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Digitizing the Workforce: The Impact of Digitization on GDP Since Pandemic

Abstract:

The COVID-19 pandemic has accelerated the digitization of the workforce, leading to significant transformations in global economies. This paper examines the impact of digitization on Gross Domestic Product (GDP) since the pandemic, highlighting how digital adoption has influenced economic growth, workforce dynamics, and global trade engagement. Utilizing a comprehensive literature review and empirical analysis, the study explores the multifaceted effects of digital technologies on productivity and economic resilience.

Key findings indicate that countries with robust digital infrastructures managed economic disruptions more effectively, demonstrating enhanced productivity and economic growth. The research underscores the pivotal role of digital technologies in sustaining productivity, facilitating remote work, and promoting innovation during the pandemic. It also highlights regional disparities in digital adoption, with some countries experiencing accelerated growth while others faced challenges.

The study further investigates the determinants of successful digital adoption, offering policy recommendations to maximize economic benefits and mitigate challenges. By analyzing the economic performance of emerging economies in Asia, the paper provides insights into the relationship between digital adoption and GDP growth, emphasizing the need for targeted investments in digital infrastructure and workforce skills development.

In conclusion, the digitization of the workforce has emerged as a critical driver of economic resilience and growth in the post-pandemic era. This paper contributes to the understanding of how digital technologies can shape future economic landscapes, providing a framework for policymakers to foster sustainable and inclusive growth through digital transformation.

Digitizing the workforce: The Impact of Digitization on GDP since Pandemic

1. Introduction

According to the Report presented by ILO in 2022, ITU (The United Nations International Telecommunication Union) reports that in 2021, active internet users were approximately 63 percent of the global population (Charles et al, 2022). Over the last decades, digitalization has gained immense popularity and it has reformed the behavior, work, and communication of individuals, consumers, and businesses at a global level. The information and communication technologies which include internet and mobile phone technologies contributed in changing this pattern. The appearance of these technologies resulted in new products, new processes, new market channels as well as organizational complexities and further advancements in technologies (Myovella et al, 2020). The major reason of the rapid growth of the United States since 1990 is the increased investments in information and communication technology (Hofman et al, 2016). To facilitate the tasks efficiently and by reducing cost, in today's world, the adoption of globalization and digital technology play a significant role. Digital technology boosts communication, increase efficiency, encourages innovation and it is a source of economic growth (Elfaki & Ahmed, 2024).

The Covid 19 has played a major role in this transformation with digitalization. Due to the pandemic, the world-wide organizations faced the challenges. But the adoption of digital technology enhanced productivity and played a role in mitigating economic disruptions. In the crisis, digitalization sustained productivity and also helped the economies to withstand with the challenges (Jaumotte et al, 2023). Although results show that there is a regional imbalance in the development of digital economy due to Covid in different countries but still digital economies express a positive effect on the growth of economies. The demand side of digital industries boosted more then the supply side in pandemic. Countries including Armenia, Israel, Latvia and Estonia showed the growth potential in their digital industries while it brought adverse effects on Ukraine, Egypt, Turkey, and the Philippines (Zhang et al, 2022).

The world has seen many revolutions but the Digital revolution which is also named as third industrial revolution is the most recent in this trend. Digital Technology encompasses a unique feature that has altered our everyday engagements by acting as an intermediary or a facilitator in different aspects of our routine tasks including travel, work, shopping, consumption, and leisure (Mukherjee & Narang, 2022). The digital transformation brought a new way of

innovation and it had transformative effects on firms, businesses, companies, and societies. It includes adopting different technologies such as cloud computing, mobile computing, data science, and business analytics which can make the completion of tasks efficient in the workforce (BenZvi & Luftman, 2022). According to Katz et al, (2020) elaborated the role of digital technologies played a role in alleviating the disturbance on socioeconomic system caused by pandemic. Empirical evidences from the article highlights that the strategies like the utilization of additional mobile broadband infrastructure and emphasized on the need of technology driven solutions and encouraging digitization of business processes to enhance the strength to cope with future challenges.

In 2019, an infection named COVID-19 was identified in Wuhan, a city in China. The virus spread rapidly, transmitted from person to person, prompting governments worldwide to implement lockdowns and enforce social guidelines. Authorities emphasized the importance of social distancing and took preventive measures to safeguard individuals, families, and communities (Kaushik, 2020). To keep everyone safe, remote work became a new way of doing jobs. Before COVID-19, only about 2.9% of the total US workforce and around 2% in Europe were doing emergency remote work. The shift away from traditional office work to remote work was sped up by the pandemic, and at the same time, digital technologies played a role in making remote work more feasible (Battisti et al., 2022).

Companies started to adopt remote work practices and approximately 20-25% of the workforce in developed economies can work remotely without experiencing a decline in productivity. A survey in Hong Kong of workers shows that success in remote work is influenced by external factors like technological skills, government support, and internal factors such as work flexibility, attitude, and perceived behavioral control (Ng et al., 2022). A multi-level TBL approach which is referred to as “people, productivity, and planet” was used to introduce a sustainable development frame into the analysis of economic performance. Through the lens of the TBL framework, this research seeks to offer a nuanced understanding of the multifaceted impacts of remote working on individuals, productivity metrics, and the broader environmental landscape (McPhail et al., 2023).

