al., 2021). An incident analysis of cyberattacks in select Asia-Pacific economies found that businesses in the Philippines had the highest prevalence of cyber incidents at 75%, compared to the regional average of 59% (Kroll, 2022).

Lastly, an inadequately educated workforce was cited as the biggest obstacle by 4.1% of respondents in 2023 and was considered a major to severe constraint by 5.3% of firms. As the country's digital economy continues to expand, the future workforce must be equipped with relevant digital skills and competencies. The IT-BPM Association of the Philippines projects that the tech industry will create 1.1 million new jobs in the next four years, including 150,000 developer positions expected to be filled within the next six years (Department of Trade and Industry, 2023).

A JobStreet market report estimates a shortage of 200,000 workers with IT skills in the Philippines (Simeon, 2022). An employee survey conducted by the Economist Impact found that the biggest

barrier to acquiring new digital skills is inadequate Internet access to participate in online courses, affecting 41% of individuals. This issue is particularly significant given that more than half of the workforce relies on online courses for digital upskilling. Close to half (40%) of employees also cited a lack of time as another challenge, while 30% highlighted the high cost of courses as a further obstacle (Bhandari, 2023).

Empirical Analysis

Using the three WBES conducted in the Philippines, a regression analysis was employed to empirically analyze how factors such as infrastructure (electricity), ICT utilization, and skills training, among others, relate to the firm's labor productivity. The empirical model is shown below in Equation 1:

$$[Eq.1] \quad \ln(LP_i) = \beta_0 + \beta_1 \cdot Elec_i + \beta_2 \cdot Email_i + \beta_3 \cdot Website_i + \beta_4 \cdot Training_i + \beta_5 \cdot Cert_i + \beta_6 \cdot Foreign\ Input_i + \beta_7 \cdot Firm\ Size_i + U_i$$

For each firm *i*, labor productivity (LP), defined as the amount of goods and services produced per hour of labor, is calculated by dividing a firm's total annual sales by the number of its permanent, full-time employees. The provision of electricity (Elec) is assessed based on the establishment's experience with power outages, which is expected to negatively impact the firm's productivity. Adapting some of the indicators from the Philippine SICT, ICT utilization is evaluated by whether firms communicate with suppliers and clients via email[1] (Email), Moreover, whether they maintain their websites (Website). These digital communication tools are essential for enhancing collaboration and streamlining operations, and are thus expected to enhance productivity.

Furthermore, the presence of formal training programs for full-time employees (Training) indicates a commitment to upskilling the workforce, which is vital for improving overall productivity and competitiveness. A key indicator of quality assurance is whether the establishment possesses internationally recognized quality certifications. These certifications demonstrate a commitment to maintaining high standards and can enhance a firm's credibility in the marketplace, ultimately attracting more customers and increasing sales.

The percentage of material inputs and supplies sourced from foreign origins (Foreign Input) serves as a key indicator of participation in GVCs, highlighting its integration into international markets. The size of the firm (Firm Size), classified into small (5–19 employees), medium (20–99 employees), or large enterprise (more than 99 employees), is also taken into account. Together, these factors underscore the importance of strategic investments in workforce development, quality management, and global engagement for increased productivity and sustained business growth. Lastly, the error term Ui represents the unobserved factors other than the explanatory variables that affect the firm's labor productivity.

Summary statistics among establishments used in the regressions are presented in Table 9. The upward trend in average labor productivity was disrupted during the pandemic. A similar increasing trend was observed in ICT indicators, particularly the use of websites, which saw a significant rise among establishments surveyed in 2023. Positive developments were also noted in the adoption of training programs by establishments and the general decrease in firms experiencing power outages.

[1] The Philippine WBES 2009 and 2015 include a question on whether the establishment communicates with suppliers via email, but not in the WBES 2023.

Conversely, firms with internationally recognized certifications reported a downward trend. Similarly, the average share of material inputs sourced from abroad decreased notably in 2023.

The regression results are summarized in Table 10. Models I to III report the separate year regressions for 2009, 2015, and 2023, respectively. Pooled regression was estimated for pre-pandemic survey years (Model IV) and all years (Model V). The pooled regression estimates across all years indicate that experiencing power outages is associated with a decrease in productivity of approximately 16%, holding all other variables constant. This impact is even more pronounced in the pre-pandemic years, where productivity declines reached 24%. Power interruptions can halt production processes, leading to delays and inefficiencies. Additionally, firms may incur extra costs for backup power solutions, such as generators, and sudden outages can damage sensitive equipment, resulting in costly repairs and extended downtime. According to the WBES, average annual sales losses due to power outages averaged 5.9% in 2009, 1.9% in 2015, and 3.9% in 2023 (WB, n.d.).

The utilization of ICT resources, such as establishing a website, is associated with a 25% increase in productivity, all other factors held constant. During the pre-pandemic survey years, when relatively fewer firms had websites, this figure was even higher at about 31%. Moreover, communicating with suppliers and clients via email correlates with a 45% boost in productivity. Internet outages, especially among businesses engaged in e-commerce, can severely disrupt customer service, hindering timely responses to inquiries and potentially leading to customer dissatisfaction. While the pre-pandemic WBES did not cover losses from Internet disruptions, the 2023 survey reported an average of 2.4% in annual sales lost due to these interruptions (WB, n.d.).

Formal training programs are associated with a 28% increase in productivity, all else being equal. Such programs equip employees with new skills and knowledge, enhancing their efficiency and effectiveness, which can lead to higher output quality and faster project completion. Upskilling is crucial for preparing the workforce to adapt to new technologies and market changes, ultimately enhancing a firm's capacity to innovate and meet evolving customer needs.

Firms with internationally recognized quality certifications demonstrate about 53% higher productivity compared to those without. The impact of quality assurance on labor productivity has significantly increased, rising from about 36% in 2009 to over 72% in 2023. This highlights the growing importance of maintaining high-quality processes and practices, especially in the aftermath of disruptions caused by the COVID-19 pandemic. Sourcing inputs from abroad also shows a marginally positive association with productivity. International recognition and exposure allow firms to access new markets and customer segments, increasing sales opportunities and revenue potential. Adopting internationally recognized standards often drives firms to implement best practices in production and management, leading to improved quality and efficiency. By participating in global markets, firms can diversify their customer base, reducing reliance on local markets and mitigating risks.

Large and medium-sized firms report higher productivity levels of about 48% and 32%, respectively, compared to small-sized firms. Larger firms benefit from economies of scale, resulting in greater efficiency and lower prices for consumers. They typically have better access to financial resources, enabling investments in advanced technologies, R&D, and employee training, which further boosts productivity. The WBES supports this observation, revealing that a higher proportion of small and medium-sized firms cite access to finance as a significant obstacle compared to large firms.

TABLE 9

SUMMARY STATISTICS.

Year	2009 (n = 788)		2015 (n = 823)		2023 (n = 914)	
	Mean	SD	Mean	SD	Mean	SD
Log (Labor productivity)	13.587	1.614	13.944	1.635	13.428	1.221
Electricity: Experienced power outages (1 = yes; 0 = no)	0.647	0.478	0.429	0.495	0.432	0.496
ICT utilization: Communicates with suppliers via email (1 = yes; 0 = no)	0.801	0.400	0.874	0.332		
ICT utilization: Establishment has website (1 = yes; 0 = no)	0.419	0.494	0.479	0.500	0.753	0.432
Upskilling: Formal training programs for full-time employees (1 = yes; 0 = no)	0.411	0.492	0.554	0.497	0.540	0.499
Quality assurance: Establishment has internationally recognized quality certification (1 = yes; 0 = no)	0.329	0.470	0.272	0.445	0.130	0.337
GVC participation: Material inputs of foreign origin (%)	40.055	39.701	37.429	39.508	13.189	27.830
Firm size dummy (1 = small; 2 = medium; 3 = large)	1.943	0.789	1.976	0.781	1.811	0.804

Note: GVC, global value chain; ICT, Information and Communications Technology; n, number of observations; SD, standard deviation.
Source: Calculated by the National Expert based on data from World Bank (n.d.)

TABLE 10

REGRESSION RESULTS.

Model	I	II	III	IV	V
Dependent Variable	Log of Labor Productivity				
Year	2009	2015	2023	2009 & 2015 Only	All Years
Electricity: Experienced power outages (1 = yes; 0 = no)	−0.073 (0.112)	−0.301*** (0.106)	−0.050 (0.076)	−0.242*** (0.075)	−0.160*** (0.055)
ICT utilization: Communicates with suppliers via email (1 = yes; 0 = no)	0.506*** (0.151)	0.315* (0.166)		0.447*** (0.111)	
ICT utilization: Establishment has website (1 = yes; 0 = no)	0.167 (0.120)	0.458*** (0.117)	0.162* (0.090)	0.312*** (0.084)	0.249*** (0.058)
Upskilling: Formal training programs for full–time employees (1 = yes; 0 = no)	0.359*** (0.120)	0.079 (0.117)	0.301*** (0.082)	0.278*** (0.083)	0.278*** (0.060)
Quality assurance: Establishment has internationally recognized quality certification (1 = yes; 0 = no)	0.359*** (0.131)	0.516*** (0.133)	0.723*** (0.124)	0.383*** (0.093)	0.534*** (0.073)
GVC participation: Material inputs of foreign origin (%)	0.005*** (0.001)	0.005*** (0.001)	0.006*** (0.001)	0.005*** (0.001)	0.006*** (0.001)
Firm size dummy: Medium (1 = yes; 0 = no; baseline = small)	0.523*** (0.131)	0.274** (0.130)	0.013 (0.090)	0.410*** (0.092)	0.316*** (0.067)

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Model	I	II	III	IV	V
Dependent Variable	Log of Labor Productivity				
Year	2009	2015	2023	2009 & 2015 Only	All Years
Firm size dummy: Large (1 = yes; 0 = no; baseline = small)	0.432*** (0.155)	0.647*** (0.149)	0.174* (0.105)	0.563*** (0.108)	0.475*** (0.078)
Constant	12.367*** (0.142)	12.916*** (0.164)	12.938*** (0.091)	12.629*** (0.107)	12.887*** (0.062)
Observations	788	823	914	1611	2526
Prob > F	0.000	0.000	0.000	0.000	0.000
R–squared	0.174	0.179	0.143	0.172	0.158

Notes: Standard errors in parentheses, *** p<0.01; ** p<0.05; * p<0.1.
Source: Estimated by the National Expert based on WB (n.d.).

Policy Discussion and Recommendations

A Brief Overview of Philippine Digital Readiness Performance

A 2024 report by the International Telecommunication Union (ITU), which assesses the level of digital readiness on policy, legal, and governance frameworks in ASEAN, indicated that the region has achieved 57% of ITU's unified framework benchmark targets, surpassing the Asia-Pacific average of 46% and the global average of 51%. The report further highlighted the ASEAN region's notable progress in the following target areas: national policy agenda, legal instruments for ICT/telecommunication markets, good governance, legal instruments for digital markets, and market rules (ITU, 2024). The Philippines, with an achievement rate of 78%, along with other Southeast Asian economies, including Singapore (89%), Malaysia (84%), and Thailand (75%), was classified by the ITU as having an advanced level of digital transformation preparedness.

The Philippines received an 'advanced' rating (i.e., achieving at least 67% accomplishment rate) on all nine benchmark areas set by the ITU (see Table 11). The country received a perfect score by achieving all targets under regional and international cooperation (B9). The Philippines is a member of several international forums for a for data privacy, including but not limited to the ASEAN Digital Data Governance Working Group, ASEAN Data Protection and Privacy Forum, APEC Cross-Border Privacy Rules system, APEC Cross-Border Privacy Enforcement Arrangement, Global Forum Assembly establishing the Global Cross-Border Privacy Rules system, Global Privacy Assembly, and Global Privacy Enforcement Network, through its National Privacy Commission (NPC). The NPC is also an observer in the Consultative Committee of the Convention for the Protection of Individuals concerning Automatic Processing of Personal Data (Convention 108) (ITU, 2024).

The Philippines also scored highly in stakeholder engagement (B5) and the national digital policy agenda (B8). To this end, the Department of Information and Communications Technology, as the lead agency for ICT development, prepared the National Cybersecurity Plan 2023–28 in February 2024, which articulates the vision for a trusted, secure, and reliable cyberspace. Additionally, the development of other ICT-related plans, such as the National ICT Development Agenda, the Digital

Government Master Plan, the National Broadband Plan, and the National Emergency Communications Plan, is also underway (ITU, 2024; Department of Information and Communications Technology, 2024).

TABLE 11

ITU ACCOMPLISHMENT RATE, BY BENCHMARK TARGET AREA.

	Benchmark Target Area	ASEAN	PHL
B1	National digital policy agenda	63	85
B2	Regulatory capacity	55	81
B3	Good governance	60	73
B4	Collaborative governance	53	84
B5	Stakeholder engagement	50	90
B6	Legal instruments for ICT/telecommunication markets	61	68
B7	Legal instruments for digital markets	57	75
B8	Market rules	56	70
B9	Regional and international cooperation	54	100
	Overall	57	78

Note: ASEAN, Association of Southeast Asian Nations; PHL, Philippines.
Source: ITU (2024).

The ITU identified policy and regulatory gaps by focusing on the target areas where the Philippines achieved the lowest scores (ITU, 2024). In the area of good governance (B3), the report proposed reviewing the national policy and regulatory frameworks for their technology and service neutrality, conducting ex-post and rolling policy reviews, advancing ongoing efforts regarding the introduction of a formal requirement for Regulatory Impact Assessment, and reviewing current rules for appeals of adopted regulations by affected parties to a relevant administrative agency.

Under legal instruments for ICT/telecommunication markets (B6), ITU recommended mandating infrastructure sharing for fixed operators, introducing number portability for fixed operators, implementing mobile number portability as stipulated in Republic Act 11202, or the Act Requiring Mobile Service Providers to provide Nationwide Mobile number Portability, and introducing a mandate that requires operators to publish their Reference Interconnection Offer be considered.

Lastly, under market rules (B8), the report proposed revising the ownership structure to allow full foreign ownership and addressing the level of competition in different markets and services.

The Philippines has recently implemented significant reforms aimed at enhancing its position as an attractive investment hub, attracting much-needed capital and technology to drive innovation and support the growth of digitally enabled industries.

- In December 2021, the Philippines amended the Retail Trade Liberalization Act, which reduced the minimum paid-up capital requirements for foreign retail enterprises, eliminated the need for a certificate of pre-qualification from the Philippine Board of Investments, and lowered the investment requirements for each store owned by foreign enterprises.

Retail enterprises with more than 80% foreign ownership are no longer required to offer 30% of their shares in the Philippines publicly (Republic Act No. 11595, 2021; Implementing Rules and Regulations of Republic Act No. 8762, 2022).

- In March 2022, the Foreign Investment Act was amended to open more sectors to foreign investment, and permitted foreign investors to own SMEs fully. Foreign investors can also hold 100% company equity in select sectors, provided that the businesses utilize advanced technology (as determined by the Department of Science and Technology), are endorsed as startup enablers or recognized as startups under the Innovative Startup Act, and employ a minimum of fifteen Filipino workers (Republic Act No. 11647, 2022; Implementing Rules and Regulations of Republic Act No. 11647, 2022).

- In November 2022, the Department of Energy prescribed revisions to the Foreign Investment Negative List, which now allows full foreign ownership of the renewable energy sector. This enables broader foreign participation in exploring, developing, and utilizing the country's renewable energy resources, including solar, wind, biomass, and ocean or tidal energy (Department of Energy Circular No. DC 2022-1-0034, 2022).

- In April 2023, the Implementing Rules and Regulations that amended the Public Service Act came into effect, further liberalizing key public services by permitting full foreign ownership in select industries, including airports, railways, expressways, and telecommunications. On the other hand, public service utilities, including electricity transmission and distribution, water and wastewater systems, petroleum pipelines, seaports, and public utility vehicles, remain subject to a 40% foreign equity limit (Republic Act No. 11659, 2022; Implementing Rules and Regulations of Republic Act No. 11659, 2023).

Steps Forward

The dual strategy of promoting GVC integration and digitalization of services not only helps upgrade the workforce's skills but also ensures that labor markets can adapt to evolving economic demands. Together, these measures create a more dynamic and competitive environment that supports sustainable economic development. Deficiencies in digital infrastructure, investment, and financial gaps, as well as limited digital skills and human capital, need to be addressed to ensure that the advantages of GVC integration and digital services trade are widely and equitably shared.

The PDP 2023–28, aligned with the administration's 8-point socio-economic agenda, highlights key priorities in digital governance, investment, skills, connectivity, and resilience. Based on the aforementioned considerations, the following steps forward are recommended:

- **Address the market failures in the provision of digital trade:** The digital divide in the Philippines is exacerbated by limited infrastructure and weak competition among service providers. Many regions, especially in rural areas, suffer from inadequate Internet connectivity, which inhibits access to online platforms and digital services. This lack of infrastructure stifles growth opportunities for businesses and individuals who are unable to participate fully in the digital economy. The government and private sector must work together to accelerate the transition to a digitally-driven economy by investing in the digital transformation of industries, improving infrastructure, and supporting the growth of service-based startups.

As articulated in the PDP 2023–28, game-changing reforms must be implemented to reduce the cost of electricity, which is crucial for enhancing business competitiveness. Efforts must also be directed towards modernizing and expanding transport and digital infrastructure to facilitate the movement of people, goods, and information, thereby fostering greater connectivity and efficiency. The drive toward the servicification of industries must be strongly continued, with a focus on promoting the shift toward high-value, service-oriented sectors that are key drivers of innovation, productivity, and sustainable economic growth.

As traditional industries evolve, increasing emphasis must be placed on the development of knowledge-intensive services such as IT, finance, healthcare, education, and professional services. Furthermore, the operationalization of recent economic liberalization reforms, including the Public Service Act, Retail Trade Liberalization Act, and Foreign Investment Act, must be followed through to create a more open and competitive business environment.

- **Enhance the digital readiness of the future workforce:** Fostering a greater interest in science, technology, engineering, and mathematics (STEM) disciplines from an early age is crucial to develop problem-solving skills, critical thinking, and creativity. This can be achieved through enhanced educational programs, extracurricular activities, and partnerships between schools and IT firms that provide practical exposure to digital skills. Encouraging students to pursue STEM careers and supporting them with scholarships and mentorship can also play a pivotal role.

  Collaborations between educational institutions and industry stakeholders can ensure that curricula remain relevant and aligned with the evolving demands of the digital economy. Accommodating flexible learning options, such as online courses and hybrid learning models, can make digital education more accessible to a broader audience. Investing in digital literacy programs and reskilling initiatives for current workers is equally important to keep pace with technological advancements. The PDP 2023–28 pointed out the need to develop a national policy for lifelong learning, ensuring continuous skill development throughout individuals' careers. There must be increased access to funds and incentives for R&D, as well as the startup ecosystem, to foster innovation, support entrepreneurship, and drive technological advancements.

- **Complement investments in human capital by expanding access to finance:** Improving access to financial services through alternative financing options such as microloans and venture capital, particularly among MSMEs, can support these businesses in investing in employee training and development. Encouraging wider participation in digital payments can also help integrate more individuals and businesses into the financial system, promoting financial inclusion. Developing financial literacy programs and supporting fintech innovations can further facilitate access to affordable financial services. Government incentives and partnerships with private sector players can enhance the availability of seed funds and grants for digital skills development initiatives.

- **Build a conducive environment that minimizes the inherent risks of a digital world:** Establishing robust cybersecurity measures and data protection regulations is essential to safeguard personal and business information from cyber threats. Investing in cybersecurity infrastructure and training can help mitigate risks and protect against potential breaches.

