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Digital Economy, A Catalyst for Pakistan's Economic Growth

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Abstract

This study explores the impact of main indicators from the digital economy on Pakistan's economic growth from 1995 to 2023. For the data, this study uses the Autoregressive Distributed Lag (ARDL) model. The analysis includes the study's results for the long and short term impacts of the GDP and five factors: ICT, education, internet usage, mobile network subscriptions and trade openness. According to the findings, ICT investment and mobile network subscriptions are the main reasons behind the increases in GDP over time. Alternatively, education and internet use actually relate negatively to GDP over a long period. This may happen because of preferring quantity over quality, limited applicability of education and internet usage in Pakistan. This suggests that apart from poor schooling, being without fair digital skills and not using the internet for financial benefit may be two more possible causes. Even with open trade, countries may suffer from lower growth because of unbalanced related to exports and imports and difficulties in the digital arena. It is made clear by the research that digital gainers are held back by problems like structural constraints, inadequate coordination between policies and not being digitally equipped. Since this is important, the country needs a balanced investment in ICT, reforms in the education system, more digital literacy and better trade competitiveness to make digitalization a key part of its sustainable economic growth.

Keywords: Digital Economy, ICT Investment, Economic Growth, ARDL, Internet Usage, Mobile Connectivity, Pakistan

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CHAPTER 01

1.1 Background of the Study

Since the start of the 21st century, economic systems have moved away from the old ways and toward new digital models. Societies, businesses and governments have all been reshaped by the arrival of the digital economy based on ICTs, data analytics, automation and strong connections around the world. It is now helping economies become more productive, creative and equitable around the world. The digital economy's contribution to more accessible services, new business development and better work processes in both sectors is why it is recognized for provoking sustainable economic growth.

Countries like Pakistan have big opportunities and some big challenges due to the digital economy's rise. Over the last twenty years, Pakistan has improved its digital infrastructure by increasing internet use, mobile cellular subscriptions and investing more in ICT. These statistics show how much more digitalization is becoming a part of the country. However, so far fewer economic gains from technology have been reached than what was expected. Because many people do not have advanced digital skills, there is uneven quality in education, old governance methods and technology is not being used to its full extent, digital transformation struggles to reach its full abilities.

This study aims to analyze the part played by the digital economy in Pakistan's economic growth during the period 1995 to 2023. It looks at important aspects of digital development, for example, investment in ICT (as measured by Gross Fixed Capital Formation), education, how often the internet is used, mobile cellular subscriptions and how open countries are to trading. They stand as essential components of a working digital economy and show how much and how well digital technologies are being used in everyday business. The study believes that, assuming effective policies, strong infrastructure and accessible technology, the digital economy can greatly help Pakistan increase its economy, create more jobs and compete globally over time.

1.2 Problem Statement

Pakistan still struggles with its economic development, since there are significant fixed problems despite improvements in digital links and infrastructure. Even though mobile and internet use is growing, these advances have not yet reached the manufacturing, services and trade sectors. The education sector is not ready for the demands of a digital economy and further openness in trade has brought little impact on the country's exports or technology development.

Because of these contradictions, there are significant worries about the real impact of digital economy on Pakistan's economy. Are innovations in technology helping companies become more productive and promote the environment at the same time? Are issues like inefficiency, gaps in policies and flaws in institutions stopping the country from gaining all that digital transformation promises?

Studies done in the past recognize that digitalization can change economies, yet precise research measuring the influence on Pakistan's economic performance is lacking. To fill that gap, this research evaluates both the long-term and short-term impacts of important digital economy elements like ICT, education, internet use, mobile access and international trade on the GDP of the country. The purpose is to use facts from research to create better digital and economic policies.

1.3 Research Question

- What digital economy indicators significantly influence Pakistan's economic growth in the short and long run?
- Can the digital economy serve as a catalyst for sustainable economic growth in Pakistan?

1.4 Research Objectives

The primary objective of this study is to examine whether and how the digital economy serves as a catalyst for Pakistan's economic growth. Specific objectives include:

- To assess the effects of ICT investment, education, internet usage, mobile subscriptions and more open trade on GDP over both the short and long terms.