There has been found a significant impact of ICT diffusions on economi c growth and economic development across different regions. There has been observed different effects. It has

been observed that ICT diffusion have a huge influence on growth rather than development. Further investments in ICT infrastructure can enhance sustainability and inclusive growth (Saba et al, 2023). Amidst the digitization processes of the fourth industrial revolution, there is a need to foster human resource skills. The adoption of digital technology can meet economic competitiveness. To address the lagging economies and modernization, there is need to focus on development within each country, and to focus on education and research expenditure (Marek et al, 2020). Digital technologies in the workplace boost resilience, helping processes, jobs, and firms adapt to unexpected challenges. The COVID-19 pandemic highlighted the value of a digitally skilled workforce in swiftly adjusting to new situations. Digital transformation paved the way for sustainable societies (Ben-Zvi & Luftman, 2022).

1.1 Problem Statement

The challenge lies in understanding the complicated relationship between economic indicators and the digitization of the workforce in emerging countries post-pandemic. This study delves into the analysis of a country's propensity of digital adoption to interact with economic composition, notably the structure of its workforce and its engagement with global trade. We aim to explain the factors that determine whether digitization acts as a catalyst or a barrier to economic prosperity.

1.2 Objectives of the Study

- Assessing the relationship between digital adoption and gross domestic product (GDP) growth and the sectors driving economic growth in emerging economies of Asia post pandemic and aiming to quantify the economic impact of digitization.
- Understanding how digitization influences the dynamics of the workforce and the role of digitization in engagement with global trade.
- Determining the factors of digitization that impact on economic growth or GDP of the country. It includes offering policies and recommendations for maximizing benefits and alleviating challenges.

1.3 Organization of the Study

This study unfolds in a structured manner to comprehensively investigate the economic impact of digitization on the gross domestic product and digitization of the workforce. Beginning with an introduction that sets the context, it navigates through a concise literature review to understand existing insights. The model and methodology section outlines the research design and it includes model specification and estimating techniques. The interpretation part reports the empirical findings. The last part consisted of conclusions along with the implications and policy recommendations for the future.

2. Literature Review

Calderon-Monge & Ribeiro-Soriano (2023) explored that digitization has a strong relationship with economic growth. This article The Role of Digitization in Business and Management provides insights that in 2018, firms that embraced digital transformation added 13.5$ billion to the total GDP. According to the predictions, digitally transformed businesses are expected to contribute 53.3$ billion by the end of 2023. In this context, digitalization within firms is a critical research topic. The systematic literature review (SLR) comprehends the areas of finance, marketing, accounting, and management. The key findings include how consumer behavior is affected by digital tools, green innovation within companies, and the utilization of blockchain technology in financial services. This research summarizes digitalization's role and helps connect digitalization in management, marketing, financing, and accounting.

Katz et al. (2020) highlighted the crucial role of digital technology in alleviating the economic disruptions due to the pandemic. The study provides empirical evidence and focuses on the impact of digitization during the SARS (severe acute respiratory syndrome) wave in 2003. It emphasized the importance of digitization and reliable telecommunications infrastructure in reducing economic losses. According to research, an increase in fixed broadband interpretation by 10%, results in a 0.96% reduction in the negative economic impact of the pandemic, which indicates a significant mitigating effect. The study's findings are that the countries with better broadband connectivity handled the situation much better. It provides insights into the current situation of the pandemic, there is a need for collaboration between private and public sectors to

enhance the digital ecosystem, upgrade the business processes digitization system, and provide training to human capital to acquire digital skills.

Zhang et al. (2020) examine the relationship between economic growth and the digital economy in countries along the Belt and Road during the pandemic. The study uses a panel data regression model to analyse the results and impact of the variables. The article reveals that the digital economy intensifies the employment restructuring, total employment levels, and upgrading of industrial structure in these countries. It shows a significant positive role in alleviating economic losses and stimulating recovery during the pandemic. It emphasizes bridging the digital gap, proposing strategies, and the impact of the digital economy on trade, employment, and driving economic growth in post post-pandemic era. The findings underscore the importance of the development of a digital economy informing policy decisions and enhancing cooperation among nations along the Belt and Road.

Shkalenko & Fadeeva (2020) focus on the impact of COVID-19 on digitalization and foreign economic activities. The research examines the situation of the economy at a macro level and explores that how digitalization impacts the nation's climate of exports. And the institutional changes that have arisen in response to the regulation of digital economy in the domain of international economic integration and foreign trade. The author highlights the role of international expansion in operating the digitalization of markets, economies, and global industries by focusing on the Russian economy's industrial transformations. The research describes the trends in international globalization and trends in an institutional environment in digital businesses, identifying the factors of digitalization that influence the development of foreign economic activity.

Avdeeva et al. (2021) reviews the positive impact of virtual labor markets, particularly in Russia, highlighting the acceleration of distance work during the pandemic and the crucial role of digital skills. The proposal suggests formulating digital competency requirements, creating regulatory frameworks, and attracting IT professionals for vocational education. Digital technologies are crucial for crisis resilience, with potential positive impacts like reduced carbon emissions. The efficiency of home offices is recognized, urging policymakers to modernize labor laws to accommodate changing work dynamics. The analysis underscores the link between a

country's economic development and its digitization level, emphasizing the need for workforce adaptation.