Furthermore, the government should work to create a regulatory framework that promotes data privacy and trust while facilitating smooth cross-border data transactions. Fostering a culture of digital trust and transparency among businesses and consumers can enhance confidence in digital platforms and services. Promoting international cooperation and adherence to global standards for data protection can also support secure and reliable digital interactions.

Conclusion

In the post-COVID-19 recovery and economic rebound phase, the adoption of ICT through digital trade presents a unique and timely opportunity for the Philippines to strengthen its participation in GVCs and advance its trade and overall economic competitiveness. Digitalization has made it easier for firms to engage in globalized production networks. By adopting a dual strategy that integrates GVC development with digital trade, the country can transition into producing more sophisticated and high-value goods and services. It also provides significant potential to make trade more inclusive, resilient, and sustainable.

However, the anticipated productivity gains are hampered by challenges such as inadequate digital infrastructure, limited human capital, insufficient digital skills, and affordability issues. Significant disparities in ICT access and usage across different regions, age groups, and educational levels highlight the existence of digital divides within society. To fully capitalize on the advantages of GVC integration and digital services trade, it is crucial to address deficiencies in the digital infrastructure, investment, and skills development.

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THAILAND

Summary

Thailand has emerged as a key player in GVCs, particularly in the automotive, electronics, and agricultural sectors. This success is underpinned by the country's strategic location, skilled workforce, and favorable government policies. The country's automotive industry, known as the 'Detroit of Asia', exemplifies Thailand's success in global integration, driven by strategic investments and robust industrial policies. In electronics, Thailand is a leading manufacturer of components, including hard disk drives. In agriculture, the country plays a crucial role in the global food supply chain, exporting products like rice, canned fruit, and seafood.

Liberal trade policies and strong incentives for FDI, including tax breaks and the development of special economic zones (SEZs), have further facilitated Thailand's integration into global networks. However, Thailand faces significant barriers in skill upgradation, including limited access to finance, cybersecurity concerns, barriers to entering global markets, and a shortage of skilled human capital.

ICT offers a strategic pathway to address these constraints. By expanding digital financial access, strengthening cybersecurity, increasing digital market opportunities, promoting online education, and utilizing data-driven decision-making, Thailand can enhance workforce skills and competitiveness. These efforts align with the Thailand 4.0 initiative, which emphasizes innovation, research, and technology adoption to drive economic growth and advance the country's role in GVCs.

The Eastern Economic Corridor (EEC) invests in digital infrastructure to develop high-tech industry zones. The Digital Economy and Society Development Plan expands broadband access and promotes digital literacy. Public Private Partnerships is encouraged to boost digital infrastructure projects. Continued focus on digital infrastructure and skill development will be crucial for enhancing productivity and securing a long-term competitive advantage.

Introduction

In the 1960s, Thailand's economy underwent a significant transformation, shifting from an agriculture-based economy to one that is now industrialized and globally integrated (Goss & Burch, 2001; Pananond, 2013). The country's strategic shift in the 1980s, from import substitution to export-oriented growth, attracted international investment and spurred rapid economic development. Since the late 1980s, Thailand's economy has shifted from agricultural and basic services to industrial exports and advanced service industries (Jomo et al., 1997). Between 1985 and 1997, Thailand's rapid industrialization and economic expansion attracted global attention (Goss & Burch, 2001).

By 1987, Thailand's economic rise, alongside that of South Korea, Taiwan, Singapore, and Hong Kong, made it a potential fifth Asian Tiger. Time magazine highlighted this possibility, and by 2000, the IMF projected Thailand as the new industrializing nation. However, this economic boom was abruptly halted by the 1997 financial crash in Asia (Charoenloet, 2000). Thailand's post-crisis economic recovery was supported by structural reforms and export-driven growth (Pickard & Lemma, 2022). The country

diversified its economy, expanding into tourism, automotive, and electronics sectors (Chiasakul, 2004; Jongwanich, 2020; Kontogeorgopoulos, 1998). Besides, Thailand's strategic location helped establish it as a regional trade and investment hub (Chirathivat & Cheewatrakoolpong, 2016).

In recent years, the government has launched Thailand 4.0, an initiative aimed at transforming the economy through innovation and technology (Kohpaiboon, 2020). This policy aims to develop high-tech industries, enhance digital infrastructure, and improve human capital. Despite ongoing challenges, including political instability, an aging population, and the impact of the COVID-19 pandemic, Thailand continues to adapt and evolve. Despite challenges, Thailand's strong economic fundamentals and ongoing reforms provide a solid foundation for future growth and resilience (Marome & Shaw, 2021).

GVCs are complex networks that connect businesses worldwide. These supply chains include every stage required to produce and provide goods or services, from the first concept to the very end of their intended use. At present, numerous businesses, particularly those in developing countries, are positioned lower in these chains. Typically, they engage in labor-intensive manufacturing and assembly, but undertake low-value-added tasks. Although these positions are essential, there are few opportunities for substantial innovation, expansion, or profit increases.

Thailand's GDP

As indicated in Table 1, Thailand's national GDP in 2018 was primarily driven by the services sector (41%), followed by manufacturing (26.8%), wholesale and retail (15.9%), and other sectors, including agriculture, at 8.2% and 8.1%, respectively. When focusing on the GDP contribution from SMEs, the service sector remained the largest contributor at 39.1%, with a growth rate of 4.6%. Wholesale and retail ranked second, contributing 31.4%, but with a higher growth rate of 7.6%. Manufacturing and other sectors contributed 22.6% and 6.9%, respectively. Table 2 further illustrates that SMEs accounted for only 15% of the share in manufacturing, whereas wholesale and retail dominated with 72%, and the services sector had a share of 39%.

TABLE 1

NATIONAL GDP AND SME-GENERATED GDP BY ECONOMIC SECTOR IN 2018.

	National GDP		SMEs GDP	
	Share	Growth	Share	Growth
Agriculture	8.1	5.1	–	–
Manufacturing	26.8	3	22.6	3.1
Wholesale and retail	15.9	7.3	31.4	7.6
Services	41	4.3	39.1	4.6
Other	8.2	1.8	6.9	2.5

Source: Trade, global value chains, and small and medium-sized enterprises in Thailand: A firm-level panel analysis, ADBI.

TABLE 2

THAILAND'S GDP BREAKDOWN BY KEY ECONOMIC SECTOR AND ENTERPRISE SIZE IN 2018 (IN THB TRILLION).

	Manufacturing		Wholesale and Retail		Services	
	Value	Share	Value	Share	Value	Share
Small enterprise	0.64	15%	1.88	72%	2.21	39%
Medium-sized enterprise	0.94	22%	0.32	12%	0.53	9%

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	Manufacturing		Wholesale and Retail		Services	
	Value	Share	Value	Share	Value	Share
Large enterprise	2.78	64%	0.4	15%	2.99	52%
Total	4.37	100%	2.6	100%	5.74	100%

Source: Trade, global value chains, and small and medium-sized enterprises in Thailand: A firm-level panel analysis, ADBI.

Current Position of Firms in the Global Value Chain

Businesses in Thailand operate at various levels within GVCs, reflecting the country's diverse economy of agriculture, manufacturing, and services (Durongkaveroj, 2023; Laura et al., 2023; Riccardo & Oliver, 2022; Teipen et al., 2022). Key aspects of their current position include:

Manufacturing and Assembly Hubs

- **Automotive industry:** Thailand is a significant hub in Asia for the automobile industry, producing vehicles for numerous international brands (Simon, 2023).

- **Electronics and electrical appliances:** Electronics, primarily ICs, hard drives, and other components, are Thailand's main export. These sectors play a significant role in the GVC's manufacturing and assembly processes, frequently depending on imported intermediate goods and raw materials (Errighi & Bodwell, 2017).

Agriculture and Food Processing

- **Agricultural exports:** Rice, rubber, seafood, and other agricultural products are among the top exports from Thailand (Poapongsakorn, 2011; Thammachote & Trochim, 2021). Although it still plays a significant role in the GVC, the agricultural sector primarily contributes to lower-value phases, such as raw material production and basic processing (Chen & De Lombaerde, 2013).

- **Processed foods:** Thailand has made significant progress in food processing, thereby enhancing the value of its agricultural exports. Companies in this industry are increasingly involved in higher-value operations such as innovation, branding, packaging, and marketing of processed food items (Intarakumnerd et al., 2015; Kusano, 2019; Piyanantisak, 2018).

Textiles and Garments

This industry is important, although it is primarily involved in labor-intensive manufacturing and assembly processes. In Thailand and other ASEAN countries, tiny, informal local suppliers dominate the clothing industry. These vendors frequently have identical production architectures, focusing mostly on primary manufacturing processes. Individual countries face difficulty in differentiating themselves and moving up the value chain due to the region's commonality (Ahlstrom & Stalros, 2005; Goto & Endo, 2014).

Service Sector

Thailand's economic growth has been driven by industry and exports, although this paradigm may be maturing. As costs rise and regional competition intensifies, Thailand must strengthen its services sector and enhance manufacturing with advanced technologies. The expanding relationship between commodities and services trade opens up new prospects for Thai enterprises (Suzuki et al., 2020).

- **Tourism:** As one of the world's top tourist destinations, Thailand's service sector, particularly tourism, plays a critical role in the economy (Suzuki et al., 2020).

- **Logistics:** The analysis of Thailand's industrial sectors revealed that enterprises have successfully integrated into GVCs. These chains are mostly handled and coordinated by huge multinational logistics organizations that oversee complex international networks of production, distribution, and supply (Kohpaiboon, 2019). As a result, Thai logistics providers have the option to enter the sector.

This overview illustrates Thailand's diverse participation in GVCs, spanning from primary production to advanced services, reflecting its current stage of economic growth. The majority of enterprises in the lower segments of GVCs highlight the crucial need for skill upgrading. By training their workers with advanced competencies, firms can improve their competitive edge, stimulate innovation, and move up the value chain, resulting in increased profitability and long-term sustainability.

Importance and Necessity of Skill Upgrading

The importance and necessity of skill upgrading for Thailand can be clarified through the following key dimensions (Ministry of Education, 2023; Rattana, 2023).

- **Enhancement of global competitiveness:** As Thailand seeks to improve its standing in GVCs, workforce skill development is critical. Advanced competencies in technology, management, and innovation are necessary for transitioning from labor-intensive, low-value-added activities to higher-value areas such as R&D, design, and high-technology manufacturing. This skill augmentation enables Thai enterprises to enhance efficiency, innovate effectively, and improve quality, all of which are essential for global competitiveness (Simon, 2023).

- **Compliance with international standards and market demands:** Global markets set high requirements for quality, safety, and efficiency. Upgrading staff skills enables Thai companies to reach international standards, allowing them to enter new markets and improve their competitiveness (Intarakumnerd, 2021). Furthermore, a deeper understanding of global customer needs through enhanced compliance and conformity can lead to higher satisfaction and loyalty, further solidifying Thailand's position in GVCs.

- **Promotion of economic growth and development:** A highly skilled workforce promotes economic growth by increasing productivity and stimulating innovation (Litsareva, 2017). In Thailand, skill development can help close the gap between current workforce capabilities and the expectations of modern industries. This not only benefits individual enterprises but also contributes to national economic development by creating high-quality job opportunities, attracting foreign investment, and improving overall economic resilience.

- **Adaptation to technological advancements:** The rapid advancement of technology, particularly the introduction of Industry 4.0, requires a workforce that is skilled in emerging technologies such as automation, AI, and the IoT. Skill development ensures that staff can utilize these technologies to enhance operational efficiency, product quality, and innovative potential. This adaptability is critical for staying relevant and competitive in the global market.

- **Alignment with government initiatives and policies:** The Royal Thai government has launched several attempts to shift the economy toward a more innovative model. Thailand's 4.0 policy, for example, aims to shift to a value-based economy powered by innovation, technology, and creativity. Skill upgrading is essential to achieving these goals because it provides the workforce with the competencies required to drive and sustain this transformation.

- **Mitigation of inequality and promotion of social inclusion:** Skill development can play a crucial role in reducing economic inequality and enhancing social participation (Bennell, 1999). Thailand can promote more equitable access to high-quality employment and career advancement by offering chances for people to improve their skills, particularly those from disadvantaged backgrounds. This helps to establish a more inclusive and harmonious society.

Skill development is crucial to Thailand's advancement within GVCs. As the country transitions from labor-intensive, low-value industries to more complex, high-value operations, the need for a highly skilled workforce becomes increasingly apparent. The current economic landscape, characterized by rapid technological change, requires personnel to possess not only high technical skills but also adaptive qualities (Grant Thornton, 2020). These improved competencies enable businesses to effectively integrate and utilize new technology, while also fostering creativity and operational efficiency. Thailand's economic position can be strengthened by focusing on skill development as a top priority.

Constraints on Firms' Skill Upgrading and ICT's Potential

Access to Finance

The restricted availability of financial resources is one of the major hindrances to skill development among Thai organizations, particularly SMEs, which comprise a significant percentage of Thailand's economy (Amornkitvikai & Harvie, 2016; Korwatanasakul & Paweenawat, 2020; Tambunan, 2008; Wattanapruttipaisan, 2003). These SMEs often struggle to obtain suitable funding for workforce development initiatives. Implementing comprehensive training programs frequently requires significant financial investment, which can be prohibitively expensive for smaller businesses with limited capital. This financial limitation has several implications:

- **Restricted investment:** It hinders firms' ability to invest in their employees' skill development.

- **Competitive disadvantage:** It hinders their ability to expand the value chain and improve their competitive position.

- **Innovation gap:** This may exacerbate the disparity between larger, well-funded enterprises and SMEs in terms of innovation and productivity.

- **Economic growth constraint:** On a larger scale, it may slow the overall rate of economic growth and technological adoption.

Due to financial constraints, organizations' capacity to react to changing market needs suffers significantly. This challenge highlights the need for targeted governmental interventions and alternative financing channels to support SMEs' efforts to develop personnel capacities and, by extension, their competitiveness in the GVC.

Safety of Transaction

In Thailand, the security of financial transactions poses a substantial obstacle to enterprises' efforts to upgrade skills. Thai businesses, particularly SMEs, frequently raise concerns about cybersecurity and the reliability of digital payment systems. These concerns may dissuade businesses from investing in online training programs and digital platforms for talent development.

- **Digital transformation:** Thailand pursues its Thailand 4.0 initiative, which aims to transform the economy through digitalization. However, many firms are still in the early stages of adopting digital technologies (Matt et al., 2020; Niyawanont, 2022). This transition period makes them particularly vulnerable to cyber threats.

- **Cultural factors:** Traditional Thai business procedures frequently emphasize in-person interactions and physical documents. The transition to digital transactions and online training platforms marks a profound cultural shift, raising security issues. Effective organizational policies play a crucial role in addressing this issue. Effective company-level strategies can have a substantial impact on digital technology adoption and cybersecurity improvement. Despite limited resources, businesses can develop a framework for enhancing digital literacy, increasing cybersecurity awareness, and supporting the integration of new technologies by establishing clear guidelines (Wilaisakoolyong, 2018).

- **Recent cyber incidents:** Thailand has experienced numerous high-profile cyberattacks in recent years, targeting both the public and private sectors (Charoen, 2018). These incidents have heightened awareness of cybersecurity risks among Thai businesses.

- **Regulatory environment:** Although the Royal Thai government has introduced laws such as the Cybersecurity Act and the Personal Data Protection Act, their implementation is still in progress (Phusamruat, 2018). This evolving regulatory landscape can create uncertainty for businesses considering digital investments.

- **Limited cybersecurity expertise:** Many SMEs in Thailand lack internal cybersecurity expertise, making them cautious about implementing new digital finance systems or e-learning platforms. As a result, development partners and donors play a crucial role in assisting developing and emerging economies in addressing the cybersecurity resource gap (Baur-Yazbeck et al., 2019).

Consequently, Thai businesses' trust in digital transactions may be weakened by worries about financial fraud, data breaches, and other cyber threats. This hesitation may limit the rate of workforce growth and technical advancement in Thailand's business sector by hindering the adoption of new technologies essential for skill upgrading.

Access to the Global Market

To promote innovation and update skills, Thai enterprises must have access to international markets. Nonetheless, many Thai companies face significant challenges that prevent them from fully engaging in global trade, which affects their ability to develop labor capacities. These difficulties can take many different forms as follows:

- **Trade standards and regulations:** Despite Thailand's efforts to liberalize commerce, many businesses, particularly SMEs, continue to face challenges due to complex

international standards and regulations, as well as bureaucratic processes (Korwatanasakul & Paweenawat, 2020). While there have been improvements, the nation's position in the World Bank's Ease of Doing Business index shows persistent regulatory obstacles.

- **Tariffs and non-tariff barriers:** Despite Thailand having signed FTAs with several countries, their use remains minimal. This is due to a variety of causes, including low trade volumes, the availability of rival schemes with larger benefits, and a lack of proper information and understanding of FTAs (Suksri et al., 2015). Non-tariff barriers such as Sanitary and Phytosanitary regulations and Technical Barriers to Trade also impede the effective implementation of FTAs (Jaroensathapornkul, 2017; Korwatanasakul & Baek, 2021; Lim, 2023).

- **Logistical challenges:** Although Thailand has made significant infrastructural improvements, logistical inefficiencies persist, particularly for firms based outside large urban centers. According to the World Bank's Logistics Performance Index, Thailand lags behind its regional competitors, such as Singapore and Malaysia, in several areas (Logistics Development Strategy Division, 2023).

- **Language and cultural barriers:** Many Thai businesses, particularly SMEs, struggle with language barriers and cultural differences when attempting to enter foreign markets, which limits their ability to learn from global best practices (Anitsal, 2014).

- **Digital trade limitations:** As e-commerce expands globally, some Thai firms encounter challenges in utilizing digital platforms for international trade due to limited digital infrastructure or e-commerce regulations in target markets.

Access to Skilled Human Capital

The availability of competent human capital is a significant barrier to Thai enterprises' ability to enhance their capabilities. Thailand faces a substantial shortage of personnel with advanced technical skills, particularly in key areas critical to the country's economic development (Chemsripong, 2016). Several key factors characterize this skills gap in Thailand:

- **Mismatch in education system:** Thailand's education system has traditionally emphasized Rote Learning over critical thinking and problem-solving skills. This approach, while deeply rooted in Thai culture, has led to a disconnect between educational outcomes and industrial needs.

- **Emerging industry demands:** As Thailand strives to move up the GVC through its Thailand 4.0 initiative, there is an acute shortage of skilled workers in IT, automation and robotics, digital services, advanced manufacturing, and biotechnology.

- **Aging workforce:** Thailand's rapidly aging population further exacerbates the skills shortage, with a shrinking pool of young workers entering technical fields.

- **Brain drain:** A substantial number of highly skilled Thai professionals seek opportunities abroad, leading to a loss of talent in critical sectors (Chemsripong, 2016).

- **Language barriers:** Despite improvements, English proficiency remains a challenge for many Thai workers, limiting their ability to engage with global technologies and practices.

- **Regional disparities:** The concentration of skilled workers in Bangkok and major urban centers creates challenges for firms operating in other regions.

Many Thai businesses continue to face substantial challenges in attracting and retaining people with the capabilities required to drive innovation and competition. This skills gap remains a significant barrier for Thailand as it strives to improve its position in the GVC and transition to a knowledge-based economy.