- To discover which digital economy elements affect economic growth in a positive or negative way.
- To give expert advice on policies that help achieve Pakistan's digital growth plans.

1.5 Significance of the Study

Because the world is becoming more global, technology is now crucial for an economy's strength and success. To make future development plans, Pakistan should focus on understanding how the digital economy contributes to the country's economy. The study adds to research on digital transformation by studying it in a developing country with recommendations that match Pakistan's circumstances.

As a result, this research gives planners and experts the knowledge needed to shape digital policies in the best interests of growth. It shows why investment in ICT matters, why better digital education is needed, why using the internet wisely is important and why trade rules must be in line with what technology can do. Thanks to these outcomes, research can help policy-makers improve how digital technologies aid sustainable and inclusive development.

1.6 Hypothesis of the Study

The research is based on the following hypothesis:

H_0 states that the digital economy does not significantly influence Pakistan's economy.

H_1 states that the digital economy is connected to the significant rise in Pakistan's economic growth.

To check this hypothesis, economic analysis of time-series information will be carried out to assess relationships between GDP and the selected digital economy indicators over the short run and long run.

1.7 Structure of the Study

This thesis is broken down into a specific organization.

Chapter 1 sets the stage by explaining what the research is about, its past context, why it is important and what is being tested.

In **Chapter 2**, the authors summarize and analyze the relevant existing studies about digital economy and economic growth.

In **Chapter 3**, the details of the research methodology are given, including the sources of data, the variables examined, the chosen models and the econometric procedures.

ARDL results together with their analysis and checking for model problems are shown in **Chapter 4**.

The **Chapter 5** ends the study by sharing the main results, ideas for policy and pointers for further study.

CHAPTER 02

LITERATURE REVIEW

2.1 Introduction

Pakistan has new ideas and opportunities in the digital economy, helping the country to grow and sell in markets all over the world. Even so, infrastructure problems and regulations hold back the industry somewhat. The chapter covers research on how digital advancements affect productivity, trading and entrepreneurship, looking at what Pakistan has accomplished and the difficulties it has faced. It highlights where more policy and infrastructure is needed, so that the next phase of research is well informed.

2.2 Literature Review

Grimes et al. (2009) looked at the link between using the internet and business productivity in New Zealand. The researchers contrasted firms equipped with dial-up, slow and fast broadband connections to see the effects of digital infrastructure on efficiency. Businesses using broadband were found to do better than those using dial-up connections. In fact, the tiny difference in productivity among those with slow and fast broadband shows that upgrading to faster internet rarely means people will work more efficiently. The research showed the significance of digital infrastructure to better business performance, confirming that strong internet is key for an economy to develop.

In their paper (2019), Bahrini et al. investigated how mobile phones, internet and broadband affect the advancement of Africa and the Middle East's economies. The results showed that economies with better digital technology performed much better, as those with stronger infrastructure experienced faster growth. Still, the researchers pointed out that in many less developed countries, old guidelines and a lack of high-tech tools hindered growth. Reports said governments should focus on improving technology and revising rules to ensure tech growth continues to drive their economies.

Zhang et al. (2022) analyzed the role the digital economy played in rebuilding economies that participate in China's Belt and Road Initiative, focusing on the time after COVID-19. According to their findings, the use of digital technology in industries kept economies running during restrictions from lockdowns. Yet, the report pointed out that digital adoption is not the

same everywhere: some nations progressed further than others. According to the researchers, specific policies were required to close the digital divide and let every BRI nation enjoy growth through technology.

Gomes et al. (2022) studied ICT adoption and its link to economic growth of OECD countries between 1995 and 2019. Applying GMM to panel data, they discovered that the economies of these countries grew more when people used the internet more, owned more mobile phones or signed up for broadband. However, the results found that the influence of ICT adoption depended on how developed a country was. Although highly developed countries advanced through technology-based progress, the digital shift looked different in transitional countries. According to researchers, policy leaders should focus on enhancing digital infrastructure, raising digital knowledge levels and guaranteeing equal use of technology to get the best economic results from the digital economy.