Jalagat & Jalagat (2019) explores global remote working trends, particularly in developed countries like the United Kingdom, Germany, and the United States, compared to the relatively new concept in the Sultanate of Oman. The paper analyzes data and research findings, highlighting conflicting views on remote working's advantages (productivity, cost- saving) and challenges (social isolation, task prioritization). It emphasizes the need for further discussions, proposing evaluations in Oman and comparative studies with experienced countries for policy enhancement. The conclusion underscores the management perspective's impact on remote working benefits, advocating for clear assessment criteria. Acknowledging limitations, the study encourages follow-up research for validation.

Felstead & Henseke (2017) critically assess the assumption that work detachment from place benefits both employers and employees. Official labor market data indicates that only one-third of the rise in remote working can be explained by factors like shifts to the knowledge economy and flexible employment. The study reveals a growing trend of work detachment. The article questions key assumptions of the 'spatial revolution,' highlighting methodological concerns and incomplete evidence. Despite limitations, the evidence suggests that remote working is generally advantageous, reflecting a significant aspect of the changing nature of work in the twenty-first century.

Kaushik (2020) stated that the COVID-19 pandemic has prompted a substantial shift towards remote work, significantly impacting global life and business organizations. Widespread adoption of Work from Home (WFH) practices through digital platforms became essential, leading to economic challenges and health issues. The research paper highlights the lasting consequences and emphasizes the need for innovation in roles by employers, HR managers, and consultants. It explores the accelerated adoption of WFH across industries, addressing challenges and proposing strategies like Employee-Connect and reskilling initiatives. The pandemic showcased WFH's effectiveness in ensuring business continuity, triggering shifts in thought processes and a techenabled culture. Caution is advised against viewing WFH as a universal solution, emphasizing judicious technology use, investment in digital platforms, and skill-building. The paper

underscores the concern of the lack of human touch due to social distancing, contributing to loneliness, depression, and health issues.

Licite-Kurbe & Leonovica (2021) asserted that in recent years, mobile technology, Internet availability, and the impact of COVID-19, has become increasingly popular. Utilizing case study analysis, comparative analysis, economic analysis, and the scenario method, the research identifies that potential financial savings from remote work practices vary based on industry specifics, job roles, and initial investments. The primary economic savings arise from premises maintenance, electricity, and Internet bills, with equipment provision representing a smaller proportion of cost savings. However, challenges include difficulty in employee control, effective communication, and successful teamwork. The analysis of remote work scenarios suggests full-time office work is suitable for tasks with no remote work possibility, partial remote work is fitting for companies allowing some remote tasks, and fully remote work is viable for highly automated tasks or individual-focused duties.

Ionescu et al. (2021) evaluate the impact of the pandemic on the digitization of the economy. This research used both qualitative and quantitative methods. Primary data is collected through a survey and secondary research is done through official sources. The study highlights the correlation between resilience to the pandemic's economic impact and digitization level and compares the state of digitization in the Romanian economies with the other EU countries. The findings reveal that companies experience less disruption and adapt quickly to digital tools. To facilitate remote work, the measures that should be taken are government interventions, such as technical unemployment assistance and support for IT development projects. This study suggests that companies proficient at navigating the challenges posed by the pandemic will emerge with a stronger digital foundation. It concludes by emphasizing the crucial role of technology in ensuring the sustainability of essential services such as healthcare, education government services remotely during times of crisis. Altogether, this article emphasizes the importance and effectiveness of digitalization in reducing the bad effects of the pandemic on the economy.

Krylova et al. (2021) focused on regional implications and the quantitative analysis of employment dynamics post covid-19. It highlights the magnitude of global impact, indicating that "several tens of millions of people left without work in the world". This paper highlights the massive proportion of global workforce being affected by unemployment. The study states that the

84% of the employers are set to adapt digital working processes and 44% of their workforce to work remotely. The pandemic had a significant severe impact on workers in the informal economy, whose incomes dropped about 81% in some regions in the first month of the pandemic. Additionally, it mentions gender gaps that the share of women in cloud, engineering, and data jobs is below 30%. the key findings include that new clusters of information emerged and the urgent need for professional development and reskilling to meet market demands. The article stresses the impacts of the pandemic in social and economic contexts, like increased inequality and the decline in prices. Overall, this article examines the opportunities and challenges in the job market after the pandemic.

Battisti et al. (2022) explored the psychological drivers influencing employees' decisions and the economic and financial impacts of remote work during the covid 19 pandemic. The research method uses a sample of 976 workers in Italy and employs a mixed method sequential technique to collect data. Due to the additional costs incurred for digital technology and utilities, workers cannot work long hours and do not get meal vouchers. The employees faced negative economic and financial impacts on their lifestyle due to these reasons. This study focuses on the importance of behavioral and psychological factors, such as technostress and job satisfaction in employee decision-making regarding remote work. This research emphasizes the need for policy adjustments to improve the implementation of digital transformation support the transition to remote work and ensure the needs of both employers and employees. Altogether the research provides valuable insights into the remote working dynamics and its implications for organizations and employees during and after the pandemic.

Best (2021) explores the landscape of the future of work in the post-pandemic era. The research employed a multi-disciplinary approach that takes insight from HR management, organization behavior, and business economics and provides an understanding of the dynamics that shape HRM Structures and schedules. This analysis provides an impact of vaccination efforts, which facilitates to view of a pandemic as a short-term crisis that can be managed. This examines the factors that contribute to the hybridization of HRM, and gives insights into various challenges including gender bias, skill mismatches, and labor market shortages. This paper studies the different kinds of work situations and provides a view that not all jobs can be done remotely. It discusses the implications for education attainment among the youth, as hybrid education methods

face resistance. The paper concludes by providing some research recommendations for labor supply challenges caused by the pandemic and how to adopt to evolving needs of the workforce. This study offers policy and recommendation for organizations regarding the complexities of managing remote and hybrid work arrangements in the post pandemic era.