The Role of ICT in Skill Upgrading

ICT adoption is skill-biased, implying that higher-skilled workers are in greater demand within organizations because the technologies tend to enhance their productivity (Behaghel et al., 2012). In Thailand, firms face significant challenges in upgrading their workforce's skills, primarily due to constraints in financial access, transaction security, global market entry, and the availability of skilled human capital. However, ICT presents a transformative solution to these obstacles, aligning with Thailand's broader digital transformation goals as follows:

- **Digital financial solutions:** Fintech innovations are playing a crucial role in expanding financial access in Thailand, with a focus on supporting SMEs, which are vital to the country's economy. These innovations make it easier for SMEs to get the financial resources they require to grow and thrive. Furthermore, the use of blockchain and other cutting-edge technologies improves the transparency and efficiency of financial operations in Thailand (Moenjak et al., 2019). This technological advancement addresses critical concerns in the country's fast-growing digital economy, paving the way for more secure and efficient financial operations.

- **Cybersecurity enhancement:** Thailand is emphasizing the importance of improving digital security measures to increase trust in online transactions and digital learning platforms. This focus is especially crucial considering the tremendous growth of the country's e-commerce and e-learning industries. These measures align with Thailand's Cybersecurity Act, which aims to create a more secure digital environment for businesses. By boosting cybersecurity, Thailand is not only defending its digital infrastructure but also fostering an atmosphere that promotes future growth and innovation in its digital economy. This comprehensive approach to digital security is critical for maintaining the pace of Thailand's digital transformation and ensuring that businesses and consumers can conduct online transactions with confidence.

- **Digital market access:** E-commerce platforms are emerging as practical tools for Thai enterprises, particularly those in rural areas, to grow into worldwide markets. This digital strategy is removing regional constraints and creating new chances for growth and competition. At the same time, these platforms play a crucial role in advancing Thailand 4.0's objectives. E-commerce enables Thai enterprises to access foreign best practices, improve their operations, and become more integrated with GVCs by making participation in the digital economy more accessible.

- **Online education and training:** Massive Open Online Courses and other e-learning platforms are helping Thailand bridge its skills gap, particularly in developing technology.

These digital learning tools provide Thai residents with unprecedented access to global information and expertise, enabling them to develop skills in high demand. This approach is especially beneficial in IT, digital services, and sophisticated manufacturing industries, which are the top priorities for the Thai government. These platforms promote a culture of lifelong learning by providing chances for continual learning and upskilling, resulting in a more versatile and competitive workforce.

- **Virtual collaboration tools:** Digital technologies are transforming how Thai businesses function on a global scale, creating new opportunities for international collaboration. These technologies enable Thai companies to form partnerships with global peers, facilitating the transfer of valuable information and exposing local enterprises to best practices worldwide. This expanded connectivity not only boosts the competitiveness of Thai enterprises but also accelerates their integration into GVCs.

- **Data-driven decision making:** Big data analytics has emerged as a critical tool for enterprises to make informed decisions, resulting in operational gains and strategic advantages. Companies that use massive amounts of data can get important insights, discover trends, and anticipate events more precisely. This data-driven strategy enables firms to streamline operations, enhance client experiences, and design more effective strategies, leading to increased market performance and competitiveness (Kerdpitak et al., 2019; Limpeeticharoenchot et al., 2022; Pitchaya, 2020).

This data-driven approach not only enhances employee performance but also contributes to the growth of Thailand's digital economy (Saetang et al., 2020). Companies that foster data literacy and analytical skills contribute to the country's digital transformation while enhancing their global competitiveness. By emphasizing data-driven decision-making and analytical skills, Thailand is well-positioned to prosper in an increasingly digital economic landscape.

By utilizing these ICT solutions, Thai enterprises can invest in and enhance their employees' skills more efficiently. This approach is consistent with the goals of the Digital Economy Promotion Agency (DEPA) and Thailand's national strategy for improving digital infrastructure and capabilities.

Key industries such as automotive, electronics, and food processing can benefit from ICT's transformative impact on skill upgrading, resulting in economic growth, innovation, and competitiveness. Furthermore, it supports Thailand's objective of moving up the value chain in these areas. Furthermore, by ensuring that everyone in Thailand has fair access to educational materials, ICT-enabled skill development can help to resolve regional disparities within the country. This aligns with the government's goals to distribute economic development outside the Bangkok metropolitan area.

In summary, while Thailand faces substantial challenges in skill development, the strategic use of ICT offers a method to overcome these obstacles. By adopting digital solutions, as outlined in its Thailand 4.0 plan, the country can enhance its position in GVCs, stimulate innovation, and transition to becoming a knowledge-based economy.

Background Statistics of ICT

This section provides an overview of the significant ICT features in Thailand, examining the growth of broadband Internet infrastructure, trends in household Internet and mobile phone usage,

the evolution of e-payment systems, and the remaining challenges to ICT implementation in Thailand. These components are the foundation of Thailand's digital landscape and play critical roles in the country's continuing digital transformation.

Infrastructure of Broadband Internet

Thailand has made significant progress in creating broadband infrastructure over the last decade, altering the country's ICT landscape. This success is the result of a combination of deliberate government initiatives and significant private-sector investments, establishing Thailand as an emergent digital economy. The country's emphasis on building and strengthening digital infrastructure has been critical to growing Internet access and adoption rates in both urban and rural areas. Thailand's digital transformation is seen in reports such as Digital 2022: Thailand, which shows a significant increase in Internet users and broadband subscription rates. A summary of Thailand's broadband Internet infrastructure is presented in Table 3.

This accomplishment is crucial for Thailand's ability to remain competitive in global markets and aligns with the country's goal of becoming Southeast Asia's leading digital economy. The continuous commitment to digital development is projected to boost economic growth and stimulate innovation across various sectors. Thailand's position in the global digital economy is set to be strengthened further as it implements its digital master plan, which includes promoting 5G technology and expanding Internet coverage via satellite technology. This comprehensive approach to digital infrastructure development not only improves Thailand's economic prospects but also aligns with the country's objective of establishing a more connected, technologically advanced society.

TABLE 3

SUMMARY OF INFRASTRUCTURE OF BROADBAND INTERNET IN THAILAND.

Year	Detail
2013–17	During its initial phase, Thailand focused on building basic infrastructure to increase Internet accessibility. The government created the Village Broadband Internet initiative, also known as Net Pracharat, to provide high-speed Internet access to rural communities. This endeavor paid off in late 2017, with fiber optic networks installed in 24,700 selected rural towns. This extension not only boosted connection but also promoted socioeconomic growth at the local level (Telecom Review, 2024; The Nation, 2022).
2018–22	Following the first infrastructure expansion, Thailand aimed to increase Internet use and accessibility. The Village Broadband Internet initiative had significant development, with over 4.5 million registered users by 2018 and monthly increases of 200,000 to 300,000 additional customers. To support this growth, the government established free public Wi-Fi hotspots in rural areas, providing high-speed Internet for educational and business purposes. The telecommunications industry faced extensive change in the early 2020s. National Telecom was founded in 2021 from the merger of state-owned providers CAT Telecom and TOT Plc. This was followed by the 2022 merger of TrueMove and DTAC into True Corporation. These mergers changed the competitive landscape and boosted investment in digital infrastructure (Telecom Review, 2024).

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Year	Detail
2023–Present	Thailand's Internet ecosystem has evolved fast in recent years. The fixed broadband market expanded significantly by 2023, driven by increased demand for high-speed Internet in both urban and rural areas. Advanced Info Service Public Company Limited (AIS) strengthened its market position by acquiring 3BB and a stake in Jasmine Broadband Internet Infrastructure Fund, which improved its fiber-optic Internet service offerings. Thailand is now implementing the third phase of its digital master plan, which runs from 2023–27. This phase is strategically focused on using the Internet to promote economic growth, with the ambitious goal of raising digital revenue to 30% of the country's GDP by 2027 (The Nation, 2022). To attain this goal, Thailand has announced several significant measures. The strategy involves lowering broadband fees to make Internet connections more affordable to a larger portion of the population. Simultaneously, initiatives are underway to increase online literacy rates, ensuring that residents can successfully use digital technologies. The government is also actively supporting 5G adoption to improve connectivity and enable innovative digital applications. Additionally, Thailand aims to enhance Internet coverage via low Earth orbit satellite technologies, particularly in remote locations. These projects illustrate Thailand's strong commitment to digital transformation and its understanding of the Internet's important role in promoting economic development. Thailand hopes that by focusing on these areas, it will be able to develop a more inclusive digital economy, boost business competitiveness, and establish itself as a regional digital hub.

Source: Telecom Review (2024); The Nation (2022).

Table 4 reveals that digital engagement varies significantly across various sectors in Thailand. While the trade and service sector shows higher adoption rates of Internet usage (49.0%) and online sales (15.7%), the manufacturing sector lags with only 29.9% using the Internet and 8.6% selling online. Private hospitals and the information and communication sector lead in digital integration, highlighting the significant potential for productivity gains through increased technological adoption and e-commerce activities.

TABLE 4

NUMBER AND PERCENTAGE OF ESTABLISHMENTS CLASSIFIED BASED ON THE USE OF ICT ECONOMIC ACTIVITIES AND SIZE OF ESTABLISHMENTS BY NUMBER OF WORKERS IN THAILAND (IN 2021).

Economic Activity	Number of Establishments	Computer Usage		Internet Usage		Having Website		Goods or Services Ordered Via the Internet		Goods or Services Sold Via the Internet	
		Number	%	Number	%	Number	%	Number	%	Number	%
All	2,516,253	920,271	36.6	1,151,331	45.8	271,129	10.8	386,671	15.4	355,901	14.1
Trade and service	1,969,687	781,561	39.7	964,279	49.0	230,036	11.7	332,300	16.9	308,349	15.7
Manufacturing	439,330	91,478	20.8	131,344	29.9	26,363	6.0	40,878	9.3	37,749	8.6
Construction	46,137	16,869	36.6	22,349	48.4	4,709	10.2	5,964	12.9	3,532	7.7

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Economic Activity	Number of Establishments	Computer Usage		Internet Usage		Having Website		Goods or Services Ordered Via the Internet		Goods or Services Sold Via the Internet	
		Number	%	Number	%	Number	%	Number	%	Number	%
Logistics	48,428	18,148	37.5	21,250	43.9	5,664	11.7	3,524	7.3	3,154	6.5
Private hospital	384	384	100.0	382	99.5	330	86.1	206	53.7	119	31.1
Information and communication	12,287	11,830	96.3	11,727	95.4	4,026	32.8	3,799	30.9	2,998	24.4

Source: NSO.

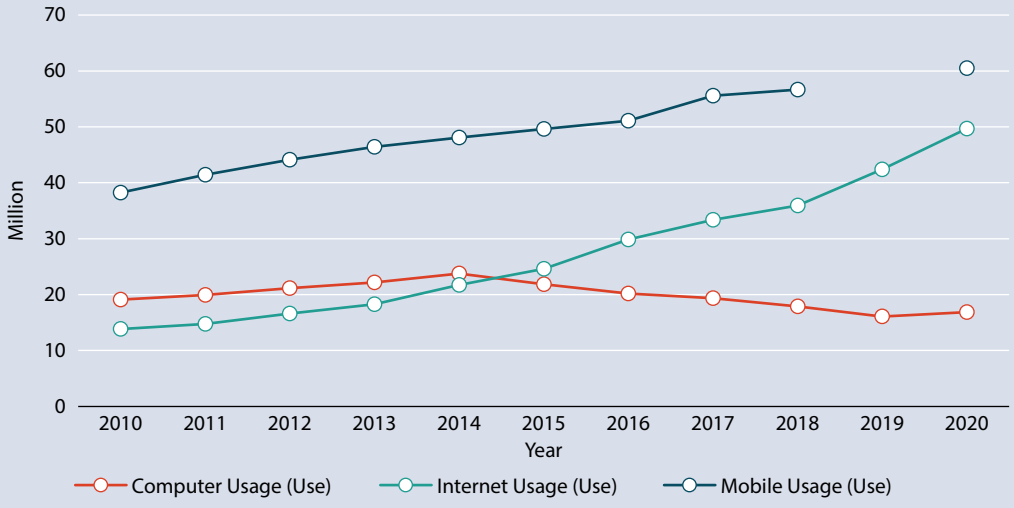
Household Usage of the Internet and Mobile Phone

This section examines the usage trends of computers, the Internet, and mobile phones by Thai individuals and households over the past decade. Figure 1 illustrates technology usage among Thais aged six and above between 2010–20. Mobile phone usage rose steadily from 40 million to 60 million users, while Internet usage surged from 15 million to 40 million, surpassing computer usage by 2015. In contrast, computer usage followed a different trajectory, increasing slightly until 2014 before declining to just under 20 million users by 2017.

These trends highlight a significant shift toward mobile and Internet technology, aligning with global digitalization trends and underscoring the growing importance of mobile devices and online access in Thai society. From 2010–22, the number of Thai households with Internet access increased nearly tenfold, from 2.24 million to 21.34 million, with notable spikes in 2014–15 and 2019–20. This growth, driven by enhanced digital infrastructure, increased affordability, and the rising significance of connectivity across various sectors, exemplifies the rapid digitalization of Thai society, as depicted in Figure 2.

FIGURE 1

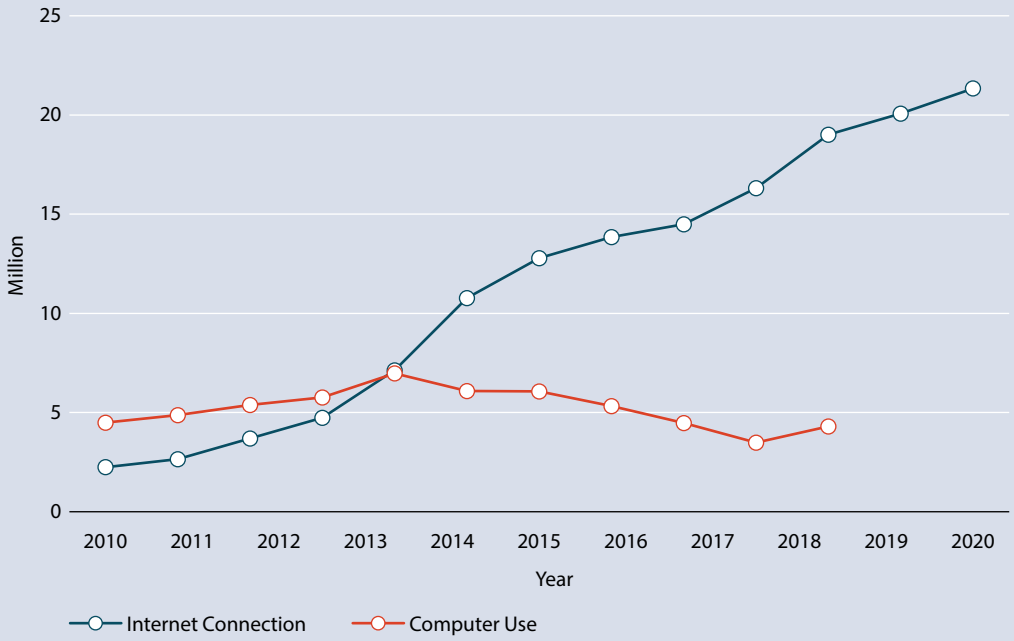
ICT USE BY POPULATION AGED 6+ BY REGION AND PROVINCE (2010–20).



Source: NSO.

FIGURE 2

HOUSEHOLDS WITH INTERNET ACCESS AND COMPUTER USE IN THAILAND.



Source: NSO.

Electronic Payment Systems

Thailand's e-payment systems have experienced significant growth over the last decade, driven by technological advancements, governmental support, and shifting consumer behaviors. E-payments have become a vital aspect of Thailand's financial ecosystem, beginning with early adoption in the early 2010s and progressing to significant development and diversification in the mid-to-late 2010s, followed by consolidation and innovation in recent years. A summary of e-payment systems in Thailand is presented in Table 5. The future of e-payments in Thailand appears bright, with continued initiatives to improve digital infrastructure, expand financial inclusion, and incorporate new technology. These achievements are likely to boost Thailand's position as a digital economy leader in Southeast Asia.

TABLE 5

SUMMARY OF ELECTRONIC PAYMENT SYSTEMS IN THAILAND.

Year	Detail
2017–19 (2C2P, n.d.; Bank of Thailand, 2016; Intarot & Beokhaimook, 2018)	**Mobile wallet:** The proliferation of mobile wallets such as TrueMoney, Rabbit LINE Pay, and AirPay has given users more options for making e-payments. These wallets provided ease and were compatible with a variety of applications, including e-commerce platforms and utility payments. **Payment using QR code:** The introduction of standardized QR code payments in 2017 enabled businesses to accept payments via QR codes, thereby accelerating the adoption of e-payments among SMEs and street vendors.

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Year	Detail
2020–22 (2C2P, n.d.; Bank of Thailand, 2020c)	**Impact of COVID-19:** The COVID-19 pandemic accelerated the adoption of e-payments as consumers and businesses sought contactless payment options. This period witnessed a surge in Internet transactions, mobile banking, and the use of mobile wallets. **Government and commercial sector collaboration:** The government and the commercial sector collaborated to create a more inclusive digital payment environment. Initiatives such as the National e-Payment Master Plan aimed to improve the efficiency and security of e-payments. **Cross-border payments:** The Bank of Thailand aimed to enhance cross-border payment systems, facilitating smoother transactions with neighboring countries, particularly those in the ASEAN region. This involved connecting Thailand's PromptPay to comparable systems in Singapore and other countries.
2022–24 (Bank of Thailand, 2023b; Thailand.go.th, 2023a, 2023b)	**Digital banking:** The Bank of Thailand granted licenses to digital banks to promote the adoption of e-payments and enhance financial inclusion. These digital banks offer innovative services tailored to the digital economy. **E-commerce integration:** E-payment systems are increasingly being integrated with e-commerce platforms, making online shopping more convenient and secure for consumers. Payment gateways and fintech companies played critical roles in this integration. **Blockchain and cryptocurrencies:** There is a growing interest in blockchain technology and cryptocurrencies, with several FIs investigating their potential to improve e-payment systems. **Enhanced security:** Continuous advancements in cybersecurity measures are required to retain consumer trust in e-payment systems. To protect themselves from fraud and cyber risks, the Bank of Thailand and FIs have implemented robust security protocols.

Source: 2C2P; Bank of Thailand (2016, 2020b, 2020c); Intarot & Beokhaimook (2018); Thailand.go.th (2023a, 2023b).

Obstacles in ICT Implementation in Thailand

- **Digital divide:** One of the most significant hurdles for ICT growth in Thailand is the digital divide between urban and rural communities. While cities like Bangkok have expanded the ICT infrastructure, many rural communities continue to lack basic Internet connectivity. This discrepancy restricts access to digital services, education, and economic prospects for persons living in rural areas (Malisuwan et al., 2016; Setthasuravich et al., 2024).

- **Infrastructure gaps:** Despite substantial progress, gaps remain in the country's ICT infrastructure. Inconsistent Internet speeds, insufficient coverage of high-speed broadband, and inadequate maintenance of existing infrastructure all reduce the overall effectiveness

of ICT growth. Rural and underdeveloped areas are most affected by these infrastructure shortcomings (Moolngearn & Kraiwanit, 2024; Nguyen, 2023).

- **Regulatory and policy challenges:** Navigating the regulatory framework can be challenging for ICT growth. Bureaucratic impediments and delays in policy implementation can stymie development. Furthermore, anomalies in legislative regimes may impact the adoption of new technologies, such as 5G and fiber-optic networks (Wongwuttiwat et al., 2023).

- **Digital literacy:** Another significant barrier is the general public's lack of digital literacy. Many people, especially in rural regions, lack the necessary skills to use digital tools and services appropriately. This not only limits their ability to benefit from ICT breakthroughs but also decreases the general adoption rates of new technology (Tuamsuk & Subramaniam, 2017).