Arif (2018) studied how mobile networks and access to the internet influenced the country's economy. The study pointed out that thanks to progress in technology, banking, healthcare and government services were all at a higher level. Even so, the study found that infrastructure is not up to date, policies are old and not everyone is familiar with digital technologies. The researcher pointed out that tackling these issues, together with modernizing laws and infrastructure, training workers in the latest technology and investing in digital growth, could help Pakistan see faster development in many industries.

Szeles et al. (2020) looked at how digital transformation changes in EU countries and how older and newer member states vary in this area. According to the study, the EU countries with a wealthier, older population were able to advance promptly in digital adoption due to right education systems, better innovative policies and well-built digital infrastructure. Meanwhile, EU countries that joined more recently had difficulties modernizing, thanks to weak technology and fewer digital users. The researchers suggested that special policies should be designed to close the digital gap and provide equal access to digital technology for all EU countries.

In a recent article, Javed (2020) looked at Pakistan's fast-developing technology sector, focusing on the rise of jobs, foreign participation and new technology-based services. Although the industry saw major growth, the study pointed out key challenges such as inadequate internet, strict rules and not enough skilled staff. The researcher believed that creating more technology hubs outside of leading cities, encouraging investment in learning digital skills and

rethinking certain government policies could aid the tech sector and lead to more global funds coming into it.

In 2010, Ahmed et al. reviewed the role of education and technology spending in improving productivity in East Asian economies. They found that higher levels of education and the use of computers and internet made a real difference in increasing productivity. Researchers explained that education teaches workers to handle technology, while technology makes economic work more efficient. The researchers pointed out that, based on their results, governments should develop and finance educational institutions and modern technologies, since combining education and technology is vital for a country's economic success.

Ahmed et al. (2011), In their analysis, Ahmed and colleagues studied ASEAN-5 countries to understand if economic growth in the region was mainly due to a rise in workforce and resources or better efficiency. It appears that the main reason for economic growth in these countries was additional labour and resource use, but education and technology contributed positively to increased productivity. Despite these factors, they were not yet leading sources of growth which points to these countries continuing a shift toward knowledge-based economies. According to the study, greater focus should be placed on boosting higher education and modern technology in order to maintain economic growth for a long time.

Qalati et al. (2020) looked at how small businesses earned advantages from using Facebook and WhatsApp. Based on the study, it was seen that digital tools increased effective communication among staff, improved how businesses market themselves and increased customer engagement. Strong use of social media by small businesses resulted in higher visibility and a rise in sales. Nonetheless, the researchers noted that limited digital knowledge and access to the internet made it hard for small businesses to take full advantage of these features. They advised that governments should provide small businesses with training in digital skills and help make internet access easier, so they can take full advantage of social media.

In Yushkova (2013), authors examined the way technology helps drive international trade in electronics and software. The study discovered, with a trade analysis model, that companies that used the internet more were more engaged in international trade. According to the researchers, lower transaction fees, more efficient supply management and larger market reach are what explain the value of digital tools. The researchers found that advanced technology is

essential for businesses dealing in advanced products, since it helps them compete on an international level.

Using research published in 2022, Javed et al. studied the effect of digital trade, mainly e-commerce, on Pakistan's economy. They examined important digital trade goods, looked at the amounts that were traded and looked at the main difficulties that come with regulation and infrastructure for digital trade. While digital trade could greatly help the Pakistani economy grow, the lack of proper digital tools and strict policies were preventing its growth. The experts urged the government to adopt new policies and invest more in technology to help Pakistan take part more actively in international digital trade.

Most studies suggest that the impact of digital economy indicators highly depends on the usage and quality of these tools in the economy. How, when and where these tools are used greatly influence their impact on economic growth.

2.2.1 Summary of Literature Review

- **ICT and Digital Infrastructure**

Digital infrastructure forms the backbone of economic competitiveness. Grimes et al. (2009) quantified broadband superiority over dial-up for New Zealand business productivity. Bahrini et al. (2019) linked ICT access to inclusive growth in Africa/Middle East, though regulatory barriers persist in LDCs. Zhang et al. (2022) highlighted digital infrastructure's role in sustaining BRI economies during COVID, while exposing adoption disparities. OECD analysis (Gomes et al., 2022) confirmed internet and mobile adoption drives growth, with impact varying by development level. Szeles et al. (2020) documented infrastructure-driven divides between EU states. Pakistan-focused studies (Arif 2018; Ahmed 2011; Javed et al. 2022) collectively emphasize how outdated infrastructure limits economic progress and digital trade.