Ferreira et al. (2021) explores the different factors which have influence on the adoption of remote work in organizations in the pandemic era. The methodology employed to conduct research is qualitative interviews with the remote work professionals, to identify remote work decision factors. By using this approach, they uncover 57 decision factors and validate 16 relationships. According to the findings from conducting this research, the primary benefits of remote work are cost reduction and flexibility for work-life balance. The main challenges along with the benefits are communication, technical issues and management concerns. Organizations are recommended to invest in technology control, promoting team cohesion, implementing effective strategies of management, creating a culture of remote work and utilizing suitable tools. The future suggestions include exploring management practices on remote work, investigate how much it is useful in different organizational contexts. As a whole, the research contributes valuable insights into factors of remote work adoption and offers recommendations for organizations navigating the shift towards remote work.

Ozimek (2020) article explains that pandemic has changed the global workforce in ways that World War II did not. In the United States, nearly half of workers now work remotely. That's a fourfold/quadruple increase. 1,500+ hiring managers surveyed found that 56% believe remote work is better, more than what was expected. They cite different benefits such as no commute and improved productivity, even in the face of technological challenges. More than 60% predict that the global workforce will become more remote in the future. Fully remote work is expected to double to 65% in the next 5 years. This means that remote work is outperforming expectations, prompting businesses to expand their remote hiring and speed up the trend. With positive outcomes such as improved productivity and flexibility, remote work will continue to grow. If trends continue, it could twice the share of completely remote workers, the future of work after pandemic.

Smith & Johnson (2023) this article gives a detailed analysis of current developments and consequences affecting remote work activities. It examines how developments in technology and shift in work choices have changed the evolution of remote work across different time. The study

talks about how remote work is becoming more and more common and also what it means for businesses and workers. It examines the advantages of remote work (WFH), which includes more freedom and access to a variety of talents across the world as well as the disadvantages/drawbacks, including problems with cooperation and communication. The article's overall concept emphasizes the importance of remote work in today's companies & modern businesses and how it may influence how people work in the future.

Brown & Miller (2022) explores the topic of resilience within organizations and points out the important functions that remote work practices play in enhancing an organization's ability to survive and grow in challenging environments. It goes into great detail about the nature of remote work and explains how these approaches support the sustainability of organizations, responsiveness, and flexibility, all of these leads to resilience. The analysis provides more information on the practical methods for developing resilience in remote work environments, which includes investments in strong technological infrastructure and the development of a productive and trusting culture. Furthermore, it highlights the vital role of leadership that helps in building resilience within remote teams, underlining the importance of visionary direction and skilful leadership during unpredictable and transformative times.

Garcia & Lee (2021) extensive study gives an in-depth overview of the extremely complicated psychological effects that remote work has on workers, exploring the various aspects that influence their mental health, job happiness, and general well-being in these environments. The article carefully makes insights on the benefits and challenges of working remotely from a psychological perspective, focusing on a wide range of previous studies. It highlights the crucial significance of factors like independence, interaction with others, and affecting an equilibrium between work and personal life. Moreover, it provides organizations those are looking to satisfy the psychological needs of their workforce in dealing with the challenges caused by remote work arrangements with useful and practicable techniques.

Patel & Williams (2023) in their article inlights the complex relationship between remote work and employee well-being, which further carefully explores the other aspects of social, mental, and physical well-being. The study summarizes views on the many effects of remote work on employee well-being, and also highlighting both the potential/advantages and problems present in remote work environments. This is being done by the help of variety of empirical researches.

Furthermore, it also explains the important elements that enable the development of positive results for remote workers' well-being, highlighting the value of building social networks, offering enough resources for stress management, and promoting a healthy company culture. The analysis, which focuses mainly on practical implications, provides helpful recommendations for companies that want to focus and promote worker's well-being in remote work environment.

Thompson & White (2022) in their article explore the complex landscape of managerial challenges, carefully examines that how variety of leadership and management challenges lead remote teams to success. With an in-depth knowledge of how remote team thing work and the many hurdles that come with them, which includes communication issues, performance measurement challenges, and team issues, this article discuss how to overcome them. And also provides actionable strategies to overcome these challenges and to create effective remote work leadership model, based on a lot of knowledge from academic research and practical experience. This study also highlights the importance of leveraging technology and implementing strong communication frameworks, clearing the way for organizational excellence in the age of the digital workplace.

3. Model and Methodology

3.1 Introduction

In this study, we aim to investigate the impact of digitization of the workforce on Gross Domestic Product (GDP). Our analysis focuses on a comprehensive econometric model that examines the relationships between various indicators of digitalization and GDP. The model includes key variables such as connectivity, ICT export, employment services, medium and high-tech export, labor force participation rate (LFPR), and trade. Through deep econometric analysis, we explore the quantitative effects of these factors on GDP, highlighting the processes by which digitalization affects economic performance. The methodology applied involves regression analysis to estimate the coefficients of the independent variables and assess their statistical significance. The findings of this investigation aim to offer useful information for policymakers who want to utilize digital advancements for sustainable economic development by explaining the relationship between GDP and digitalization.