- **Economic disparities:** Economic inequality might also stifle ICT development. Low-income households may be unable to access or benefit from digital breakthroughs due to the high prices associated with ICT services and devices. This worsens the digital divide and reduces total ICT adoption (Setthasuravich et al., 2024).

- **Political and economic stability:** Political instability and economic changes can also have a substantial impact on ICT growth. Changes in government policies, economic downturns, or political upheaval can disrupt ongoing initiatives and discourage investment in the ICT sector (Songsrisanga, 2023).

Data Analysis

This section provides an overview of productivity indices and ICT utilization in Thailand, followed by an analysis of the relationship between productivity measures, including TFP and the Labor Productivity Index, and ICT adoption.

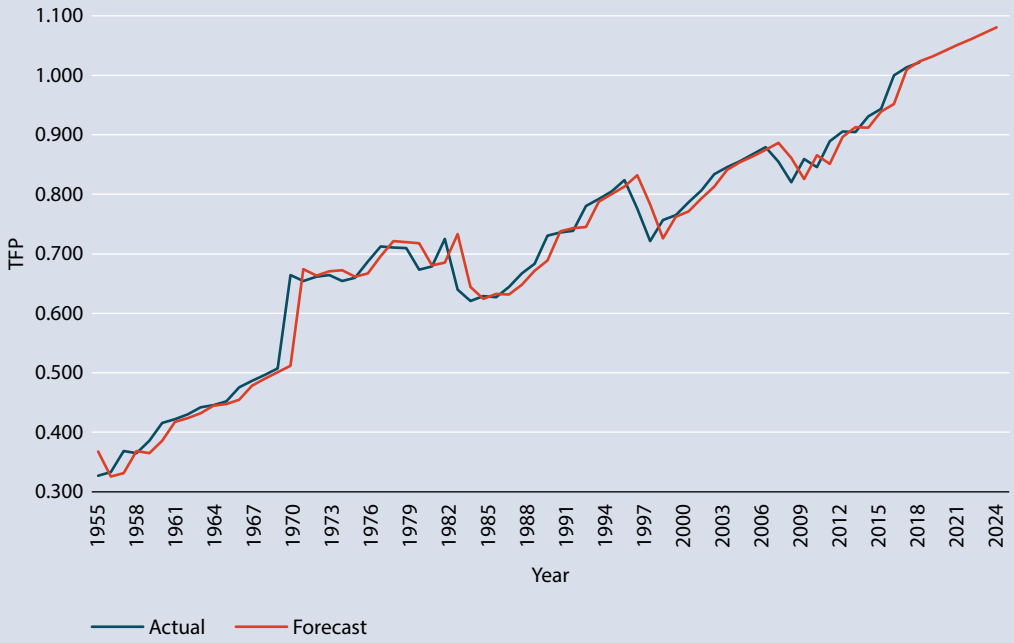
Firm Productivity by Considering TFP and Labor Productivity Index

As seen in Figure 3, Thailand's TFP increased from 0.327 in 1955 to 1.022 in 2019, with notable increases in the 1970s and stabilization from the mid-1980s. Despite fluctuations and the 2008 GFC, TFP recovered. Projections of TFP by Double Exponential Smoothing indicate further growth from 1.032 in 2020 to 1.081 in 2025, reflecting continued productivity enhancements through technological progress and policy reforms. Thailand's Labor Productivity Index (2013–23) reveals diverse sectoral trends as shown in Table 6.

The agriculture sector exhibits steady growth with an average index of 114.46. The manufacturing sector experienced fluctuations, peaking in 2021, with an average index of 111.18. The wholesale and retail trade sector shows continuous growth, albeit with a decrease in 2021, averaging 125.43. The transport and storage sector has faced volatility since 2020, averaging 104.96. The accommodation and food services sector grew prior to the pandemic but struggled subsequently, averaging 120.96. The information and communication sector demonstrated exponential growth, averaging 175.30. These trends reflect a shift towards digital services, resilience in agriculture and trade, and challenges within the transport and hospitality sectors.

FIGURE 3

THE TFP TRENDS IN THAILAND.



Source: Federal Reserve Economic Data (2024).

The forecast model is Double Exponential Smoothing: $\hat{Y}_{t+n} = E_t + nT_t$

$$E_t = \alpha Y_t + (1-\alpha)(E_{t-1} + T_{t-1}), \text{ where } \alpha = 0.999 \quad (1)$$

$$T_t = \beta(E_t - E_{t-1}) + (1-\beta)T_{t-1}, \text{ where } \beta = 0.035 \quad (2)$$

TABLE 6

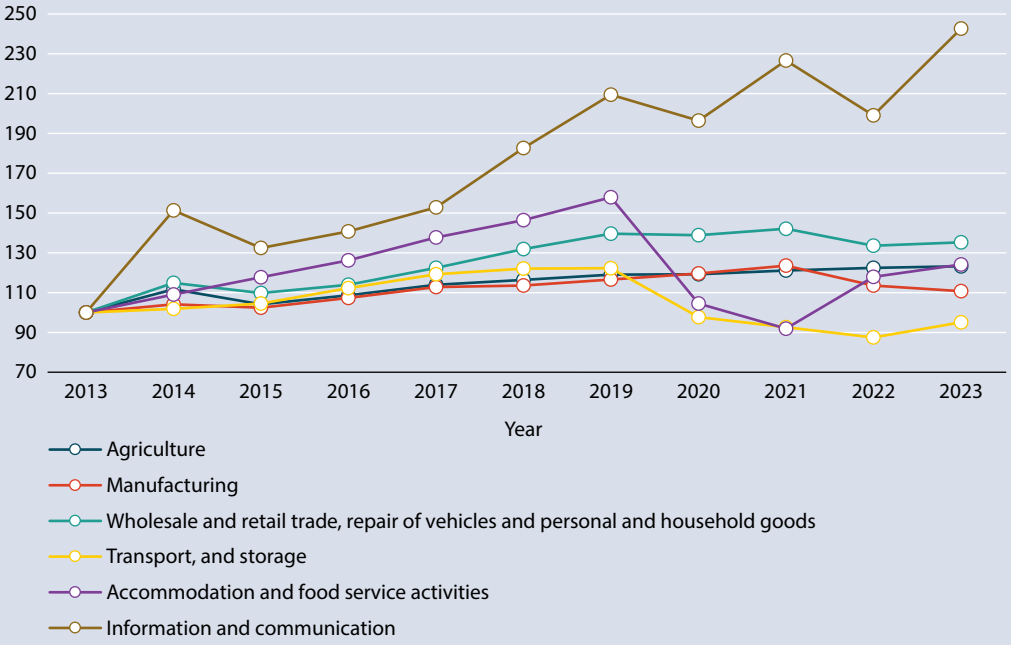
LABOR PRODUCTIVITY INDEX PER HOUR WORKED BY ECONOMIC ACTIVITY IN THAILAND.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Avg.
Agriculture	100.00	111.64	104.06	108.61	113.92	116.49	118.98	119.18	121.17	122.45	123.27	114.46
Manufacturing	100.00	104.16	102.51	107.42	112.80	113.60	116.60	119.68	123.56	113.61	110.82	111.18
Wholesale and retail trade, repair of vehicles, and personal and household goods	100.00	114.88	109.77	113.85	122.43	131.92	139.63	138.93	142.12	133.59	135.26	125.43
Transport and storage	100.00	101.93	104.52	112.30	119.19	122.15	122.29	97.68	92.59	87.46	95.15	104.96
Accommodation and food service activities	100.00	109.05	117.68	126.24	137.73	146.39	157.90	104.54	91.94	117.86	124.22	120.96
Information and communication	100.00	151.24	132.47	140.71	152.85	182.73	209.55	196.38	226.58	199.14	242.64	175.30

Source: Bank of Thailand (2024a).

FIGURE 4

LABOR PRODUCTIVITY INDEX PER HOUR WORKED BY ECONOMIC ACTIVITY IN THAILAND.



Source: Bank of Thailand (2024a).

Labor Productivity (World Bank Enterprise Survey, 2018)

The WBES 2016 included 1,000 participating companies. Of these, 70 companies (7%) reported experiencing power outages, with most incidents occurring in the southern and northeastern regions of Thailand. Additionally, 510 companies (51%) had websites, with the majority based in the central and southern regions. When analyzed by industry, the manufacturing and other services sectors were the most affected by power outages. Moreover, the other services sector had the highest proportion of companies with websites, followed closely by the manufacturing sector.

TABLE 7

FREQUENCY OF POWER OUTAGES AND NUMBER OF WEBSITES BY RESPONDENT LOCATION.

	Frequency of Power Outages		No. of Website		
Location	Number	Ratio	Number	Ratio	Total
Bangkok	1	0.36%	122	44.53%	274
Central	15	4.60%	192	58.90%	326
South	22	17.46%	69	54.76%	126
North	8	6.11%	64	48.85%	131
Northeast	24	16.78%	63	44.06%	143
Grand Total	70	7.00%	510	51.00%	1,000

Source: World Bank Enterprise Survey, 2018.

TABLE 8

FREQUENCY OF POWER OUTAGES AND NUMBER OF WEBSITES BY INDUSTRY TYPE.

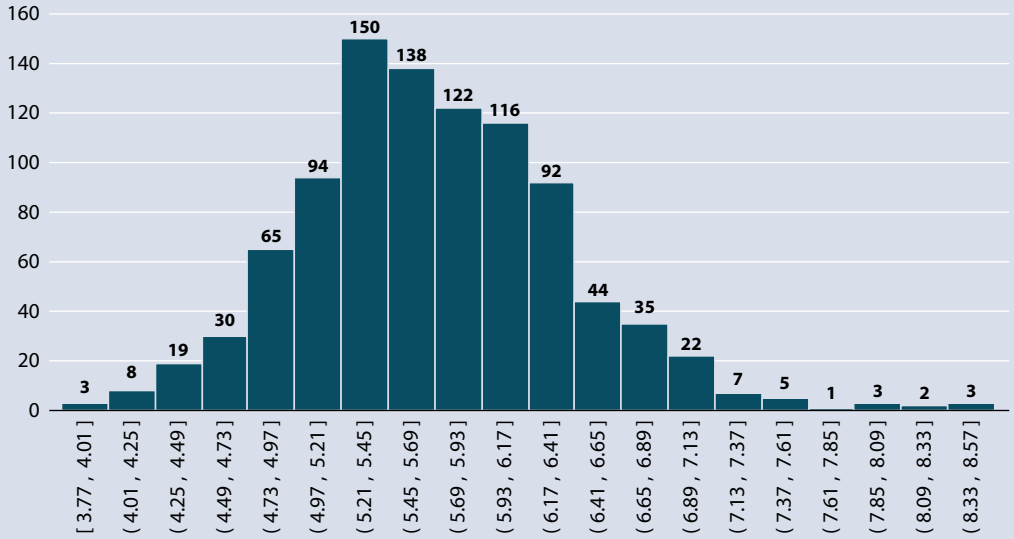
Type of Industry	Frequency of Power Outages		No of Website		Total
	Number	Ratio	Number	Ratio	
Manufacturing	57	7.85%	377	51.93%	726
Other services	11	7.33%	81	54.00%	150
Retail services	2	1.61%	52	41.94%	124
Grand total	70	7.00%	510	51.00%	1,000

Source: World Bank Enterprise Survey, 2018.

Then, labor productivity was calculated by dividing the revenue by the number of workers and then applying the logarithm to the resulting productivity. The values are displayed in Figure 5, which indicates that the logarithm of labor productivity follows a log-normal distribution, with a mean of 5.69 and a standard deviation of 0.68.

FIGURE 5

LOGARITHMIC DISTRIBUTION OF LABOR PRODUCTIVITY (959 RESPONDENTS).



Source: Analysis by the national expert based on data from WBES 2018.

Regression of the labor productivity as Equation 3:

$$Log\left(\frac{\text{Sales}}{\text{\# of employees}}+1\right)_i = \beta_0 + \beta_1 Website_i + \beta_2 Innovation_i + \beta_3 Log(Land+1)_i + \beta_4 Log(Machine+1)_i + \beta_5 Outage_i + \epsilon_i. \quad (3)$$

Where β_0 is the intercept term, β_j refers to the coefficient of variable j, where $j \in$ {Website, Innovation, Log(Land+1), Log(Machine+1), Outage}

i = observation i,

ϵ_i referred to the error term of observation i

The variables Website, Innovation, and Outage are binary, representing two distinct states for each. A Website value of 0 indicates a company does not have its website, whereas a value of 1 signifies that it does. Similarly, Innovation is assigned a value of 1 if a company has introduced new or significantly improved products or services; otherwise, it is 0. For Outage, a value of 1 means the company has experienced power outages, while 0 indicates no such occurrences. Additionally, the variable Land represents the value of land and buildings after depreciation, while Machine refers to the depreciated value of machinery, vehicles, and equipment.

After cleaning the initial dataset of 1,000 entries, 822 valid data points were retained for analysis. A log-linear model was used to facilitate interpretations in percentage terms. The model yielded an R-squared of 0.049, indicating a weak correlation between predictors and the outcome. Notably, the regression results showed that innovation exerted the most significant negative impact on labor productivity, with a decrease of 36.8% ($p = 0.000$). This negative effect is likely a short-term consequence, as innovation-driven sales gains may not materialize immediately, and workforce expansion to support innovation teams can temporarily reduce efficiency. Over time, however, innovation is expected to boost sales and streamline operations by reducing redundancies. The variables "Outage" and "Machine" were also associated with labor productivity declines of 19.0% ($p = 0.043$) and 2% ($p = 0.088$), respectively. Power outages disrupt production and other operations, significantly hindering productivity. Meanwhile, the negative impact of "Log(Machine+1)" on productivity contradicts typical expectations, potentially reflecting an inability of machinery investments to resolve capacity constraints within the company.

Conversely, having a company website positively influenced labor productivity, contributing an 8.5% increase ($p = 0.075$). This effect likely stems from the website's role in attracting more customers and boosting sales, though its impact is more pronounced in industries where websites are integral to customer interaction. Similarly, "Log(Land+1)" was linked to a 2.8% productivity increase ($p = 0.088$), underscoring the value of investments in physical infrastructure such as machinery, vehicles, and equipment. However, the frequent power outages underscore Thailand's manufacturing sector's reliance on traditional capital-intensive assets over modern ICT systems, whose benefits often take years to materialize. In summary, innovation emerged as the most impactful factor, followed by outages and websites. While both innovation and websites offer long-term advantages, such as better customer engagement and operational efficiency, their short-term effects are often constrained by high implementation costs, workforce adjustments, and delayed returns. To improve productivity, firms should focus on managing innovation strategically, addressing power outages proactively, and developing efficient websites. These measures are crucial for enhancing performance, fostering sustainable growth, and ensuring operational resilience.

TABLE 9

RESULT OF REGRESSION MODEL.

Variable	Coefficients Beta	t	P-Value
Website	0.085* (0.047)	1.78	0.075
Innovation	–0.368*** (0.075)	–4.924	0.000
Log (Land+1)	0.028*** (0.011)	2.614	0.009
Log (Machine+1)	–0.020* (0.012)	–1.707	0.088

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Variable	Coefficients Beta	t	P-Value
Outage	–0.190** (0.094)	–2.032	0.043
Constant	5.732*** (0.046)	125.43	0.000
Observations	822	822	822
R-Square	0.049		

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

ICT Utilization: Firms' Expenditure on the Internet, Use of Websites and E-payments

The analysis of Key Performance Indicators (KPIs) on Internet usage in Thailand during 2023–24, shown in Table 10, reveals notable improvements in several areas. Internet usage among individuals increased from 85.3% to 88.0%, and the number of households with Internet access rose from 88.7% to 90.4%. Active mobile broadband subscriptions per 100 inhabitants grew significantly from 111.9 to 121.8. Mobile broadband Internet traffic per subscription increased from 254.6 GB to 275.5 GB, and fixed broadband traffic rose from 3,362.7 GB to 3,816.6 GB, indicating higher data consumption. Costs for mobile data and voice services as a percentage of GNI per capita slightly decreased, while fixed-broadband costs remained stable. Mobile phone ownership also grew, from 86.7% to 88.3%. Improvements were observed in the Universal Connectivity Pillar and the ICT Development Index (IDI), reflecting enhanced Internet accessibility and overall ICT development in Thailand.

TABLE 10

KPI OF INTERNET USAGE IN THAILAND.

Year	2023	2024
Individuals using the Internet (%)	85.3	88.0
Households with Internet access at home (%)	88.7	90.4
Active mobile broadband subscriptions per 100 inhabitants	111.9	121.8
Population covered by at least a 3G mobile network (%)	98.8	98.8
Population covered by at least a 4G/LTE mobile network (%)	98.1	98.1
Mobile broadband Internet traffic per subscription (GB)	254.6	275.5
Fixed broadband Internet traffic per subscription (GB)	3,362.7	3,816.6
Mobile data and voice high-consumption basket price (as % of GNI per capita)	3.0	2.9
Fixed-broadband Internet basket price (as % of GNI per capita)	3.5	3.5
Individuals who own a mobile phone (%)	86.7	88.3
Individuals using the Internet (%)	89.8	92.6
Households with Internet access at home (%)	93.4	95.2
Active mobile broadband subscriptions per 100 inhabitants	74.6	81.2
3G and 4G/LTE Network Coverage	98.4	98.4
Mobile broadband Internet traffic per subscription (GB)	89.2	90.4

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Year	2023	2024
Fixed broadband Internet traffic per subscription (GB)	88.2	89.5
Mobile data and voice high-consumption basket price (as % of GNI per capita)	90.3	90.6
Fixed-broadband Internet basket price (as % of GNI per capita)	92.2	92.4
Individuals who own a mobile phone (%)	91.2	92.9
Universal Connectivity Pillar	85.9	89.7
Meaningful Connectivity Pillar	91.6	92.4
ICT Development Index (IDI)	88.7	91.0

Source: International Telecommunication Union (2023, 2024).

Thailand's digital banking statistics from 2019 to 2023 reveal divergent trends, as depicted in Table 11. Internet banking agreements peaked in 2022 but declined in 2023, while transaction volumes and values continued to rise. Mobile banking exhibited a strong growth in the number of agreements, transaction volume, and value in 2023. Mobile transactions surged from 5.30 billion in 2019 to 29.55 billion in 2023, primarily for fund transfers and payments. This data highlights a robust growth in mobile banking adoption and usage, while Internet banking experienced a decline in user agreements but sustained high transaction volumes and values. This shift underscores the increasing preference for mobile banking solutions in Thailand's financial landscape.

TABLE 11

USE OF MOBILE BANKING AND INTERNET BANKING IN THAILAND.

	2019 r	2020	2021	2022	2023
Internet Banking					
No. of agreements	29,404,466	34,946,211	38,941,665	41,568,362	28,816,836
The volume of transactions (Thousand Transactions)	458,381	429,449	580,822	603,835	599,088
Value of transactions (Baht Billion)	23,626	22,838	27,174	32,404	33,731
Mobile Banking					
No. of agreements	60,084,145	68,697,059	84,291,262	96,699,938	107,240,928
The volume of transactions (Thousand Transactions)	5,299,032	9,588,722	16,041,378	22,841,523	29,551,805
• For fund transfer and payment	5,052,928	9,166,978	15,495,435	22,126,278	28,749,319
• For cash withdrawal	246,104	421,751	545,942	715,245	802,489
Value of transactions (Billions of Baht)	27,628	40,200	57,264	67,700	71,066
• For fund transfer and payment	27,171	39,424	56,170	66,231	69,342
• For cash withdrawal	458	777	1,093	1,470	1,725

Source: Bank of Thailand (2020, 2024b).