Synthesis: Accessible, high-quality infrastructure enables growth and resilience, but global inequities demand targeted investment and policy modernization.

- **Education and Human Capital**

Education and digital skills are fundamental drivers of economic adaptation. Ahmed et al. (2010) demonstrated that education enhances workers' ability to leverage technology, boosting productivity in East Asia. Ahmed et al. (2011) further confirmed this synergy in ASEAN-5

economies, where education and technology jointly supported productivity gains amid transitions toward knowledge-based models. Challenges are prominent in developing contexts: Javed (2020) identified critical skill shortages hindering Pakistan's tech sector, while Arif (2018) noted limited digital literacy constraining broader economic benefits. Qalati et al. (2020) revealed SMEs' inability to maximize social media advantages due to skills gaps. Gomes et al. (2022) contextualized this globally, showing OECD countries' ICT returns depend on existing human capital.

Synthesis: Education enables technology efficacy, skill gaps impede growth, and strategic upskilling is essential for digital transitions.

- **Trade and Economic Integration**

Digital technologies reshape global trade dynamics. Yushkova (2013) established that internet-enabled firms significantly increase electronics/software exports through reduced transaction costs and supply-chain efficiencies. Zhang et al. (2022) positioned digital tools as vital for post-COVID BRI trade recovery, warning that adoption gaps could exclude vulnerable economies. Javed et al. (2022) identified Pakistan's e-commerce potential as constrained by infrastructure deficits and regulatory obstacles.

Synthesis: Digital platforms expand market access and enhance trade continuity during crises, but developing economies require infrastructure upgrades and adaptive policies for equitable participation.

2.3 Research Gap

Studies focusing on Pakistan's economic development are not widespread, but earlier studies pointed out that human resources and modern communications are key to the economy (Ahmed et al., 2010, 2011; Grimes et al., 2009; Bahrini et al., 2019). The transformations digitalization brings to manufacturing, logistics and agriculture are not always discussed. Even though Zhang et al. (2022) and Javed (2020) point out digital disparities, we still do not know their impact on the economy. Arif (2018) and the Javed et al. (2022) research point out the issues, but fail to suggest any clear answers for regulators. Moreover, the role that start-ups, digital banking and fin-tech play in the growth of Pakistan has not been examined sufficiently. Closing these gaps is important for using the digital economy to support sustainable development.

This study aims to fill this research gap by providing a comprehensive, multi-indicator analysis of the digital economy's impact on Pakistan's economic growth over a long period (From 1995 to 2023). Unlike previous research that focused on isolated variables or short time spans, this study employs the ARDL model to assess both short-run and long-run effects, offering valuable insights into the challenges and opportunities of digital development in a developing country context.

2.4 Theoretical Framework

The theoretical foundation of this study is built upon Endogenous Growth Theory and Technology Diffusion Theory, both of which provide a robust framework for understanding the relationship between digital transformation and economic growth. These theories emphasize the role of technological innovation, knowledge accumulation, and human capital as core determinants of sustained economic development, particularly in developing countries undergoing digital transition.

Endogenous Growth Theory, particularly as advanced by Romer (1990), asserts that long-term economic growth is driven not just by external inputs but by internal factors such as investment in education, research and development, and technological advancement. Unlike traditional neoclassical models that treat technology as an exogenous variable, this theory highlights that economic agent governments, firms, and individuals can actively influence the pace of technological progress through purposeful investments. Within this framework, the digital economy emerges as a powerful engine of growth. It encompasses a wide range of components including Information and Communication Technologies (ICTs), e-commerce platforms, digital financial services, cloud computing, and mobile connectivity. These components serve as critical tools that enhance productivity, reduce inefficiencies, streamline transactions, and improve communication across sectors. For developing economies like Pakistan, where traditional sectors often face structural challenges and resource constraints, the digital economy offers a unique opportunity to leapfrog developmental stages and accelerate economic progress through innovation and integration into global markets.