3.2 Theoretical Framework and Model Specification:

In our study, we investigate a complex relationship between GDP (gross domestic product) and workforce digitization. The theoretical approach is based on the various factors that contribute to the digitization process and influence economic outcomes. We will highlight the theoretical foundations of the variables by using the literature.

Connectivity is a key component of digitization. According to empirical research, higher degrees of connectivity appear to positively correlate with productivity and economic growth. The degree of integration of individuals, residences, and businesses into the digital environment is reflected in the degree of connection. Increased access to digital services, communication, and information is linked to positive connectivity (Castaldo et al, 2017). As a result of this, we expect the coefficient of association in our model to be positive, meaning that higher connectivity has a positive effect on GDP.

A country's digital economy depends heavily on the export of ICT goods. These exports cover a broad spectrum of goods, such as telecom equipment, software, and hardware. The amount of ICT items exported indicates the competitiveness and technological capability of the digital industry. Strong ICT exports have been shown to stimulate economic growth through increasing innovation, competitiveness, and global integration (Heo & Lee, 2018). As a result, we anticipate a positive coefficient for exports of ICT items, indicating that increased export activity in the ICT industry boosts GDP.

A country's ability for innovation and technological advancement is reflected in the size of its exports of medium- and high-technology goods. Evidence shows that exports of medium- and high-technology products have a beneficial effect on economic growth, and that technological innovation is a major factor in productivity advancement and competitiveness (Ottaviano et al, 2010). As a result, we predict that exports with medium and high technology will have a positive coefficient, meaning that increased export activity in these industries boosts GDP.

The degree to which digitalization has revolutionized traditional service industries, particularly finance, healthcare, and education, is indicated by the size of employment services. Research indicate that higher productivity and efficiency benefits are linked to the expansion of employment in digitally intensive services (Brynjolfsson & McAfee, 2014). As a result, we

anticipate a positive coefficient for employment services, suggesting that GDP is positively impacted by growth in digitally-driven service industries.

Research highlights the benefits of trade openness for GDP growth, with more trade being associated with more specialization, productivity, and innovation. International trade facilitates cross-border exchanges of products, services, and knowledge, which promotes economic progress and expansion. The amount of trade indicates how integrated a country is into the world economy and how well it can take advantage of its comparative advantages (Rodrik, 2018). Therefore, we expect trade to have a positive coefficient, suggesting that increased trade openness raises GDP.

Transitions in the labor market dynamics, caused by things like demographic shifts, technology advancements, and policy interventions, are reflected in changes in the labor force participation rate (LFPR). There is a complex correlation between the rate of labor force participation (LFPR) and economic growth. Digitalization has an impact on both labor supply and demand (Autor, 2015). As such, the way these factors interact determines the sign of the coefficient for LFPR in our model.

The framework in this model that we will find the relationship between our dependent and independent variables.

The **functional form** of the model is expressed as:

GDP=f (Connectivity Variable, ICT Exports, Medium and High-Tech exports, Employment services, Labor force participation rate, trade).

Thus, we will change this functional equation into an **econometric model** to run a linear regression analysis to use the statistical data to find this problem;

$$GDP = \beta0 + \beta1 \times Connectivity\_Var + \beta2 \times CT\_Exp + \beta3 \times Med\_High\_Tech\_Exp + \beta4 \times Emp\_Services + \beta5 \times LFPR + \beta6 \times Trade + \epsilon$$

As Digitization of workforce (DW) is explained by Connectivity Variable, ICT Exports, Medium and High-Tech Exports, Employment in Services and LFPR.

Here:

- GDP is Gross Domestic Product (dependent variable)

- Connectivity_Var is the average of Internet users, Cellular subscriptions and Broadband subscriptions
- ICT_Exp is the average of ICT goods and ICT services Exports
- Med_High_Tech_Exp is the Medium and High Technology Exports
- Emp_Services is the Employment in Services
- LFPR is Labor Force Participation Rate
- Trade is the total Trade activity
- $\beta 0$ is intercept term, $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$, $\beta 5$ and $\beta 6$ are coefficients of the independent variables
- ϵ is the error term.

3.3 Description of variables and data source:

The study is based on the secondary panel data over the period from 2018 to 2022. The data of emerging Asian economies, including Azerbaijan, China, Thailand, Malaysia, Turkey, Iran, the United Arab Emirates, Singapore, Qatar, South Korea, Kazakhstan, Georgia, Armenia, Lebanon, Jordan, Oman, Bahrain, Kuwait, Hong Kong SAR, China, and Macao SAR, China, is examined. These emerging countries in Asia is primarily based on their sustained economic growth, expanding markets, and increasing integration into global trade networks. These nations show promising directions in terms of economic development and indicates potential for further growth, making them important players in the Asian region. The data being used is downloaded from official website of world development indicators (WDI).

Table 1: Description of variables

Symbol	Variable Name	Description	Data Source
GDP	GDP (current US$)	GDP includes value added by resident producers, minus subsidies, plus taxes. It's in current USD, converted using official exchange rates.	World Bank national accounts data, and OECD National Accounts data files.