The analysis of Thailand's fund transfer trends from 2019 to 2023 reveals key insights, as shown in Table 12. Overall, transfer volume slightly decreased while the value fluctuated, peaking in 2020. Third-party transfers showed consistent growth in both volume and value. Multilateral transfers remained stable. Securities settlements experienced a steady increase in both volume and value. These trends indicate a growing reliance on third-party transfers and securities settlements, a sustained demand for funds transfer services despite a slight volume decline, and the continued importance of multilateral transfers in Thailand's financial landscape.

TABLE 12

FUNDS TRANSFER BY TRANSACTION TYPE IN THAILAND.

	2019		2020		2021		2022		2023	
Type of Transaction	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Funds transfer	189,546	490,707	185,871	594,427	182,013	561,207	187,073	537,895	180,767	581,142
Third-party fund transfer	4,457,105	318,932	4,503,379	342,637	4,561,736	333,931	4,769,320	370,706	5,060,855	390,946
Multilateral funds transfer	4,182	11,301	4,837	10,545	5,117	10,471	5,335	10,703	5,423	10,610
Securities settlement	4,650,833	820,940	4,694,087	947,610	4,748,866	905,610	4,961,728	919,305	5,247,045	982,699

Source: Payment and Bond Department, Bank of Thailand (2024).

Relationship Between Productivity Measures and ICT Adoption

The relationship between ICT utilization and productivity in Thailand is significant and multifaceted, demonstrating how technological advancements drive economic performance. Increased ICT adoption, as evidenced by higher Internet usage, mobile broadband subscriptions, and digital banking uptake, has a positive impact on both TFP and the Labor Productivity Index.

- **Total Factor Productivity:** The growth of TFP, from 0.327 in 1955 to 1.022 in 2019, with projections of reaching 1.081 by 2025, underscores the role of ICT in technological progress and efficiency. Increased expenditure on Internet services, website utilization, and e-payments enhances firm-level productivity by optimizing operations, reducing costs, and expanding market reach.

- **Labor Productivity Index:** Sectoral analysis reveals diverse ICT-influenced trends. The exponential growth of the information and communication sector (with an average index of 175.30) highlights the transformative impact of digital technologies. Agriculture and trade sectors also show ICT-supported improvements in supply chain management and market access.

- **Digital banking and funds transfer:** Mobile banking transactions surged from THB5.30 billion in 2019 to THB29.55 billion in 2023, while Internet banking maintained high transaction values despite fewer agreements. This shift towards digital financial services enhances financial inclusion and productivity through faster, more efficient transactions.

- **Internet and broadband utilization:** Key indicators show improved connectivity, with Internet usage increasing among individuals (from 85.3% to 88.0%) and households (from 88.7% to 90.4%), while mobile broadband subscriptions rose from 111.9 to 121.8 per 100

inhabitants. This enhanced connectivity supports productivity by facilitating access to information, enabling remote work, and fostering innovation.

- **Sectoral shifts:** The increased utilization of ICT, reflected in higher data consumption and an improved IDI, signifies a shift towards digital services. This is particularly evident in the growth of third-party funds transfers and securities settlements, demonstrating increased reliance on digital platforms for financial transactions.

In summary, the integration of ICT across Thailand's economic sectors has been instrumental in driving productivity improvements. Enhanced ICT utilization supports technological progress, operational efficiency, and financial inclusion, contributing to sustained economic growth and resilience across various sectors.

Policy Discussion

National policies are crucial to enhancing a country's economic position within Global Value Chains (GVCs) (Kummritz et al., 2017). This section examines Thailand's current policy landscape for digital skill development and ICT infrastructure enhancement. It begins by detailing current measures aimed at boosting skill development within businesses, particularly in light of the developing digital economy. The discussion then shifts to strategies for strengthening and expanding ICT infrastructure throughout the country. Finally, the section provides policy recommendations for leveraging ICT to facilitate more successful skill-upgradation programs within enterprises, meeting the changing needs of Thailand's workforce in the digital age.

Current Policies to Promote Firms' Skill Upgrading

Thailand has developed several initiatives to encourage enterprises to upgrade their skills, recognizing their relevance in increasing productivity and maintaining global competitiveness. These policies encompass some incentives and support systems aimed at encouraging innovation, technical advancement, and workforce development, as follows:

- **The EEC project:** This project aims to attract high-tech industries and promote skills development in targeted sectors.

- **Tax incentives:** Thailand offers R&D tax breaks based on R&D expenditure, providing double deductions for such costs. The Board of Investment (BOI) has also introduced the Skill, Technology, and Innovation plan, which provides additional tax breaks for businesses that conduct in-house R&D, train employees, and collaborate with local universities. This initiative encourages enterprises to invest in technical upgradation activities, such as product design and advanced technology training (Intarakumnerd & Liu, 2019).

- **Investment promotion measures:** The BOI has implemented nine steps under the fifth Strategic Plan (2023–27) to encourage investment in industries vital to Thailand's development. These strategies include enhancing competitiveness, retaining and expanding current manufacturing bases, facilitating thorough company relocation, and supporting SMEs. The plan intends to improve sectors to become "smart" and "sustainable," emphasizing the importance of technical breakthroughs and innovation (Thailand.go.th, 2023c).

- **Human capital development:** Thailand's Ministry of Labor and other state agencies have launched various training programs to foster skilled human capital development. These programs prioritize upskilling the workforce to meet the demands of modern industries, ensuring that workers have the essential skills to operate innovative technologies and contribute to innovation within their firms (Intarakumnerd & Liu, 2019). To achieve this goal, academic institutions and the corporate sector must work closely together to ensure that educational programs align with industrial requirements. Additionally, the advocacy for changes in vocational training aims to boost hands-on skill development. Furthermore, efforts must be made to promote STEM education and digital literacy from the outset of schooling.

- **Support for SMEs:** Specific policies are designed to assist SMEs in adopting new technologies and enhancing their competitiveness. These include financial support, technical assistance, and training programs aimed at improving SMEs' skills, enabling them to participate more effectively in GVCs (Korwatanasakul & Paweenawat, 2020; Thailand.go.th, 2023c).

These regulations are part of Thailand's broader effort to integrate into GVCs by creating an environment that fosters innovation and technical advancement. Thailand aims to enhance the global competitiveness of its enterprises by investing in skill development and providing robust support mechanisms.

Current Policies to Promote ICT Infrastructure

Thailand has developed various programs to strengthen its ICT infrastructure, enhance connectivity, promote the digital economy, and support smart city initiatives, as outlined in Table 13.

- **Thailand 4.0 policy:** This national strategy aims to transform Thailand into a value-based economy driven by innovation, technology, and creativity. It encompasses efforts to enhance the country's digital infrastructure to support industries such as smart electronics, affluent medical and wellness tourism, and digital logistics (PwC; Ministry of Industry, 2017; Yuqing, 2023).

- **EEC:** The initiative focuses on developing infrastructure in three eastern provinces, aiming to transform them into high-tech industry zones. This includes significant investments in digital infrastructure to support smart cities and industrial development (EEC, n.d.).

- **Smart City initiative:** Thailand aims to develop 100 smart cities by 2024 as part of its Thailand 4.0 vision. This initiative is supported by the DEPA. It involves partnerships with global networks, such as City Possible, to integrate technology for urban development (DEPA, n.d.).

- **Digital Economy and Society Development Plan:** Implemented by the Ministry of Digital Economy and Society, this initiative aims to expand broadband Internet access, enhance digital literacy, and promote e-commerce to stimulate economic growth and digital inclusion nationwide (DEPA, 2022).

- **Public-Private Partnerships:** Thailand encourages Public-Private Partnerships to enhance ICT infrastructure. Investments in projects such as data centers, telecommunications, and

other digital infrastructure are facilitated through these partnerships, aiming to bridge the infrastructure gap and support economic growth (PwC Thailand, 2021).

- **Smart Green ASEAN Cities:** Thailand participates in the Smart Green ASEAN Cities project, a joint initiative with the European Union, to promote sustainable urban development. This project focuses on creating environmentally friendly and technologically advanced urban areas (The ASEAN Post, 2020).

These policies underscore Thailand's commitment to enhancing its ICT infrastructure, which is essential for driving economic growth and positioning the country as a competitive player in the global digital economy.

TABLE 13

OBJECTIVES, RELEVANCE, AND CONCERNS OF CURRENT ICT INFRASTRUCTURE POLICIES IN THAILAND.

Policy	Objective	Suitability	Concern
1. Thailand 4.0 Policy	Transform Thailand from a manufacturing and agriculture-based economy to a value-based economy driven by innovation and technology.	Suitable for upgrading Thailand to an upper-income country. Thai workers can benefit from collaboration with international organizations and technology transfer.	• Risk of foreign investment dominating local businesses. • Bureaucracy and corruption are significant concerns. • Inequality between urban and rural areas.
2. Eastern Economic Corridor (EEC)	Develop Thailand's eastern region into a hub for advanced industries, including automotive, aerospace, digital, and biochemicals.	Aligns with the Thailand 4.0 policy.	• Risk of environmental degradation, regional disparities. • Insufficient infrastructure and urban planning in the EEC area.
3. Smart Cities Initiative	Leverage technology to enhance urban infrastructure, governance, and sustainability in cities like Bangkok, Chiang Mai, and Phuket.	Suitable for rapidly growing urban areas, addressing challenges in the environment, mobility, living, people, energy, economy, and governance.	• Achieving success in all aspects by 2022 is ambitious. Nonetheless, it is a positive start.
4. Digital Economy and Society Development Plan	Transform Thailand into a digital economy, enhancing productivity, competitiveness, and public sector efficiency.	Supports the first three policies, focusing on building digital manpower, transforming into a digital economy, empowering communities, and fostering innovation.	• Requires transformation in the government and private sectors, especially SMEs. • Data privacy and digital divide issues need to be addressed.

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Policy	Objective	Suitability	Concern
5. Public-Private Partnerships	Drive infrastructure development, improve public services, and boost economic growth through collaboration between the public and private sectors.	Facilitates infrastructure development with private sector involvement, potentially reducing the public budget burden.	• Bureaucracy and corruption are potential concerns.
6. Smart Green ASEAN Cities	Develop sustainable, eco-friendly cities across ASEAN through the adoption of green technology and environmental protection, aligning with regional climate goals.	Aligns with the Smart Cities Initiative policy, focusing on sustainability.	• Requires significant investment in infrastructure, waste management, and green energy. • SMEs may struggle to participate.

To overcome these problems, Thailand has been aggressively engaging in trade discussions and implementing programs to boost its global competitiveness. Thailand 4.0 and the EEC project aims to encourage high-tech sectors and improve logistics, which could help alleviate some of these constraints. However, for many Thai businesses, particularly SMEs, these barriers continue to impede their capacity to fully participate in global markets. This limited market access has an influence not only on their existing operations but also reduces the need for skill development, as the immediate advantages of such expenditures may not be evident in a constrained market environment. Overcoming these constraints is critical for promoting skill development and increasing Thailand's overall competitiveness in the GVC.

Policy Recommendations for Firms' Skill Upgrading Through ICT

For skill upgradation through ICT of the company, the following policies are recommended:

- **Enhance financial support for ICT investments:** To facilitate the digital transition of Thai SMEs, more access to capital through specialized financial instruments is critical. This involves providing low-interest loans, grants, and tax breaks for ICT adoption. Furthermore, establishing public-private collaborations could result in new financing solutions that leverage the strengths of the government, FIs, and the private sector to assist SMEs with their ICT investments.

- **Strengthen cybersecurity measures:** To enhance digital security in Thailand, comprehensive cybersecurity policies and regulations should be implemented that are tailored to the country's unique digital landscape. Simultaneously, national awareness efforts should be undertaken to educate enterprises and the general public about cybersecurity best practices and digital hygiene. These collaborative efforts are intended to build a more secure and resilient digital environment for all stakeholders.

- **Improve access to global markets:** To increase global market access, Thailand should continue to invest in digital infrastructure, particularly in rural and underserved areas, to facilitate international trade and e-commerce. Additionally, specific trade facilitation

initiatives should be designed to assist Thai SMEs in navigating international markets, focusing on digital marketing, export laws, and cross-border e-commerce platforms. Concurrently, efforts should be undertaken to negotiate favorable trade agreements and lower trade barriers, allowing Thai products easier access to global markets.

- **Develop skilled human capital:** To solve Thailand's digital skills gap, educational reforms should incorporate ICT and digital skills training into the national curriculum at all levels, with a focus on practical skills relevant to the job market. Simultaneously, continuous learning and upskilling programs for the existing workforce should be formed, with a focus on future technologies such as AI, big data, and cloud computing, to encourage lifelong learning in the digital age.

- **Promote innovation and R&D:** To foster innovation in major Thai industries, there should be a greater emphasis on R&D. This can be accomplished by forming public-private partnerships between universities, research institutes, and enterprises, thereby creating an ecosystem that promotes technological innovation and information transfer.

- **Develop infrastructure:** Ongoing infrastructure expenditures, notably in digital connectivity and logistics, will help Thailand integrate into GVCs. Efficient infrastructure lowers production costs and increases supply chain reliability.

- **Supporting SMEs:** SMEs play a crucial role in the economy. Policies that give access to financing, technology, and markets can help SMEs grow and integrate into global supply chains.

- **Sustainable development:** Emphasizing sustainable practices in industrial development can lead to long-term economic prosperity. Policies that support energy efficiency, waste reduction, and environmentally friendly technologies will become increasingly vital.

Conclusion

Thailand has emerged as a significant player in GVCs, particularly in the automotive, electronics, and agricultural sectors. The country has effectively leveraged its capabilities to integrate into the global industrial networks. These advantages include a strategic position in Southeast Asia, highly trained and cost-effective labor, and favorable government laws.

The automotive industry is a prime example of Thailand's success in GVC integration. The country has become a vital hub for manufacturing and exporting vehicles and auto parts, earning it the nickname Detroit of Asia. This success is the result of decades of careful industrial policy and investment in infrastructure and workforce development. Thailand has positioned itself as a leading producer of hard disk drives, ICs, and other electronic components. Thailand's agricultural business also plays a major role in global food supply chains, as the country exports vast amounts of rice, rubber, and processed commodities.

A variety of factors have contributed to Thailand's integration into GVCs. The country has implemented liberal trade policies, which have boosted the economy and improved international economic ties. It offers attractive FDI incentives, such as tax breaks and streamlined procedures for foreign businesses. Thailand's attractiveness has grown further with the introduction of SEZs,

which provide modern infrastructure as well as additional incentives for export-oriented enterprises.

Thailand aims to enhance its position in GVCs and transition to higher-value, knowledge-based economic activities by capitalizing on its strengths and addressing areas for improvement. This change has the potential to redefine Thailand's role in the global economy, shifting it from a manufacturing hub to a center of innovation and high-value output. Despite its advances, Thailand has had challenges in moving up the value chain to higher-value-added activities. Thailand 4.0, the government's initiative, aims to address this by fostering innovation, R&D, and the widespread adoption of advanced technology across industries.

Thailand has made significant progress in ICT development, but a variety of barriers impede it from realizing its full potential, particularly in terms of economic upgradation and productivity growth. Key constraints include insufficient funding for ICT initiatives, concerns about digital transaction security, challenges in joining global markets, and a scarcity of qualified human capital. These constraints hinder Thai companies' ability to fully leverage ICT for economic growth and inclusion in the GVCs. Despite these constraints, government initiatives, such as the Digital Economy and Society Development Plan and the establishment of Community Digital Centers, have helped to improve digital literacy and increase access to digital resources. The merger of major telecom companies, as well as the ongoing investments in broadband infrastructure, have all led to improved connectivity and digital services.

Thailand's economic upgradation and productivity growth potential through ICT is excellent. Continued investments in digital infrastructure, as well as an emphasis on developing a technologically educated workforce, can help Thailand compete in GVCs. Embracing emerging technology and encouraging innovation through supportive policies will be critical to sustaining development and ensuring long-term economic stability. By addressing existing constraints and implementing the recommended policies, while taking into account its unique cultural, economic, and social characteristics, Thailand can improve its ICT capabilities, drive productivity growth, and gain a competitive advantage in this increasingly digital global economy.

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TURKIYE

Summary

This report examines the role of digital transformation, workforce skill development, and ICT adoption in enhancing the productivity and competitiveness of Turkish firms within GVCs. By analyzing data from the WBES and national ICT usage statistics, the study examines the impact of digitalization on TFP and labor productivity across various sectors. It highlights the importance of digital skills and robust ICT infrastructure in fostering innovation and operational efficiency.

Key findings reveal that firms with higher ICT integration, such as website presence, consistently exhibit better productivity metrics, particularly in production-intensive sectors. However, the impact on labor productivity is less uniform, emphasizing the need for workforce development and skill upgradation initiatives. Challenges, such as limited access to finance, inadequate digital infrastructure, and cybersecurity concerns, hinder SMEs from fully capitalizing on digital tools. Additionally, electricity outages significantly disrupt productivity in several sectors.

The report emphasizes the need for policies that enhance ICT infrastructure, promote digital literacy, and facilitate the adoption of advanced technologies by SMEs. Recommendations include expanding high-speed broadband access, fostering Industry 4.0 technologies, and implementing productivity-focused digital transformation initiatives. By addressing these gaps, Turkiye can advance its position in GVCs, transitioning towards higher-value-added activities and solidifying its role in the global digital economy.

Introduction

The contemporary global economy is experiencing a period in which ICT is rapidly proliferating, and digitalization is transforming business processes. Firms are striving to integrate digital technologies into their operations to gain a competitive advantage and increase production efficiency. As part of this global transformation, Turkiye also aims to climb higher in global GVCs by expanding the use of ICT. However, this process is not limited to mere adoption of digital tools, but also necessitates the development of a workforce capable of adapting to digitalization.

The primary objective of this study is to evaluate the impact of ICT usage on production processes and productivity in Turkish firms. By addressing the challenges and opportunities faced by SMEs in their digitalization processes, the study will analyze the effects of ICT usage on firm productivity. Increased operational efficiency, reduced production costs, and enhanced innovation capabilities, driven by digitalization, are among the key factors that bolster the firms' competitiveness in global markets.

Furthermore, it is acknowledged that ICT is not merely a technological tool but also a factor that transforms the quality of the workforce. The effective use of ICT requires optimizing firms' operational processes while simultaneously enhancing employees' digital skills. Strategies aimed at increasing digital competencies in Turkiye can enable firms to engage in higher-value-added activities within GVCs. In this context, the study comprehensively examines the contribution of ICT usage to firm productivity and the role of these technologies in enhancing firms' competitiveness.

Position, Role, and Characteristics of Firms in Turkiye Within the GVC

The global economy has undergone a significant transformation over the past thirty years, with GVCs playing a critical role in this process. GVCs organize various stages of a product or service—from design to production, distribution to after-sales services—on a global scale by dividing them across different geographies. Thanks to its production capacity and geographical advantages, Turkiye has become an essential player in GVCs. However, its role in GVCs has primarily been limited to production based on low- and medium-technology, and there remains a need for further integration into high-value-added activities.

Turkiye's Position and Characteristics in GVC

Turkiye's performance in GVCs is particularly evident in sectors such as textiles, automotive, and machinery. This rise has been driven by increased external demand resulting from GVC production and Turkiye's growing role in global supply chains. Especially during the COVID-19 pandemic, disruptions in Asia-centered supply chains allowed Turkiye to export more goods to European and the US markets. According to the OECD's Trade in Value Added database, as of 2018, Turkiye's overall participation rate in GVCs was 39.8%. The country's backward linkage rate was recorded at 20.9% in 2018 (OECD, 2022).