Furthermore, Technology Diffusion Theory, initially formulated by Rogers (1962), explains how the adoption and integration of new technologies spread across societies and economies over time. According to this theory, the rate and extent of technology adoption significantly influence a country's productivity and growth trajectory. In Pakistan's context, the increasing penetration of mobile cellular services, gradual improvement in internet accessibility, and

growing ICT investments illustrate the diffusion of digital tools across different layers of society. These changes reflect a transformation not just in communication habits, but in the way business, governance, and public services operate. As digital technologies become more embedded in daily life, they foster innovation, connect rural and urban economies, and provide platforms for new forms of employment and entrepreneurship. However, the benefits of this diffusion are not uniform and may depend on complementary factors such as infrastructure quality, digital literacy, institutional support, and policy environment.

This study integrates these theoretical lenses to investigate the relationship between key digital indicators specifically ICT investment, mobile cellular subscriptions, and internet usage and Pakistan's economic growth from 1995 to 2023. By analysing both short-run and long-run effects, the research aims to capture the evolving influence of digital transformation on national output. The framework assumes that the digital economy is not merely a supporting component of economic activity but a transformative force that has the potential to reshape Pakistan's growth model. It enables innovation-driven development, strengthens governance through transparency and efficiency, and promotes inclusive growth by expanding access to finance, information, and markets for previously marginalized populations. Thus, the digital economy, underpinned by the principles of endogenous growth and technology diffusion, stands as a critical driver of sustainable economic advancement in Pakistan.

2.5 Conclusion

Evidence in the literature points to the how digitalization has improved economic growth and helped expand businesses globally, including in Pakistan. Although digital growth is rising, problems with the country's infrastructure and regulations are still present. A lot remains unclear about digitalization's impacts on old-established industries, new regulations and how the workforce is adapting. Overcoming these challenges allows Pakistan to get more from its digital growth, improve trade and increase employment. Further research ought to guide the development of policies for a digital economy that includes all people.

CHAPTER 03

METHODOLOGY

3.1 Introduction

Research design, the variables concerned, where the data were found and the methods for analysis were all discussed in this Chapter to examine digital economy's role in Pakistan's economic growth. The authors use secondary data sets from the WDI and PBS database to analyze, through statistical methods, the connection between digital infrastructure and growth in the Pakistan economy.

3.2 Research Design

This research follows an explanatory approach to understand and measure how digital infrastructure helps Pakistan's economic growth. This research uses the positivist approach by thinking that economic events can be observed, quantified and described with statistics. It is believed that developing digital infrastructure and technologies greatly helps with Pakistan's economic progress.

3.3 Data Collection

The study draws its secondary data from the World Bank's World Development Indicators (WDI) and Pakistan Bureau of Statistics (PBS). They are chosen because of their strong records, wide coverage worldwide and simple access. The research covers a period from 1995 to 2023.

Information is collected on topics such as Mobile cellular subscriptions, Internet usage, money spent on new assets (GFCF), Education, Trade openness, digital trade and infrastructure, plus the major economic indicator Real GDP per capita.