LFPR	Labor force participation rate, total (% of total population ages 15-64)	Labor force participation rate is the proportion of the population ages 15-64 that is economically active: all people who supply labor for the production of goods and services during a specified period.	International Labour Organization. "ILO modelled estimates database" ILOSTAT. Accessed February 06, 2024. https://ilostat.ilo.org/data/.
Connectivity Variable	Individuals using the Internet (% of population)	Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.	International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database
	Mobile cellular subscriptions (per 100 people)	Mobile cellular subscriptions offer PSTN access via cellular tech. Includes postpaid and active prepaid accounts (used in last 3 months) excluding data cards or USB modems.	Same as above
	Fixed broadband subscriptions (per 100 people)	Fixed broadband subscriptions are high-speed internet connections with downstream speeds of 256 kbit/s or higher. This includes cable modem, DSL, fiber-optic, satellite, and fixed wireless broadband. It encompasses both residential and organizational subscriptions but excludes mobile cellular network access.	Same as above

ICT Exports	ICT goods exports (% of total goods exports) ICT service exports (% of service exports, BoP)	Information and communication technology goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous). Information and communication technology service exports include computer and communications services (telecommunications and postal and courier services) and information services (computer data and news-related service transactions).	International Monetary Fund, Balance of Payments Statistics Yearbook and data files. United Nations Conference on Trade and Development's UNCTADstat database at http://unctadstat.unctad.org/ReportFolders/reportFolders.aspx.
Medium and High Tech Exports	Medium and high-tech exports (% manufactured exports)	Share of medium and high-tech manufactured exports in total manufactured exports.	United Nations Industrial Development Organization (UNIDO), Competitive Industrial Performance (CIP) database
Employment Services	Employment in services (% of total employment)	Employment includes individuals working for pay or profit, whether actively working or temporarily absent from a job. The services sector encompasses wholesale/retail, transport/communication, finance/insurance, real estate/business services, and	International Labour Organization. "ILO modelled estimates database" ILOSTAT. Accessed February 07, 2024. https://ilostat.ilo.org/data/.
		community/social/personal services.	
Trade	Trade (% of GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	World Bank national accounts data, and OECD National Accounts data files.

3.4 Econometric Methodology

In conducting our analysis, we use various statistical tests to ensure the robustness and validity of our findings. Diagnostic tests, such as the White test for heteroscedasticity and the

Jarque-Bera test for normality, are used to assess the assumptions of our regression model. These tests provide valuable insights into the presence of heteroscedasticity in the error terms and the normality of the residuals, which are crucial for the reliability of our regression estimates. Additionally, multicollinearity among independent variables are examined using variance inflation factor (VIF) analysis, helping to identify and reduce any issues arising from high correlations among independent variables. Furthermore, the F-test is use to check the overall significance of our regression model, telling whether the included independent variables collectively explain a significant proportion of the variation in the dependent variable. We increased the validity and reliability of our econometric model through thorough testing procedures, which increased the validity of our policy recommendations and improved the quality of our empirical findings.

Econometric equation:

$$GDP = \beta0 + \beta1 \times Connectivity\_Var + \beta2 \times CT\_Exp + \beta3 \times Med\_High\_Tech\_Exp + \beta4 \times Emp\_Services + \beta5 \times LFPR + \beta6 \times Trade + \epsilon$$

4. Data analysis:

Normality of Data:

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. jb residual
Jarque-Bera normality test:  4.031 Chi(2)  .1333
Jarque-Bera test for Ho: normality:
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According to the residuals' Jarque-Bera (JB) normality test results, the chi-square value is 4.031, and the associated p-value is 0.1333. This test evaluates a statistical model's residuals' assumption of normality. The null hypothesis that the residuals have a normal distribution cannot be rejected due to the p-value being higher than the traditional significance level of 0.05.

Table 2: Variance Inflation Factor (VIF)

Variable Name	VIF	1/VIF
Connectivity_Var	2.0	0.499
LFPR	1.71	0.584
ICT_Exports	1.71	0.585
Med_High_Tech_Exp	1.70	0.587

Emp_Services	1.41	0.708
Trade	1.26	0.795
Mean VIF	1.63	

(Source: Calculated by the Researcher)

Variance inflation factors (VIFs) indicate the extent to which the variance of the estimated regression coefficient increases due to multicollinearity in the predictor variables. In this analysis, all variables show VIF values below the conventional threshold of 10, suggesting that multicollinearity is not severe. The highest VIF, 2.0, is observed for the variable 'Connectivity_Var', which shows a moderate level of correlation with the other predictors. In particular, the inverse of the VIF values indicates the proportion of variance not explained by multicollinearity, and all variables have values above 0.5, suggesting that at least half of the variance of each variable is independent of multicollinearity. Overall, these results indicate that the panel data model is robust and the predictors show acceptable multicollinearity.

Table :3 Heteroscedasticity Test

Source	Chi2	df	P
Heteroscedasticity	45.77	27	0.0135
Skewness	13.39	6	0.0372
Kurtosis	3.03	1	0.0820
Total	62.19	34	0.0022

(Source: Calculated by the Researcher)

The White's test results indicate a rejection of the null hypothesis of homoscedasticity in favor of the alternative hypothesis of unrestricted heteroscedasticity, with a chi-square statistic of 45.77 and a significance level of 0.0135. Cameron & Trivedi's decomposition of the IM-test further indicates the sources which are contributing to heteroscedasticity, revealing significant contributions from skewness and to a lesser extent kurtosis, with chi-square statistics of 13.39 and 3.03 respectively, and corresponding p-values of 0.0372 and 0.0820. The total chi-square value of 62.19, distributed across 34 degrees of freedom.