Turkiye focuses on medium-technology segments in GVCs, with a strong presence in sectors such as automotive, textiles, and machinery. However, production in these sectors primarily involves low-value-added activities. For instance, in the automotive industry, Turkiye is mainly involved in assembly processes, while higher-value-added activities, such as R&D and design, are typically conducted abroad. According to the World Bank's 2022 report, firms integrated into GVCs exhibit higher TFP than other firms, with average wage levels being 45% higher in these firms (World Bank, 2022).

On the GVC front, Turkiye faces challenges due to global economic uncertainties and shifting trade policies. Given its current production capacity and technological competencies, these challenges are becoming increasingly complex, and the limitations of low- and medium-technology production are becoming more apparent. The Russia-Ukraine war, which began in 2022, along with the global energy crisis, caused significant fluctuations in Turkiye's trade, leading to bottlenecks in global supply chains. However, despite these challenges, Turkiye's geographical location and production capacity position it as a key supplier close to European markets, thereby enhancing regional opportunities within GVCs.

New regulations, such as the EU's Green Deal and carbon border taxes, are increasing the necessity for Turkiye to transition into sustainable production technologies within the GVCs. Without transitioning to green technologies in carbon-intensive sectors like chemicals and metals, Turkiye risks losing its long-term competitiveness.

To improve its position in GVCs and generate more value-added activities, Turkiye must encourage a transition to high-technology and innovation-based production processes. Increasing R&D expenditures and establishing global partnerships in this area could facilitate the country's participation in higher-value-added activities within GVCs. Additionally, investing in sustainable production technologies is crucial for reducing Turkiye's carbon footprint.

Relationship Between Digitalization, Skill Development, and Global Competitiveness

In today's global economy, competitiveness is increasingly dependent on firms' capacities for sustainable growth and innovation, with digitalization and skill development forming critical components of this process. The rapid advancement of digital technologies and their integration into business processes

play a pivotal role in enhancing the global competitiveness of countries and firms. Turkiye also aims to ascend higher in GVCs by advancing its digitalization strategies. However, this process is not solely about adopting digital tools but also about transforming human resources to adapt to digitalization.

The Impact of Digitalization on Global Competitiveness

Digitalization has become a fundamental factor in increasing global competitiveness by enhancing firm productivity, reducing costs, and fostering innovation. The digital transformation process, referred to as Industry 4.0, is characterized by the reshaping of production processes through technologies such as automation, AI, IoT, big data analytics, and cloud computing. Turkiye aims to enhance its global competitiveness, particularly in the manufacturing and services sectors, through the adoption of these technologies. For instance, digitalization has made production processes more efficient in the automotive and machinery sectors, while optimizing supply chain management (World Bank, 2022).

The full potential of digitalization can only be realized if the workforce possesses the necessary digital skills. Digital transformation is not limited to technological innovations; instead, it relies on the workforce's capacity to effectively utilize these technologies. In Turkiye, various training programs and public policies are being implemented to enhance digital skills, with a particular focus on encouraging the younger population to adapt to digital technologies. According to the OECD, improving digital skills boosts firms' innovation capacities, enabling them to engage in higher value-added production and, thus, helping them attain a more competitive position in GVCs (OECD, 2022). In this context, the need to integrate Turkiye's young population into the digital transformation process is a critical factor for the country's future competitiveness.

Turkiye has placed digitalization at the core of its economic development strategy and has developed various policies to accelerate industrial digital transformation. In particular, the 11th Development Plan outlines goals for digitalization, highlighting the importance of digitizing industrial production, increasing the use of high technology, and expanding the digital economy. The Digital Turkiye initiative, launched by the Ministry of Industry and Technology, aims to promote digitalization across the industrial sectors and position Turkiye as a regional technology hub.

Digitalization and skill development are two critical factors in enhancing Turkiye's global competitiveness. The opportunities presented by digitalization allow firms to improve the efficiency of their production processes, increase their innovation capacity, and gain competitive advantages in the global markets.

Importance of Skill Upgradation in Turkiye

Skill upgradation is crucial for Turkish firms as they seek to enhance their positions within GVCs and compete more effectively in the global marketplace. The rapid pace of technological change, particularly in digitalization and automation, has made it imperative for firms to develop a workforce capable of utilizing advanced ICT tools and adapting to new business models (OECD, 2017). However, Turkiye faces a persistent skills mismatch, particularly in the ICT sector, where access to qualified human capital remains challenging. According to a survey conducted by Manpower Group (2018), 54% of businesses in Turkiye report difficulties in finding skilled labor, which is significantly higher than the European average of 34%. This disparity represents a significant barrier to the global competitiveness of Turkish firms during the ongoing technological transformation process.

A recent study highlights further evidence of Turkiye's digital skills gap. While 30% of individuals in Turkiye possess digital skills, this rate is considerably higher in the EU at 54% (PAL, 2023).

Using the methodology developed by Eurostat (2021), it was observed that the proportion of individuals aged 15–74 in Turkiye with digital skills rose from 22% in 2016 to 30% in 2021. However, during the same period, the EU experienced only a modest increase, with the proportion rising from 51% in 2016 to 54% in 2021. These findings suggest that while Turkiye has made notable progress in enhancing digital competencies, the gap with the EU remains significant, posing challenges for Turkish firms aiming to leverage digital technologies within GVCs.

In comparison, Asian economies such as Singapore and South Korea have placed a strong emphasis on skill development as part of their economic strategies. Singapore, for instance, has implemented comprehensive lifelong learning initiatives, including the SkillsFuture program, to ensure its workforce remains competitive in a rapidly changing global economy. These programs have been instrumental in helping Singapore maintain its position as a leading hub for finance, technology, and innovation.

Similarly, European countries, particularly those in Northern Europe, have prioritized skill development through robust vocational training systems and close collaboration between industry and educational institutions. For instance, the dual education system in Germany, which combines classroom-based education with practical on-the-job training, has been highly effective in producing a skilled workforce that meets the country's advanced manufacturing sectors' needs (Thelen, 2004). This focus on skill development has allowed European firms to maintain high levels of productivity and innovation.

The misalignment between Turkiye's vocational education system and labor market demands further exacerbates the skills mismatch issue. Many graduates from vocational education programs fail to meet the labor market's needs, which increases both unemployment rates and employers' difficulties in accessing skilled labor (Suna et al., 2020). Even among higher education graduates, a significant mismatch between education and employment is evident (Alpaydın, 2015). Addressing these skills mismatches requires policymakers to focus on strategic education and reskilling programs tailored to the needs of the digital economy and the ICT sector.

For Turkiye to achieve similar success as its peers in Asia and Europe, there must be a concerted effort to address the skills gap and invest in education and training programs that are aligned with the needs of the digital economy. According to the OECD, digital skill development policies could play a critical role in enhancing labor productivity (Dlugosch, 2023). By doing so, businesses in Turkiye can better position themselves within GVCs, increase their competitiveness, and capture higher-value-added activities.

In this regard, skill upgradation in Turkiye plays a vital role in enhancing the global competitiveness of firms that have the potential to ascend the GVCs.

Constraints on Firms' Skill Upgrading and ICT's Potential in Turkiye

Access to Finance

Limited access to finance is a significant constraint on the ability of Turkish firms, especially SMEs, to upgrade their skills and integrate advanced ICT solutions. According to the European Bank for Reconstruction and Development (2023), SMEs in Turkiye face substantial difficulties in obtaining financing due to high collateral requirements, which are often unattainable for smaller firms. This financial barrier limits their capacity to invest in new technologies and skills, which are crucial for enhancing productivity and competitiveness.

However, ICT solutions such as mobile banking and fintech platforms offer promising alternatives for overcoming these financial constraints. Research by Beck et al. (2007) indicates that the adoption of mobile banking services can significantly improve financial inclusion in emerging markets by reducing transaction costs and providing more accessible financial services. In Turkiye, the proliferation of mobile banking has already shown potential in increasing access to financing for SMEs, particularly in rural areas where traditional banking services are limited. By leveraging these digital tools, Turkish firms can gain the necessary capital to invest in skill upgradation and technological advancements.

These digital tools can significantly enhance SMEs' access to necessary capital, thereby increasing their capacity to invest in skill upgradation and technological advancements.

Safety of Transactions

Security concerns in both digital and general transactions hinder ICT adoption, as many SMEs fear cyber threats, regulatory complexities, and compliance issues, which can undermine trust in overall transaction safety, especially in cross-border transactions involving the EU. When evaluated in terms of harmonization with the EU, Article 4 of Turkey's Personal Data Protection Law regulates the procedures and principles regarding the processing of personal data in line with the Council of Europe Convention No. 108 and the EU's Data Protection Directive No. 95/46/EC. This legal harmonization shows that Turkiye's data protection legislation is integrated with EU norms, has adopted international standards on personal data security, and provides a framework to ensure a secure and legal infrastructure regarding issues.

Recent guidelines, such as the Banking Guidelines published by the Personal Data Protection Authority of Turkiye in 2022, emphasize that transaction safety involves compliance with data protection laws and ensuring secure data transfer in financial transactions. These guidelines outline best practices for banks, including ensuring transaction safety, managing data responsibly, and taking precautions during unusual banking activities, which are particularly relevant for cross-border transactions involving the EU. Ensuring ease and security in cross-border transactions is crucial for building trust and facilitating smoother trade relationships with international markets. On the other hand, the fear of cyberattacks, data breaches, and fraud can deter businesses from fully embracing digital payment systems, which are essential for improving operational efficiency and accessing broader markets. Compliance with foreign regulations and ensuring secure transactions are critical for firms engaging in international trade, particularly when dealing with EU customers, where regulatory frameworks and security standards are stringent and can be challenging to navigate. Asgary et al. (2020) note that Turkish SMEs view large-scale cyberattacks and data fraud/theft as significant risks, potentially causing severe impacts due to their limited cybersecurity measures. The study also emphasizes that SMEs are highly vulnerable to disruptions in IT, as their dependence on digital platforms for transactions and operations makes them particularly susceptible to these risks.

The Turkish government has taken steps to enhance cybersecurity, including the enactment of the National Cybersecurity Strategy and Action Plan (2016–19), which aimed to strengthen the country's cyber defense capabilities and promote secure digital transactions. Despite these efforts, more needs to be done to build trust in the digital financial systems among SMEs. Providing training and resources to firms on cybersecurity practices could significantly reduce the risks associated with digital transactions and encourage greater adoption of ICT.

Building this trust could encourage firms to adopt ICT solutions more widely, leading to overall improvements in economic efficiency.

Access to Global Markets

Access to global markets is crucial for the growth and competitiveness of firms in Turkiye, particularly those in export-oriented sectors. However, challenges such as logistical barriers, regulatory complexities, and limited market information hinder their ability to exploit international opportunities fully. A study by Ulengin et al. (2015) highlights that SMEs in Turkiye often face difficulties in navigating the regulatory frameworks of foreign markets, which restrict their ability to participate in GVCs.

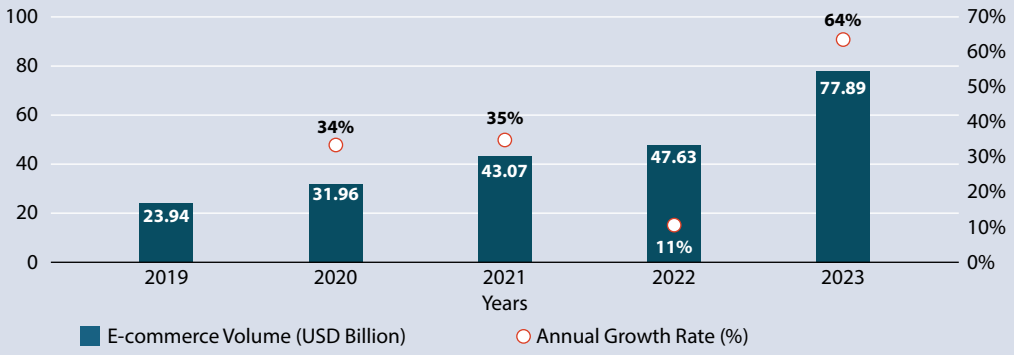
In 2023, Turkiye's Logistics Performance Index score was 3.4, placing it behind European logistics countries such as Germany (4.1) and the Netherlands (4.1). These countries outperform Turkiye, particularly in areas such as infrastructure, customs procedures, and the quality of logistics services, which is reflected in their higher scores. Germany and the Netherlands scored 4.3 and 4.2 in infrastructure, respectively, and 3.9 in customs, whereas Turkiye's scored 3.4 in infrastructure and 3.0 in customs (World Bank, 2023). According to the study by Tongur et al. (2020), these discrepancies in logistics performance raise trade costs and reduce export efficiency, highlighting that Turkiye's logistics limitations significantly hinder its competitiveness in international markets, especially in comparison to its advanced European counterparts, even if the country aligns its legislation with the EU.

ICT can play a transformative role in mitigating these challenges by providing firms with tools to connect with international buyers, manage cross-border transactions, and comply with foreign regulations. For instance, the adoption of e-commerce platforms has been shown to facilitate market access for SMEs by lowering entry barriers and reducing transaction costs. In Turkiye, initiatives such as the e-Export Action Plan aim to support SMEs in utilizing digital platforms to reach new markets and expand their global footprint.

As illustrated in Figure 1, the e-commerce volume underwent a significant transformation from 2019 to 2023. In 2019, revenue from the e-commerce sector reached USD23.94 billion, increasing by 33.5% in 2020 to USD31.96 billion, primarily driven by the shift towards online shopping during the COVID-19 pandemic. This was followed by a 34.9% increase in 2021 to USD43.07 billion, reflecting the continued growth of digital commerce. In 2022, the growth rate slowed to 10.6%, resulting in a volume of USD47.63 billion, as the market began to normalize following the pandemic. However, in 2023, the sector experienced a surge of 63.6%, reaching USD77.89 billion, indicating increased consumer confidence and the expanding adoption of e-commerce platforms.

FIGURE 1

E-COMMERCE VOLUME AND ANNUAL GROWTH RATES IN TURKIYE (2019–23).



Source: Ministry of Trade (2024).

Access to Skilled Human Capital

The availability of skilled human capital is another critical challenge for Turkish firms seeking to upgrade their economic capabilities. While Turkiye has made considerable progress in expanding education and vocational training, a significant gap remains between the skills demanded by the digital economy and those available in the workforce. Turkish firms, particularly in the manufacturing and service sectors, struggle to find workers with advanced ICT skills, such as software development and data analysis.

This skills mismatch is a barrier to the effective utilization of ICT in business processes, limiting the potential for innovation and productivity growth. A study by Tansel and Gazioglu (2014) suggests that enhancing the quality of vocational education and promoting industry-academia collaboration are essential strategies to address this skills gap. Additionally, promoting lifelong learning and continuous professional development can help equip the existing workforce with the necessary skills to adapt to technological changes.

To bridge this gap, targeted skill development programs and policies that align with the needs of the digital economy are necessary. For example, initiatives like the 42 Schools project, a branch of Ecole 42 in France, run by Turkiye Open Source Platform in Turkiye, which aims to teach coding and digital literacy to students at a young age, represent crucial steps towards building a more ICT-competent workforce. By fostering a culture of continuous learning and skill enhancement, Turkiye can ensure that its firms are better prepared to leverage ICT for economic growth and development.

Addressing this skills gap is crucial for firms to effectively leverage ICT and enhance their potential for innovation and productivity growth.

ICT Usage by Households in Turkiye

The SICT Usage in Households and by Individuals, 2024 (Turkstat, 2024) provides the most up-to-date data on Internet and IT usage in Turkiye. This section summarizes the findings from these datasets.

Internet Usage by Gender

In 2024, the Internet usage in Turkiye reached 88.8% among individuals aged 16–74, reflecting a slight increase from 87.1% in 2023. Gender differences were evident, with 92.2% of males and 85.4% of females reporting regular Internet usage. This gap highlights persistent gender disparities in digital access, suggesting that males have greater access to or engagement with Internet services than females. These findings are consistent with global trends, where males often exhibit higher Internet penetration rates, particularly in developing countries.

E-commerce Usage

The proportion of individuals engaging in e-commerce grew to 51.7% in 2024, up from 49.5% in 2023. A gender breakdown revealed that 54.1% of males and 49.3% of females participated in online shopping. This gender gap indicates that males are slightly more inclined towards using e-commerce platforms, which may be influenced by their higher Internet usage rates. However, the near-equal distribution suggests that e-commerce is becoming a mainstream activity across both genders in Turkiye.

E-government Service Usage by Age and Gender

The survey also sheds light on the use of e-government services, which were accessed by 73.7% of individuals in 2024. Notably, 80.7% of males used e-government services compared to 66.7% of

females, demonstrating a significant gender gap. When analyzed by age group, the highest proportion of users was found in the 25–34 age cohort (92.1%), while the lowest proportion was observed in the 65–74 age group (25.6%). These statistics suggest that younger individuals are more comfortable with digital government services. At the same time, older age groups may face barriers such as digital literacy issues or limited access to technology.

Smart Devices and Internet-Connected Technologies

The survey also indicates a growing adoption of smart devices and Internet-connected technologies. In 2024, 47.9% of Internet users owned or used an Internet-connected TV, making it the most popular connected device. Additionally, 10.2% of users had Internet-connected home appliances, and 9.7% used wearable devices such as smartwatches or fitness bands. This trend toward connected living reflects broader global patterns of increasing reliance on smart home technologies, driven by convenience and technological advancement.

Consumer Preferences for Purchasing Technology

Price remains the most important factor for Turkish consumers when purchasing mobile phones or computers, with 89.2% of Internet users prioritizing cost. This is followed by hardware characteristics (71.7%) and brand, design, or size (67.4%). These findings suggest that while functionality is key, affordability plays a critical role in shaping consumer decisions in the Turkish ICT market. This trend is consistent with that in other middle-income countries, where consumers often balance quality with budget constraints.

The 2024 ICT usage survey in Turkiye revealed key insights into the country's evolving digital landscape. Despite significant growth in Internet usage and the mainstream adoption of e-commerce, gender disparities remain persistent across digital activities, particularly in Internet access and the use of e-government services. Males continue to exhibit higher engagement with online platforms compared to females. At the same time, younger individuals show greater comfort in using digital services, leaving older populations at risk of exclusion due to digital literacy barriers. The increasing integration of smart devices, particularly Internet-connected TVs and home appliances, reflects a growing reliance on technology in everyday life, a trend aligned with global shifts toward smart living. However, affordability remains a primary concern for Turkish consumers, as price dictates purchasing decisions for mobile phones and computers. This suggests that while technological advancements drive digital adoption, economic factors continue to play a critical role in shaping consumer behavior.

Overall, the findings emphasize the need for targeted policies that address the gender and age-based digital divide, promote inclusivity in digital government services, and ensure affordability in the expanding ICT sector. By addressing these challenges, Turkiye can foster a more equitable digital participation and further integrate its population into the global digital economy.

Broadband Internet Usage

In Turkiye, the objective is to promote the effective, secure, and accessible utilization of ICT, with a particular emphasis on expanding mobile and fixed broadband infrastructures (Ministry of Transport and Infrastructure, 2024). The focus is on enhancing the country's digital infrastructure and improving access to broadband services. According to infrastructure indicators, significant growth is expected in broadband subscription density, which refers to the number of broadband subscriptions in a specific area relative to its population, typically expressed per 100 inhabitants, and it measures broadband penetration and digitalization levels. It also reflects the progress in strengthening digital connectivity across the country. Table 1 gives the current status and target levels in this field.

TABLE 1

BROADBAND INDICATORS IN TURKIYE.