3.4 Conceptual Framework

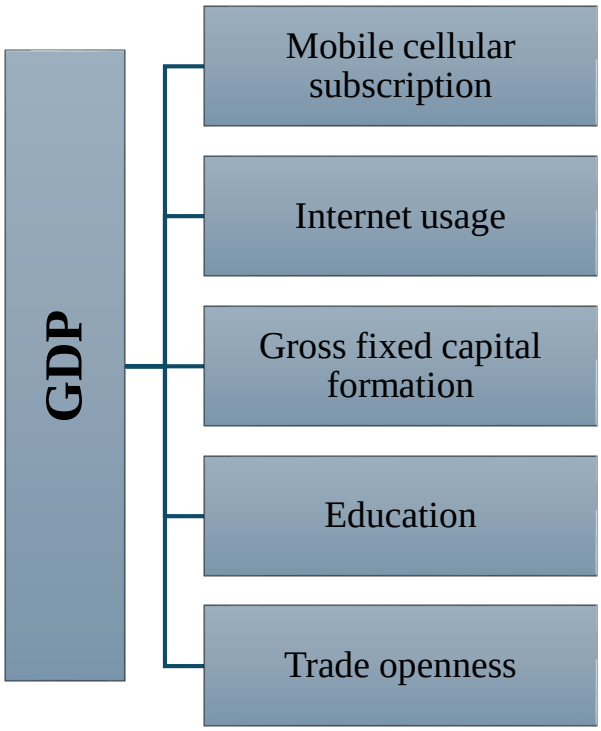


Figure 1: Conceptual Framework

3.5 Data Description

3.5.1 Dependent Variable

Real GDP per capita shows the average value of all products and services a nation produces each year. Data on Pakistan's GDP (at constant 2015 US$) from WDI of the World Bank is time series data covering 1995-2023. Using actual CPI, I converted the nominal GDP data into real GDP and then used natural log on this real GDP data.

3.5.2 Independent Variable

To put it simply, **Mobile Cellular Subscription (for every 100 users)** indicates how many active mobile lines are used to access cellular voice and data options. It represents the diffusion and accessibility of basic digital connectivity. Excluding it ignores Pakistan's mobile centric reality. WDI from the World Bank provides complete time series data of the number of Mobile cellular subscriptions from 1995 to 2023.

Internet Usage measures the percentage of people who have gone online during a certain period. It helps to represent digital connectivity which facilitates information flow and access to online services. From 1995 to 2023, I have gathered Internet usage (% of total population) data using World Bank World Development Indicators (WDI).

GFCF refers to spending on buildings, machinery and infrastructure in production that lasts for more than one year. ICT investment represents the supply side capacity and technological depth of the digital economy. I retrieved time series data on Gross fixed capital formation for ICT Investment (Constant 2015 US$) from the Pakistan Bureau of Statistics (PBS) ranging from 1995 to 2023.

Education is a social indicator demonstrates the availability of higher education which supports improving digital skills and raises productivity for digital jobs. When people are more educated, they are prepared to take advantage of digital solutions which could boost economic growth. I examined Gross school enrolment (Secondary and Tertiary) as a proxy for education quality, although it does not directly measure learning outcomes or relevance of skills. I collected figures from World Bank World Development Indicators (WDI) placed from 1995 to 2023 and then computed the average for analysis.

Trade Openness, TO measure it, count how much a country's export and import transactions are compared to its Real GDP. TO captures the degree of integration with the global digital ecosystem. I based my analysis on data from Trade (% GDP) in World Bank World Development Indicators (WDI) from 1995 to 2023.

3.6 Econometric Model

The researchers use multiple linear regression to calculate the influence of digital economy factors on economic growth. The model is designed as:

$$\textbf{Real GDP per capita} = \beta_0 + \beta_1(GFCF) + \beta_2(EDU) + \beta_3(IU) + \beta_4(MCS) + \beta_5(TO) + \varepsilon$$

After natural logging the variables, the new model is;

$$\textbf{Ln (Real GDP per capita) is equal to } \beta_0 + \beta_1 \text{ Ln}(GFCF) + \beta_2 \text{ Ln}(EDU) + \beta_3 \text{ Ln}(IU) + \beta_4 \text{ Ln}(MCS) + \beta_5 \text{ Ln}(TO) + \varepsilon$$

Where:

- β_0 is the intercept
- $\beta_1 \ldots \beta_6$ are the coefficients of the explanatory variables
- ε is the error term
- MCS stands for Mobile Cellular Subscription
- Ln MCS stands for Log of Mobile Cellular Subscription
- IU stands for Internet usage
- Ln IU stands for log of Internet usage
- GFCF stands for Gross fixed capital formation (ICT Investment)
- Ln GFCF stands for log of Gross fixed capital formation
- EDU stands for Education
- Ln EDU stands for log of Education
- TO stands for Trade openness
- Ln TO stands for log of Trade openness

In the beginning, the natural log of all variables was applied, before the data was checked using stationarity tests, including the ADF test, before regression. The figures are analyzed using Descriptive Statistics. ARCH test, Serial correlation test(LM), Model specification test (Ramsey RESET), Normality test (Jarque-Bera), as well as tests for unit root, co-integration, error correction model, both short-run and long-run analysis and CUSUM and CUSUM of squares are important for checking stability. Where necessary, the difference of a variable between time periods is used. Further tests like the VIF, Breusch-Pagan and Durbin-Watson will be done to confirm that the model is strong.