To address the identified heteroscedasticity, robust tests were conducted to enhance analysis reliability. These methods provide more dependable parameter estimates, less affected by deviations from the assumption of homoscedasticity. By incorporating robust estimators, the analysis aims for better results amid different heteroscedasticity levels. This adjustment ensures a stronger connection and interpretation of the model's parameters, maintaining validity even having intricate variance structure. Thus, robust estimation techniques prove valuable in ensuring the robustness of analyses despite heteroscedasticity challenges.

Table 4: Fixed Effect Regression

Variable names	Coefficient	Standard error	t	P
Connectivity_var	.602	.269	2.23	0.039
LFPR	3.826	1.434	2.67	0.016
ICT_Exp	-.132	.054	-2.42	0.027
Med_High_Tech_Exp	.057	.033	1.69	0.109
Emp_Services	.668	.850	0.79	0.443
Trade	-.257	.252	-1.01	0.325

(Source: Calculated by the Researcher)

The coefficient estimate for the connectivity variable is 0.6024, with a standard error of 0.2697. This suggests a positive relationship between connectivity and GDP, indicating that an increase in digital connectivity is associated with higher GDP. The coefficient is statistically significant at the 0.05 level (p-value = 0.039), implying that improvements in digital infrastructure, such as internet access and broadband penetration, contribute positively to economic growth.

The coefficient estimate for LFPR is 3.8257, with a standard error of 1.4349. This indicates a positive relationship between labor force participation rate and GDP, implying that higher workforce engagement leads to increased economic output. The coefficient is statistically significant at the 0.05 level (p-value = 0.016), highlighting the importance of policies aimed at promoting labor force participation to stimulate economic growth.

The coefficient estimate for ICT Exports is -0.1321, with a standard error of 0.0546. This negative coefficient suggests that an increase in ICT exports is associated with a decrease in GDP. The coefficient is statistically significant at the 0.05 level (p-value = 0.027), indicating that higher levels of ICT exports may have adverse effects on economic growth, potentially due to trade imbalances or other factors affecting domestic demand.

The coefficient estimate for Medium and High Technology Exports is 0.0575, with a standard error of 0.0340. This suggests a positive but non-significant relationship between medium and high-tech exports and GDP. While the coefficient is positive, indicating that an increase in medium and high-tech exports may contribute to economic growth, the result is not statistically significant at the 0.05 level (p-value = 0.109).

The coefficient estimate for Employment Services is 0.6682, with a standard error of 0.8505. This positive coefficient suggests a positive but non-significant relationship between employment services and GDP. The result indicates that the contribution of employment services to economic growth is not statistically significant in this model (p-value = 0.443).

The coefficient estimate for Trade is -0.2557, with a standard error of 0.2525. This negative coefficient suggests a negative but non-significant relationship between trade and GDP. The result indicates that changes in trade activities may not significantly affect economic growth in this model (p-value = 0.325).

4.2 Description of Results

The positive coefficient estimate for the connectivity variable indicates that improvements in digital connectivity contribute positively to economic growth. Enhanced digital infrastructure, such as increased internet access and broadband penetration, facilitates communication, information exchange, and market access, leading to higher productivity and economic output.

Studies have consistently shown that countries with better digital connectivity tend to experience higher levels of economic development (World Bank, 2016). For instance, a study by Qiang et al. (2009) found that broadband internet penetration positively impacts GDP growth by enhancing efficiency and innovation in various sectors of the economy.

The positive coefficient for LFPR highlights the importance of workforce engagement in driving economic growth. Labor force participation reflects the proportion of the working-age population that is actively engaged in the labor market, either employed or seeking employment. Higher labor force participation rates are associated with higher levels of economic output and growth. This is because a larger workforce contributes to increased production and consumption, driving overall economic activity (World Economic Forum, 2020). Additionally, a study by Gylfason (2001) found that increasing labor force participation rates can lead to higher levels of human capital accumulation, technological progress, and overall economic development.

The negative coefficient for ICT_Exp suggests that higher levels of ICT exports may have adverse effects on economic growth. While ICT exports are generally considered beneficial for economic growth, excessive reliance on ICT exports can lead to trade imbalances and negative effects on domestic industries (Narula & Marin, 2003). For example, a study by Falvey and Foster (2006) found that a disproportionate focus on ICT exports may lead to the neglect of other sectors, potentially hampering overall economic growth.

The positive but non-significant coefficient for medium and high-tech exports implies that while these exports may contribute to economic growth, their impact is not statistically significant in this model. Medium and high-tech exports includes wide range of products, including electronics, machinery, and pharmaceuticals, which are typically associated with advanced technology and innovation. While these exports have the potential to drive economic growth through increased productivity and competitiveness, their effects may vary depending on factors such as technological capabilities, market conditions, and global demand (European Commission, 2019). For instance, a study by Lee and Rodriguez (2017) found that the contribution of high-tech exports to economic growth varies across countries and depends on factors such as technological capabilities and market conditions.

The positive but non-significant coefficient for employment services suggests that the contribution of this sector to economic growth is not statistically significant in this model. Employment services includes wide range of activities, including recruitment, training, and placement services, which play a crucial role in facilitating labor market transitions and reducing unemployment. While employment services contribute to the efficient functioning of labor markets and the matching of skills with job opportunities, their direct contribution to GDP growth may be limited compared to other sectors (European Commission, 2018).