ICT Infrastructure Indicators as Broadband Subscriber Density*	Current Status (2024)	Target (2028)
Mobile broadband subscriber density (%)	87.0	100.0
Fixed broadband subscriber density (%)	22.5	27.5
Fiber broadband subscriber density (%)	7.4	11.0

Note: * Broadband subscriptions per 100 inhabitants.
Source: Ministry of Transport and Infrastructure (2024).

These targets are supported by the planned expansion of technologies such as fiber, 4.5G, and 5G. Strategically, infrastructure investments are being planned to ensure high-speed and high-quality broadband access. However, risks such as infrastructure deficiencies in rural areas and insufficient demand for subscriptions are also being considered.

This five-year plan aims to strengthen Turkiye's broadband infrastructure and align its Internet penetration with OECD averages. Additionally, accelerating 5G efforts and developing local technologies are the key strategic components of the plan.

The focus on expanding broadband infrastructure and increasing subscription density reflects Turkiye's ambition to close the digital divide and enhance its competitiveness in the global digital economy. The emphasis on 5G and fiber technologies is aligned with global trends in ICT development, which increasingly prioritize high-speed and reliable Internet access as a driver of economic growth and innovation. However, the challenges in rural areas, where infrastructure may lag, highlight the need for targeted policy interventions to ensure equitable access across the country. By addressing these barriers, Turkiye can not only improve overall Internet penetration but also foster greater social inclusion and economic opportunity through digital transformation.

Mobile and Electronic Banking in Turkiye

Turkiye, with a population of approximately 85 million, has seen significant advancements in digital banking and e-payment systems over the past decade. The widespread adoption of the Internet and mobile banking reflects the rapid digital transformation of the financial sector. Based on data from the Turkish Banks Association (TBB, 2024) for March 2024, critical statistics on the utilization of digital banking services in Turkiye are as follows:

- **Total digital banking customers**
  - 113.63 million (including individual and corporate users)
  - 1.67 million users only use Internet banking.
  - 102.61 million users only use mobile banking.
  - 9.35 million users utilize both Internet and mobile banking services.
- **Breakdown of active users**
  - Individual users: 109 million

- Corporate users: 4.59 million

- **Internet banking statistics**
  - Registered individual users: 100.70 million
  - Active individual users: 9.47 million

- **Mobile banking statistics**
  - Registered users: 178.16 million
  - Active users: 111.96 million

Despite a population of 85 million, Turkiye's digital banking infrastructure has reached a user base exceeding this number, thereby highlighting the robustness and expansion potential of the country's digital financial ecosystem. Quantitative data (PwC, 2021) further substantiates this strong position. As of 2020, 37% of general-purpose loans were provided through digital channels, with this rate reaching 70–80% among leading banks. The share of mobile applications in digital lending increased from 74% in 2017 to 93% in 2020. Moreover, branch usage in Turkiye has decreased significantly, with 55% of consumers never visiting bank branches. These figures not only demonstrate widespread adoption but also indicate a significant shift toward digital platforms in financial services.

The regulatory framework for digital banking in Turkiye has been structured to foster innovation and competition within the sector. Clear regulations regarding digital banking licenses and operations have established a reliable environment for both consumers and service providers. These regulations emphasize data security and transparency, aiming to enhance consumer confidence. This regulatory approach has contributed to Turkiye's rapid growth in financial technologies and digital banking, thereby solidifying its strong infrastructure.

The predominant role of mobile banking in financial transactions illustrates a high level of digital adoption. The increasing number of mobile and Internet banking users in Turkiye has established a solid foundation for the development of e-payment systems. However, a recent study on the reluctance to use mobile payment systems in Turkiye (Yıldırımoğlu et al., 2024) reveals that, despite the strong digital infrastructure, users remain cautious about mobile payments due to specific concerns and issues. According to the research, Internet access and technological literacy are key factors influencing the use of mobile payments. Individuals with Internet access tend to favor mobile payments, whereas those facing access challenges are less likely to utilize this technology. Additionally, factors such as transaction fees, security concerns, issues with customer service, and technical difficulties, including password recovery, contribute to users developing a negative attitude toward mobile payment systems. In particular, concerns about personal data security and fraud risks exacerbate individuals' hesitation in adopting this technology.

When these dimensions are considered together, it becomes evident that, despite the strong infrastructure of Turkiye's digital financial ecosystem and a supportive regulatory environment, specific barriers hinder the widespread adoption of mobile payment systems. Socio-demographic factors also play a role in this dynamic. Younger individuals and those with higher levels of education tend to adopt mobile payment technologies more readily, while older individuals and

those with lower technological literacy remain more cautious. The considerable potential of Turkiye's digital financial services sector can be further enhanced by strategic improvements such as developing more user-friendly interfaces and addressing security concerns to promote the widespread use of mobile payment systems.

In conclusion, the growth of Turkiye's digital financial ecosystem can be supported by expanding the reach of digital banking and mobile payment systems to a broader audience. To achieve this, however, the reliability of the existing technological infrastructure must be strengthened, transaction convenience ensured, and users' security concerns addressed. In this manner, mobile payment systems could become a natural extension of Turkiye's success in digital banking, leading to broader adoption.

Productivity Analysis

The dataset used in this study contains financial and operational data on firms operating in various sectors in Turkiye, based on the WBES 2019 survey. Additionally, the dataset includes factors related to digitalization, such as the presence of a website and the frequency of electricity outages experienced by businesses.

Although the dataset comprises a large number of variables, only selected variables relevant to the scope of this study have been utilized. Firms are classified into nine different sectors: Food, Textiles, Apparel, Metal Products, Machinery and Equipment, Other Manufacturing, Construction, Retail, and Other Services. Additionally, firms are categorized by size using a scale variable, dividing them into small, medium, and large enterprises. The distribution of a total number of 1214 firms across these categories is presented in Table 2 below.

TABLE 2

THE DISTRIBUTION OF FIRM DATA BY SCALE AND SECTOR.

Sector	Scale	Number of Firms
Food	Small	63
	Medium	59
	Large	25
Textiles	Small	46
	Medium	40
	Large	50
Garments	Small	46
	Medium	40
	Large	50
Fabricated metal products	Small	77
	Medium	37
	Large	14
Machinery and equipment	Small	55
	Medium	30
	Large	22

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(Continued from the previous page)

Sector	Scale	Number of Firms
Other manufacturing	Small	69
	Medium	70
	Large	29
Construction	Small	39
	Medium	61
	Large	26
Retail	Small	71
	Medium	46
	Large	20
Other services	Small	62
	Medium	67
	Large	0

Source: World Bank Enterprise Surveys.

The dataset includes information on firms' capital structures, annual sales, electricity consumption, and labor costs. The categorical variables of website presence and the occurrence of electricity outages offer important insights into the level of digitalization and energy infrastructure challenges faced by the firms.

One of the key variables in the dataset is TFP, which measures the productivity with which a firm utilizes all its inputs in production. In contrast, labor productivity assesses the output per employee on a logarithmic scale. This data is deemed sufficient for analyzing firms' operational efficiency and the impact of disruptions in their production processes.

Firm Productivity

Using the WBES dataset, the analysis calculates TFP and labor productivity for the surveyed firms. This study examines the differences in TFP and labor productivity across various sectors in Turkiye. The firms are classified based on the presence of a website, a key component of digitalization, and operational challenges such as electricity outages. The primary aim of this analysis is to investigate the sectoral impacts of ICT usage (particularly website presence) and electricity outages, which are assumed to be a basic indicator of ICT infrastructure, on firm productivity.

Methodology

The data used in this study were obtained from firms operating in various sectors within the WBES database. TFP and labor productivity values for each firm were examined based on the presence of a website and whether the firm experienced electricity outages. Stochastic frontier analysis was employed to calculate TFP. The analysis was performed using the "prodest" module in STATA software, and the Levinsohn and Petrin approach was selected as the most appropriate method based on data availability. In this approach, labor costs, intermediate goods (electricity), and capital stock were treated as independent variables, while sales were the dependent variable. Since the dataset does not include capital stock information, a special method was used.

In this research, a weighted approach was employed to estimate firms' capital stock. The representation values, included in the survey, reflect how well the surveyed firms represent the

overall population in Turkiye based on sector and scale. The weighting and estimation process was carried out as follows:

- **Use of eligibility values:** Median values of eligibility for each sector and scale were taken. This ensured that the representative electricity of the selected sectors and scales reflected the midpoint of the distribution for the given year.

- **Calculation of eligibility weights:** For each breakdown (based on year, scale, and sector), weights were compiled internally and distributed to the respective breakdowns. As a result, different representation weights were obtained for each year, scale, and variable.

- **Estimation of capital stock using fixed assets as a proxy variable:** To update the values, sectoral balance sheets published by the Central Bank of the Republic of Turkiye were used. The median representation weights of the surveyed firms calculated in the previous step were multiplied by the sector-specific values of fixed assets from the balance sheets, which were then used as a proxy variable for the firm's capital stock.

Consequently, estimates were made for sectors across Turkiye based on data from 1,214 firms. By utilizing the weighting method and Central Bank data, the survey results more accurately reflect the strength and representation of sectors in Turkiye. This approach ensures the generalizability of the data obtained from the sectoral, scale, and year-based analyses.

In the data analysis, the presence of a website and the experience of electricity outages for each firm were tested using a t-test to determine productivity differences. In this context, sectoral performances in terms of TFP and labor productivity were analyzed in detail. Additionally, the TFP values for each sector were compared with the overall sample TFP values to test whether the sectors significantly differed from the general average.

The regression results for the analysis conducted in the study are presented in the table below. According to this table, the model is statistically significant, as indicated by the p-value being below the conventional threshold (e.g., $p < 0.05$)

TABLE 3

REGRESSION RESULTS OF THE MODEL.

Variables	(1) Sales (log)
Labor (log)	0,7609***
	(0,0000)
Capital Stock (log)	0.0964**
	(0,048)
Observations	1214
Number of groups	1214
Chi2	31.37
	(0.00)

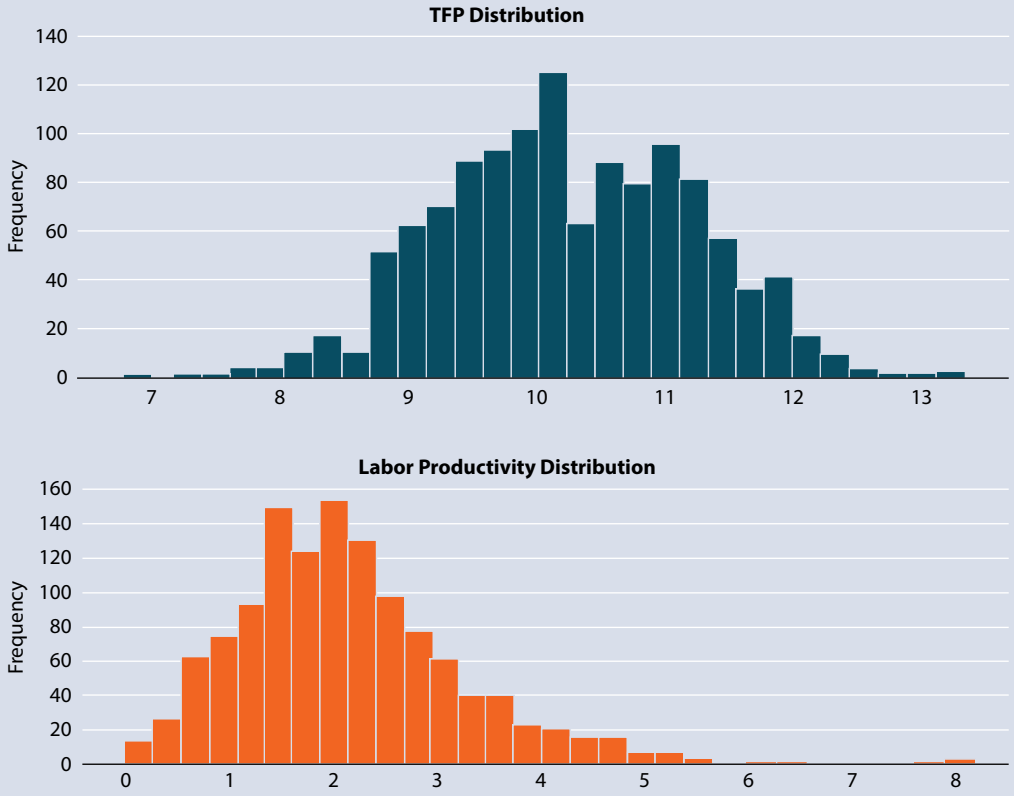
Note: p-values in parentheses: *** $p<0.01$, ** $p<0.05$
Source: Calculated by the National Expert.

Results on TFP and Labor Productivity

The distribution graph of TFP indicates that the firms' productivity levels vary widely, revealing significant differences in productivity across firms. The distribution of labor productivity per employee, measured on a logarithmic scale, shows that while some firms have notably high productivity, the majority of firms are concentrated at lower productivity levels (Figure 2).

FIGURE 2

DISTRIBUTION OF TFP AND LABOR PRODUCTIVITY.



Source: Calculated by the National Expert.

Table 4 shows the correlation between the calculated TFP, labor productivity, and the other independent variables:

TABLE 4

CORRELATION BETWEEN DEPENDENT AND INDEPENDENT VARIABLES.

	TFP	Labor Productivity	Capital Stock	Labor Cost	Sales	Electricity Cost
TFP	1.00	–0.17	0.11	0.42	0.34	0.20
Labor Productivity	–0.17	1.00	0.00	–0.09	0.16	0.01
Capital Stock	0.11	0.00	1.00	0.46	0.41	0.22
Labor Cost	0.42	–0.09	0.46	1.00	0.78	0.54
Sales	0.34	0.16	0.41	0.78	1.00	0.61
Electricity Cost	0.20	0.01	0.22	0.54	0.61	1.00

Source: Calculated by the National Expert.

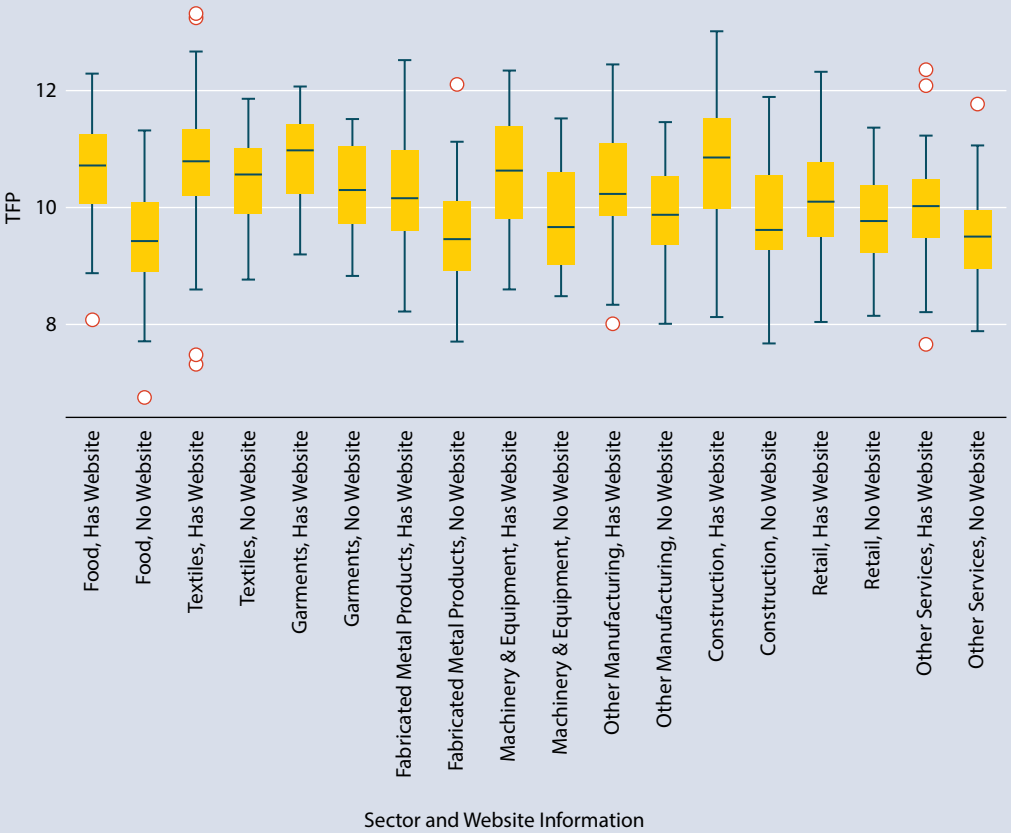
According to the findings, significant relationships were identified between TFP and other variables. Notably, a strong positive correlation was observed between TFP and labor cost (r=0.42), indicating that as labor costs increase, productivity tends to rise as well. Additionally, a positive but weak relationship was observed between TFP and capital stock (r = 0.11), suggesting that the impact of capital stock on productivity is limited. Furthermore, there is a positive correlation between electricity consumption and TFP (r=0.20), implying that higher electricity consumption is associated with increased productivity.

On the other hand, no significant correlation was found between labor productivity and the other variables. This indicates that the differences in labor productivity do not show strong relationships with the other factors examined in this study.

Figure 3 illustrates the sector-wise distribution of TFP differences based on website presence, as derived from the analysis results. The subsequent section provides a statistical examination (t-tests) of the distributions depicted in this figure.

FIGURE 3

TFP DIFFERENCES BY SECTOR AND WEBSITE PRESENCE.



Source: Calculated by the National Expert.

The Impact of Website Presence on Productivity

The impact of website usage on TFP and labor productivity was analyzed across nine different sectors in Turkiye. The results of the t-tests on mean values indicate that the differences between firms with and without a website vary by sector.

The analysis indicates that firms with a website consistently outperform those without a website in terms of TFP across most sectors. Table 5 provides a detailed comparison of mean TFP values for the two groups, along with t-test results.

TABLE 5

SECTOR-WISE ANALYSIS OF WEBSITE USAGE IMPACT ON TFP AND LABOR PRODUCTIVITY.

Sector	TFP Mean (Has Website)	TFP Mean (No Website)	TFP t-stat	TFP p-value	LP Mean (Has Website)	LP Mean (No Website)	LP t-stat	LP p-value
Food	10.8	9.5	7.70	<0.001	4.25	4.00	1.90	0.060
Textiles	10.1	9.7	1.86	0.066	4.10	3.95	1.46	0.149
Garments	10.6	9.8	4.55	<0.001	4.30	4.05	1.99	0.049
Fabricated metal	11.0	9.6	4.18	<0.001	4.20	4.00	1.50	0.139
Machinery and equipment	10.7	9.7	3.18	0.004	4.15	4.10	0.88	0.386
Other manufacturing	10.3	9.9	3.01	0.003	4.12	3.97	1.91	0.060
Construction	10.5	9.6	4.31	<0.001	4.05	4.00	0.53	0.599
Retail	10.2	9.8	2.32	0.022	4.00	3.95	0.70	0.485
Other services	10.4	9.7	3.08	0.003	4.10	3.90	1.35	0.180

Note: TFP, Total Factor Productivity; LP, Labor Productivity.
Source: Calculated by the National Expert.

The first three sectors with the most significant differences in TFP are:

1. **Food:** Firms with a website exhibit a notably higher TFP (10.8) compared to those without a website (9.5), with a highly significant difference ($t = 7.70$, $p < 0.001$).

2. **Garments:** Website-using firms achieve a TFP of 10.6, compared to 9.8 for non-users, indicating a significant difference ($t = 4.55$, $p < 0.001$).

3. **Fabricated metal products:** Firms with a website demonstrate a TFP of 11.0, significantly surpassing those without a website, which have a TFP of 9.6 ($t = 4.18$, $p < 0.001$).

These results highlight the crucial connection between website usage and productivity performance, particularly in production-intensive industries.