3.7 Analytical Tools

EViews 12 software is used to analyze the data and it provides reliable tools for researching time-series data.

CHAPTER 04

RESULTS AND INTERPRETATIONS

4.1 Introduction

In this chapter the outcomes of estimation are described and the use of descriptive statistics, the Unit root test, two ARDL forms for both the short and long run, ARDL bound test, error correction form and CUSUM and CUSUM of squares to verify stability was done using 29 years of time series data (1995 to 2023).

4.2 Descriptive Statistics

Data analysis is used to present the relationship between digitalization and economic development in Pakistan from 1995 to 2023.

Table 1: Descriptive Statistics

VARIABLE	MEAN	MEDIAN	S.D	MIN	MAX
Ln GDP	11.87819	11.87289	0.539624	10.75934	12.72611
Ln GFCF	16.81503	16.67133	0.938813	14.56672	18.17149
Ln EDU	2.697622	2.881476	0.525870	1.648659	3.304202
Ln IU	0.922510	2.079442	2.849525	-7.500000	3.310543
Ln MCS	2.087668	3.900000	2.778086	-3.500000	4.695925
Ln TO	3.380568	3.397139	0.150371	3.066189	3.646236

Source: Eviews-12

Interpretation of Results:

Real GDP per capita (Ln GDP) is increasing on average by 11.88 percent every year. The growth rate seen here is very impressive. Since 11.87 is very close to the mean, we can tell the data is symmetrical. The spread of GDP around the average is indicated by a standard deviation of 0.54. In 2023 the GDP growth rate is the lowest at 10.76 percent and in 1995, the highest, at 12.73 percent.

On average, gross fixed capital formation (ICT investment) (Ln GFCF) rises 16.82 percent each year. Fact that the median is 16.67, near the mean of 16.75, lets us know data is symmetrical. The dispersion from the GFCF mean value can be seen with a standard deviation

of 0.94. In 2023, the investment in ICT is about 14.57 percent and in 2007 it reached its highest value among all 29 years, pegged at 18.17 percent.

Education (Ln EDU) is rising at a yearly pace of 2.70 percent. The range between median and mean is very small, so the data is close to symmetrical. Standard deviation in Education stands at 0.53, indicating how far from the mean each group is dispersed. The Educational growth rate is lowest in 1995 (1.65 percent) and in 2021, it reached the highest point among the 29 years (3.30 percent).

Annually, the use of the Internet (Ln IU) rises at the average rate of 0.92 percent (Ln IU). 2.08 percent is the median percent of return. Dispersion from the mean amount of Internet usage is shown by its standard deviation of 2.85 percent. The number of people using the Internet grew a lot, from just 1.65 percent in 1995 to 3.31 percent in 2023, due to reasons including cheap internet, easy accessibility, powerful signals and improvement in the country's technology infrastructure.

Global mobile cellular subscription (Ln MCS) increases each year by an average of 2.09 percent. The lowest third of borrowers pays only 3.90 percent on average. The dispersal from the average MCS can be seen in the 2.78 percent standard deviation. In particular, in 1996 the MCS was at its lowest point (-3.50%), mainly due to new mobile industry, costly phones and expensive service. Correspondingly, in 2023 it reached its highest rate (4.70%), especially because of the introduction of 3G/4G, higher urbanization and new developments in phone and network technologies.

Trade Openness (Ln TO) is growing by an average of 3.38 percent in each year. Since the median is close to 3.39, we can tell that data is symmetrical. Dispersion from the mean value of trade openness is shown by its standard deviation of 0.15 percent. The TO was lowest in 2000, at 3.07 percent and highest in 1996 at 3.65 percent.