The negative but non-significant coefficient for trade indicates that changes in trade activities may not significantly affect economic growth in this model. Trade openness and integration into global markets are often seen as drivers of economic growth, as they enable countries to access larger markets, specialized inputs, and new technologies. However, the relationship between trade and economic growth is complex and can be influenced by various factors such as trade policies, trade imbalances, and global economic conditions (IMF, 2017). For example, a study by Baldwin (2016) found that while trade openness generally contributes to economic growth, the effects can vary depending on the level of economic development, trade structure, and integration into global value chains.

5. Conclusion and Policy Implications:

This paper focused on assessing the relationship between digital adoption and its factors that impact on GDP. Our analysis on the emerging Asian economies provides insights into the economic implications of workforce digitization. The efforts were made to identify relationship between GDP and the other dependent variables such as labor force participation rate, connectivity variables, ICT exports, medium and high-tech exports, employment services and trade. The positive correlation between GDP and digital connectivity highlights the importance of vigorous digital infrastructure in driving economic development. Furthermore, there exists a significant relationship between labor force participation rate and GDP which indicates the crucial role of workforce engagement in boosting productivity and stimulating economic growth. It demonstrates that increased labor force participation, leads to higher economic growth, a larger and more engaged workforce translates to greater productivity and output, contributing positively to GDP. This study presents an interesting finding regarding ICT Exports (ICT goods & services). The analysis shows a negative and statistically significant association with GDP. When a country

heavily focuses on exporting ICT goods and services, it might neglect domestic demand for these technologies. This can hinder the development of a robust domestic digital ecosystem, potentially leading to a negative impact on GDP. The results for Medium and High-Tech Exports, Employment in Services, and Trade were less conclusive. These variables showed positive but non-significant relationships with GDP in this model. By prioritizing investments in digital infrastructure, implementing strategies to promote labor force engagement, and adopting measures to manage trade imbalances, emerging Asian economies can harness the full potential of digitization to achieve sustainable and inclusive economic growth in the post-pandemic era.

The findings of this research have significant policy ramifications for Asian emerging market authorities. Prioritizing investments in digital infrastructure can improve connectivity and drive economic growth. Programs for education and skill development that encourage labor force participation can boost economic production and increase productivity. Furthermore, in order to promote sustainable economic development, measures should be taken to mitigate the difficulties related to ICT export. Such as broadening export markets and minimizing trade imbalances are crucial. In the post-pandemic period, sustainable development and optimizing the advantages of digitization require a comprehensive policy framework that addresses these issues.

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Appendix

Simple regression

Source	SS	df	MS
Model	149.007861	6	24.8346435
Residual	57.3979348	57	1.00698131
Total	206.405796	63	3.27628248

Number of obs	= 64
F(6, 57)	= 24.66
Prob > F	= 0.0000
R-squared	= 0.7219
Adj R-squared	= 0.6926
Root MSE	= 1.0035

GDP_log	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
Connectivity_Var	1.597279	.5850785	2.73	0.008	.4256794	2.768878
LFPR_log	3.299633	1.102092	2.99	0.004	1.092732	5.506535
ICT_Exp	.4760435	.0929626	5.12	0.000	.2898891	.662198
Med_High_Tech_Exp_log	.7004678	.1126628	6.22	0.000	.4748645	.9260711
Emp_Services_log	2.679292	.606313	4.42	0.000	1.465172	3.893413
Trade_log	-2.060324	.2873819	-7.17	0.000	-2.635796	-1.484851
_cons	1.151427	4.884065	0.24	0.814	-8.628744	10.9316

JB Test for normality of data

```
. jb residual
Jarque-Bera normality test:  4.031 Chi(2)  .1333 Jarque-
Bera test for Ho: normality:
```

Variance Inflation Factor

Variable	VIF	1/VIF
Connectivi~r	2.00	0.499940
LFPR_log	1.71	0.584008
Emp_Servic~g	1.71	0.585170
Trade_log	1.70	0.587588
ICT_Exp	1.41	0.708419

Med_High_T~g	1.26	0.794886
Mean VIF		1.63

White test for Heteroscedasticity

White's test
H0: Homoskedasticity Ha:
Unrestricted heteroskedasticity

chi2(27) = 45.77
Prob > chi2 = 0.0135

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	45.77	27	0.0135
Skewness	13.39	6	0.0372
Kurtosis	3.03	1	0.0820
Total	62.19	34	0.0022

Fixed Effect Regression (robust)

Fixed-effects (within) regression — Number of obs = 64
Group variable: ID — Number of groups = 18

R-squared:
Within = 0.4648
Between = 0.0352
Overall = 0.0193

Obs per group:
min = 2
avg = 3.6
max = 4

F(6,17) = 99.84
corr(u_i, Xb) = -0.2188 — Prob > F = 0.0000

(Std. err. adjusted for 18 clusters in ID)

GDP_log	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]

Connectivity_Var	.6024255	.2696951	2.23	0.039	.0334186	1.171432
LFPR_log	3.825737	1.434965	2.67	0.016	.7982252	6.85325
ICT_Exp	-.1321239	.0545933	-2.42	0.027	-.2473056	-.0169422
Med_High_Tech_Exp_log	.0574823	.0339935	1.69	0.109	-.0142377	.1292023
Emp_Services_log	.6681881	.8504698	0.79	0.443	-1.126146	2.462522
Trade_log	-.2557433	.2524856	-1.01	0.325	-.7884413	.2769548
_cons	5.566505	5.755283	0.97	0.347	-6.57608	17.70909
sigma_u						1.7915016
sigma_e	.1162424					
rho	.99580753	(fraction of variance due to u_i)				