For labor productivity, the effect of website usage appears more nuanced, with only a few sectors showing significant or borderline significant differences. Firms with a website generally report slightly higher labor productivity values; however, these differences are less pronounced than those compared to TFP. The first three sectors with the most significant differences in labor productivity are:

1. **Garments:** Website-using firms have a higher labor productivity (4.30) compared to non-users (4.05), with a marginally significant difference ($t = 1.99$, $p = 0.049$).

2. **Food:** Firms with a website report a labor productivity of 4.25, while those without have a labor productivity of 4.00. The difference is borderline significant ($t = 1.90$, $p = 0.06$).

3. **Other manufacturing:** Website usage is associated with a labor productivity of 4.12, compared to 3.97 for non-users, also showing borderline significance ($t = 1.91$, $p = 0.06$).

The results indicate that the presence of a website is associated with notable differences in TFP across various sectors. In production-heavy sectors such as food, garments, fabricated metal products, and machinery and equipment, firms with a website tend to have significantly higher TFP values compared to those without a website. This suggests that website usage may display a critical relation in improving firm productivity, particularly in sectors reliant on operational efficiency and digital integration.

However, it is important to note that this analysis demonstrates an association, not causation. While firms with a website generally exhibit higher TFP, the observed differences may also be influenced by other unobserved factors, such as firm size, managerial capabilities, or access to resources.

For labor productivity, the relationship with website presence appears less consistent. Only a few sectors, such as garments and food, exhibit marginally significant differences in labor productivity between firms with and without a website. This suggests that the productivity benefits of having a website may not directly translate into measurable improvements in labor productivity across all sectors.

Interpretation of TFP Differences

Firms with a website tend to exhibit higher TFP values compared to those without one, particularly in production-intensive sectors such as Food, Garments, and Machinery and Equipment. This association suggests that having a website may contribute to better operational outcomes by increasing a firm's visibility in the market and enhancing its ability to interact with customers and suppliers. Greater market visibility and improved communication capabilities can support efficient operations and resource allocation, leading to higher productivity.

In the service sectors, such as Other Services and Retail, firms with a website similarly demonstrate higher TFP values. Websites enable these firms to strengthen relationships with customers, expand their market reach, and deliver services more efficiently through digital platforms. This suggests that firms with significant positive differences in TFP may already possess inherent advantages, such as greater resources or more effective management practices, which facilitate the adoption of digital tools like websites and maximize the associated benefits.

Conversely, firms lacking a website may face competitive disadvantages, particularly in sectors where market visibility and customer interaction are critical. Without an online presence, these firms miss opportunities to engage with customers, utilize digital marketing channels, and streamline operations through digital solutions. This disadvantage is particularly apparent in production-heavy sectors, where the absence of a website correlates with lower operational efficiency and reduced productivity.

Interpretation of Labor Productivity Differences

The analysis suggests that website presence is associated with higher labor productivity in specific sectors. In labor-intensive sectors, such as Garments and Textiles, firms with a website tend to have more productive employees. This relationship may reflect the potential of digital tools to integrate the workforce more effectively into production processes, thereby enabling more efficient data management and accelerating production cycles. However, it is important to emphasize that this association does not imply causation; factors such as firm size or management practices may also contribute to these productivity differences.

In sectors such as retail, having a website is correlated with increased labor productivity. Firms with a website are often better positioned to respond swiftly to customer demands, optimize inventory management digitally, and streamline sales processes, all of which can contribute to greater labor efficiency. This suggests that website presence may indicate a firm's capacity to leverage digital tools to meet operational challenges more effectively and enhance overall productivity.

However, the link between website presence and labor productivity is not consistent across all sectors. In industries that primarily focus on physical production, such as Fabricated Metal Products and Construction, the presence of a website shows a weaker relationship with labor productivity. These findings indicate that the productivity benefits of a website depend significantly on a sector's reliance on digital processes for its core activities.

Rather than indicating a direct causal effect, having a website may serve as a proxy for a firm's broader investments in digitalization or its adaptability to evolving market demands. Firms without a website may struggle to fully capitalize on digital tools, potentially leading to a decline in competitiveness and productivity. These results underscore the importance of digital capabilities as key drivers of productivity and competitiveness across sectors, highlighting the value of ongoing investments in digital infrastructure.

The presence of a website often reflects a firm's broader investment in digitalization, serving as an important indicator of its ability to adapt to changing market demands. Firms with a website are generally better equipped to leverage digital tools effectively, resulting in enhanced operational efficiency. Moreover, a website allows firms to expand their marketing channels and strengthen customer engagement, which contributes to higher productivity and improved competitiveness in their respective markets.

The Impact of Electricity Outages on Productivity

This section examines the TFP and labor productivity differences of firms operating in various sectors in Turkiye, based on whether they experienced Electricity outages. The results of t-tests of productivity means indicate that both productivity metrics exhibit significant differences in some sectors, depending on the presence of electricity outages. Findings on the differences in TFP are:

- **Textiles:** Firms in the textile sector that experienced electricity outages had significantly lower TFP values compared to those that did not experience outages ($t = -2.18$, $p = 0.032$). This suggests that electricity outages negatively affect production processes.

- **Retail:** In the retail sector, firms that experienced electricity outages also had significantly lower TFP values ($t = -2.09$, $p = 0.039$), indicating that outages negatively impact operational efficiency in commercial operations.

- **Other services:** Firms in the other services sector that experienced electricity outages had significantly lower TFP values ($t = -2.80$, $p = 0.006$), indicating that operational disruptions in the service sector led to significant productivity losses.

In other sectors, electricity outages had a negligible impact on TFP.

Findings for Labor Productivity Differences

- **Fabricated metal products:** Firms in the fabricated metal products sector that experienced electricity outages had significantly higher labor productivity values ($t = 2.56$, $p = 0.012$). This suggests that employees increased their effort to compensate for the disruptions caused by outages.

- **Retail:** In the retail sector, electricity outages negatively impact labor productivity ($t = 2.71$, $p = 0.008$), likely due to disruptions in customer service and commercial activities caused by the outages.

In other sectors, electricity outages did not create significant differences in labor productivity.

These findings suggest that the impact of electricity outages on productivity varies across different sectors. In sectors such as textiles, retail, and other services, electricity outages have a pronounced negative effect on both TFP and labor productivity, likely due to significant disruptions in production processes and operational efficiency.

Conversely, in the fabricated metal products sector, electricity outages appear to be associated with an increase in labor productivity, possibly because the workforce exerted more effort to maintain performance during disruptions. However, this positive effect may be temporary or influenced by specific workplace dynamics, and it is crucial to consider other confounding factors that could affect this relationship.

The results highlight the need for more targeted solutions to mitigate the impact of electricity outages across different sectors. In production-heavy sectors, stable energy infrastructure plays a crucial role in ensuring long-term productivity.

Electricity outages have varying effects on firm productivity depending on the sector. In production-intensive sectors, outages directly disrupt operational processes, while in service sectors, they may lead to declines in both employee productivity and customer service. Additionally, some sectors appear more resilient to electricity outages, or the outages may be less critical to their operations. These findings emphasize the importance of reliable energy infrastructure for sustaining firms' long-term productivity and competitiveness. As digitalization and automation become more widespread, enhancing energy security to mitigate potential disruptions caused by outages is of paramount importance.

Skill Development and ICT Policies

The 12th Development Plan (2024–28) (SBB, 2024a) and the Medium-Term Program (2025–27) (SBB, 2024b) serve as the primary policy documents for tracking national strategies. These documents outline the development of human capital and digital skills as key objectives in Turkiye's digital transformation journey. Both emphasize the importance of creating a workforce equipped with the skills needed for the digital economy, alongside improving technological infrastructure.

Skill Development and the Role of ICT

Skill development is a central focus of the digitalization acceleration process within the Development Plan and Medium-Term Program. As the knowledge economy grows and digitalization becomes more widespread, individuals need to acquire ICT-based competencies.

Both documents stress the need to enhance the digital skills of workers and businesses as digital transformation and the transition to a green economy progress. These strategic steps are crucial for Turkiye's goal of achieving a more sustainable and higher-value position in GVCs. In this context, digital skills play a vital role in boosting innovation and productivity across both the public and private sectors.

Strengthening Digital Skills

The Development Plan and Medium-Term Program set concrete goals for enhancing digital skills through education and labor market reforms. These goals include:

- **Expansion of STEM Education:** STEM education has been identified as a key priority for building a workforce capable of operating in digital technology-driven sectors.
- **Lifelong learning programs:** These programs aim to equip the current workforce with digital skills, ensuring competitiveness in the job market and preventing workforce displacement.
- **Restructuring vocational education programs:** Vocational training will be restructured to incorporate digital competencies, particularly to meet the human resource needs of SMEs during their digital transformation processes.

ICT and the Innovation Ecosystem

Skill development is not limited to digital skills alone; strengthening the innovation ecosystem is also essential. The Development Plan promotes digital innovation as a means to enhance Turkiye's global competitiveness, emphasizing the importance of ICT investments by both the government and the private sector. Increasing R&D investments and supporting the technological entrepreneurship ecosystem are integral to Turkiye's growth targets in the ICT sector. R&D activities play a significant role in enhancing digital skills and increasing innovation capacity. The use of advanced technologies, such as AI, big data, and the IoT, is crucial for boosting digital skills and innovation capabilities. The proliferation of these technologies will be achieved by creating new job opportunities and integrating the existing workforce into these areas.

Cybersecurity and Digital Competencies

Cybersecurity is considered an inseparable part of digitalization. Both the Development Plan and the Medium-Term Program emphasize the need to enhance cybersecurity competencies in tandem with digital skill development. Developing cybersecurity strategies and expanding expertise in this area are critical needs for both the public and private sectors.

Current Policy Areas

The Development Plan and Medium-Term Program propose several policy initiatives for the success of skill development and digital transformation processes. These initiatives are presented below:

- **Digital literacy campaign:** A national campaign to improve digital literacy levels across Turkiye, with a particular focus on increasing access to digital skills for individuals living in rural and disadvantaged areas.
- **Expanding ICT infrastructure:** The development of the technological infrastructure necessary for digital skill development nationwide is a key priority. This includes expanding fiber Internet and 5G technologies, which will enhance access to digital services.

- **Strengthening SMEs' digital skills:** Special training programs and support mechanisms will be established to assist SMEs in their digital transformation. These will include training in digital marketing, e-commerce, data analytics, and cybersecurity, along with dedicated advisory services.

- **Advanced technology education:** Universities, technology centers, and private sector partners will collaborate to offer training and certification programs in advanced technology fields, including AI, data science, and the IoT.

The 12th Development Plan (2024–28) and the Medium-Term Program (2025–27) outline significant steps for developing Turkiye's digital skill capacity and building a workforce proficient in ICT. These programs aim to accelerate Turkiye's transition to a digital economy and enhance its global competitiveness by strengthening digital skills. The widespread adoption of digitalization and ICT investments will not only boost workforce productivity but also solidify Turkiye's position in the digital economy.

Policy Recommendations

In the preceding sections, we examined the challenges and opportunities facing Turkish firms in their efforts to integrate into GVCs, with a particular focus on the role of ICT and workforce skill development. Despite significant progress in these areas, policy gaps remain that hinder firms from fully leveraging these advancements to enhance their productivity and competitiveness. Therefore, the following policy recommendations are proposed to address these deficiencies and support the sustainable growth of Turkish firms in the global economy.

Strengthening ICT Infrastructure to Improve Operational Efficiency

To enhance Turkiye's integration into GVCs, it is essential to prioritize the development of a robust ICT infrastructure. Investments in expanding high-speed broadband, fiber-optic networks, and 5G technologies should be intensified, with particular attention given to reducing the disparities between urban and rural areas. The establishment of an equitable and efficient digital infrastructure will not only facilitate the adoption of advanced technologies but also contribute to increasing productivity by minimizing downtime, streamlining production processes, and enabling more efficient use of resources.

Promoting Digital Literacy and Workforce Skill Development

In the context of the digital economy, enhancing digital skills within the workforce is critical. National strategies must be designed to foster collaboration between educational institutions and industries, ensuring that training programs are aligned with the evolving needs of the ICT sector. Lifelong learning initiatives focused on emerging fields such as data analytics, AI, and coding are essential for fostering innovation. Additionally, integrating digital skills with productivity-enhancing methodologies, such as lean management and process optimization, will empower workers to leverage new technologies more effectively, thus driving both innovation and operational productivity in Turkish firms.

Facilitating SMEs' Access to ICT Solutions for Enhanced Productivity

SMEs in Turkiye face significant financial barriers in adopting advanced ICT solutions. To mitigate these challenges, the government should introduce targeted financial incentives, including tax breaks and low-interest loans, specifically designed to facilitate SME investment in digital technologies. Moreover, expanding mobile banking and fintech solutions could improve financial inclusion, particularly for SMEs in rural or underserved areas. By providing these firms with the

resources to adopt digital tools, such as cloud computing and automation platforms, SMEs can automate repetitive tasks, optimize supply chain management, and improve resource allocation, resulting in substantial gains in productivity and competitiveness.

Enhancing Cybersecurity to Build Trust in Digital Solutions

The widespread adoption of ICT requires a secure digital environment, particularly in the face of growing cyber threats. It is crucial to strengthen cybersecurity regulations and offer specialized training programs to SMEs to enhance their resilience against cyberattacks. By fostering greater trust in digital platforms, firms can mitigate operational disruptions caused by cyber incidents, ensuring continuity and efficiency in their business processes. This, in turn, will help to maintain and enhance overall productivity levels across industries.

Encouraging the Adoption of Industry 4.0 Technologies to Drive Productivity

To move beyond low-value-added activities in GVCs, Turkiye must encourage the adoption of Industry 4.0 technologies, such as automation, AI, and IoT. Government policies should focus on providing incentives for R&D in these areas, facilitating technological innovation in manufacturing and services. The integration of Industry 4.0 technologies will significantly enhance productivity by reducing manual labor, minimizing errors, and optimizing production processes in real time. This will allow Turkish firms to achieve higher output with fewer inputs, positioning them as competitive players in the global market.

Implementing Productivity-Focused Digital Transformation Initiatives

In addition to supporting technological advancement, the government should implement targeted digital transformation programs aimed at enhancing productivity, particularly in the manufacturing and services sectors. These programs could provide firms with the tools and expertise needed to apply data-driven decision-making, streamline operations, and reduce inefficiencies. Supporting the adoption of productivity-enhancing technologies, such as big data analytics, machine learning, and cloud-based platforms, will enable firms to monitor performance more effectively and optimize the use of resources. As a result, firms in Turkiye will be better equipped to improve their operational efficiency and competitiveness within GVCs.

Conclusion

This study provides an extensive analysis of the digital transformation journey of Turkish firms, focusing on key areas such as skill development, ICT adoption, productivity, and the challenges that hinder progress. Turkiye's position within GVCs remains predominantly in medium-technology sectors, which limits the country's ability to move towards higher-value-added activities. Enhancing productivity and competitiveness is critical to strengthening Turkiye's role in GVCs and fostering sustainable economic growth.

A major finding of this study is the significant impact of digitalization and ICT adoption on firm productivity. By integrating digital tools such as automation, big data, and cloud computing, Turkish firms can enhance operational efficiency, reduce production costs, and foster innovation. However, the benefits of digitalization are closely tied to the workforce's ability to utilize these technologies effectively. This highlights the importance of skill development, particularly in enhancing digital literacy and fostering the skills necessary for Industry 4.0 technologies. The initiatives under the 12th Development Plan and Medium-Term Program, such as expanding STEM education, lifelong learning programs, and restructuring vocational education, are vital steps towards bridging the skills gap.

The productivity analysis reveals that firms utilizing ICT tools, such as websites, exhibit higher TFP, particularly in production-intensive sectors like textiles, machinery, and fabricated metal products. However, the effects on labor productivity are less consistent, suggesting that digital adoption needs to be accompanied by broader workforce development initiatives to realize productivity gains fully.

The study also identified several constraints, including limited access to finance and inadequate digital infrastructure, which particularly affect SMEs. Expanding financial inclusion through mobile banking and fintech solutions, as well as enhancing cybersecurity to build digital trust, are essential to overcoming these barriers.

Policy recommendations stress the importance of enhancing ICT infrastructure, promoting digital literacy, supporting the adoption of Industry 4.0 technologies, and implementing productivity-focused digital transformation initiatives. By addressing these areas, Turkiye can improve both firm-level productivity and competitiveness, facilitating a shift towards higher-value-added activities in GVCs and solidifying its position in the global economy.

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LIST OF ABBREVIATIONS

12MP	Twelfth Malaysia Plan
AI	Artificial Intelligence
AIM	Amanah Ikhtiar Malaysia
ASEAN	Association of Southeast Asian Nations
BOI	The Board of Investment
BRI	Belt and Road Initiative
CAGR	Compound Annual Growth Rate
Capex	Capital Expenditure
CPI	Consumer Price Index
DCT	Dual-Cooperative Training
DEPA	Digital Economy Promotion Agency
dinf	Inflation
dlnictinv	ICT investment
dlnlbf	Labor Force Participation
dlnlbprd	Labor Productivity
DNF	Digital Nepal Framework
dpopgr	Population Growth
DVX	Domestic Value Added in Export
EEC	Eastern Economic Corridor
E-payments	Electronic Payment
FDI	Foreign Direct Investment
FI	Financial institution
FTA	Free Trade Agreement
FVA	Foreign Value Added
FY	Fiscal Year
GCC	Global Capability Center
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GoI	Government of India
GoN	Government of Nepal
GVC	Global Value Chain
IC	Integrated Circuit

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ICT	Information and Communication Technology
IDI	ICT Development Index
IMF	International Monetary Fund
IoT	Internet of Things
ISP	Internet Service Provider
IT	Information Technology
IT-BPM	Information Technology and Business Process Management
ITU	International Telecommunication Union
KPI	Key Performance Indicator
LAPNet	Lao National Payment Network Co. Ltd.
LCR	Lao-China Railway
LNCCI	Lao National Chamber of Commerce and Industry
lnusrint	Number of Internet Users
lnusrmob	Number of Mobile Banking Users
LP	Labor Productivity
LTE	Long-Term Evolution
Max	Maximum
Min	Minimum
MNC	Multinational Corporations
MOIC	Ministry of Industry and Commerce
MSMEs	Micro, Small, and Medium Enterprises
NBI	National Broadband Initiative
NCR	National Capital Region
NDP	National Development Policy
NEP	New Economic Policy
NICTHS	National ICT Household Survey
NIMP 2030	New Industrial Master Plan 2030
NPC	National Privacy Commission
NRI	Network Readiness Index
NSO	National Statistical Office
NTIS	National Trade Integration Strategy
Obs.	Observations
OECD	Organization for Economic Cooperation and Development
OSAT	Outsource Assembly & Test Services
PDP	Philippine Development Plan

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PEDP	Philippine Export Development Plan
PPP	Purchasing Power Parity
PRC	People's Republic of China
PSA	Philippine Statistics Authority
R&D	Research and Development
SDG	Sustainable Development Goals
SEZ	Special Economic Zone
SICT	Survey on ICT
SME	Small and Medium Enterprises
SMPP	Small and Medium Professional Practices
SPS	Sanitary and Phytosanitary
Std.dev.	Standard Deviation
STEM	Sciences, Technology, Engineering, and Mathematics
TBT	Technical Barriers to Trade
TEKUN	The Economic Fund for National Entrepreneurs Group
TFP	Total Factor Productivity
TVET	Technical and Vocational Education and Training
unemp	Unemployment Rate
USF	Universal Service Fund
WBES	World Bank Enterprise Survey
WDR	World Development Report
WTO	World Trade Organization

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