4.3 Testing for Unit Root

To verify the Stationary of a variable, an econometric technique known as Unit Root Test is used. It is important to make the data stationary before you can start estimation. For checking the unit root, we are using the ADF test.

Table 2: Unit Root Test (ADF)

VARIABLES	T-STATISTICS	P-VALUE	INTEGRATION ORDER
Ln GDP	-3.603202	0.0279	I(0)
Ln GFCF	-2.976263	0.0015	I(1)
Ln EDU	-2.971853	0.0057	I(0)
Ln IU	-3.622033	0.0030	I(0)
Ln MCS	-2.971853	0.0375	I(0)
Ln TO	-2.976263	0.0002	I(1)

Source: Eviews-12

Interpretation of Results:

The results of the Augmented Dickey-Fuller Unit root test (ADF) are included in the following table. Results show that each variable used in the data is stationary to the required degree of significance.

Real GDP per capita (Ln GDP) is a dependent variable which is integrated at level difference I(0). The probability value is 0.0279 which is less than 0.05, which means GDP is significance at 5% level of significance.

Gross Fixed Capital Formation, ICT Investment (Ln GFCF) is one of the independent variables used and is integrated in the first difference I(1). The value of significance associated with GFCF (ICT Investment) is 0.0015 and less than 0.05, so it is significant at the 5% level.

Education (Ln EDU) is another independent variable which is integrated at level difference I(0). The probability value is 0.0057 which is less than 0.05, which means that Education is significant at 5% level of significance.

Internet Usage (Ln IU) is an independent variable that is added to level difference I(0). The 0.0030 probability falls under 0.05, so there is significant proof that Internet usage matters at a 5% level of significance.

Mobile Cellular Subscription (Ln MCS) is integrated as an independent variable at the first level difference I(0). This means that Mobile Cellular Subscription is significant at five percent probability or at the 5% significance level.

Trade Openness (Ln TO) is a independent variable that is added at first difference, I(1). The probability is 0.0002 which is lower than 0.05, so Trade Openness is significant at the 5% level.

4.4 Autoregressive Distributed Lag (ARDL)

Researchers prefer to apply the ARDL Co-integration technique to look for the long term connection between two series, where one is I(0) and the other I(1). When the approach finds a lower critical bound, it means that none of the variables are integrated in the first differencing form and consequently, co-integration is absent. By contrast, the upper critical bound shows co-integration and a non-stationary I(1) series when examined in first difference. Co-integration exists when the F-statistic goes above the upper critical value. If the F-statistic is under the lower critical constraint, co-integration is also not detected. If the number you get for the F-statistic is between the critical values, the test is not considered conclusive.

4.4.1 Bound Test

ARDL bound test is applied to check if the long run relation exists or not.

Table 3: ARDL Bound Test

F-STATISTIC	16.70883	
10%	**2.08**	**3**
5%	2.39	3.38
2.5%	2.7	3.73
1%	3.06	4.15

Source: Eviews-12

Interpretation of Results:

See the table above to view the ARDL bound test results. The test result comes from comparing the F-statistic to the previously published ranges. A long-term link between the variables exists when the F-statistic value exceeds the upper bound critical value. When the F-statistic value is under the upper bound critical value, no long-term link exists. The results suggest that the variables stay related in the long run, Since the F-statistic of 16.70883 exceeding the critical value of 3.38 at a 5% level of significance.

4.4.2 Long Run Form

Table 4: Long Run Form

VARIABLE	COEFFICIENT	STD. ERROR	T-STATISTIC	P-VALUE
Ln GFCF	0.162876	0.037307	4.365762	0.0033
Ln EDU	-1.452116	0.190179	-7.635525	0.0001
Ln IU	-0.120810	0.046732	-2.585183	0.0362
Ln MCS	0.195842	0.058051	3.373640	0.0119
Ln TO	-1.352849	0.364495	-3.711575	0.0075
C	17.17476	1.722409	9.971360	0.0000

Source: Eviews-12

Interpretation of Results:

The data in the table above report ARDL results for the long run relationships between variables. All of the independent variables matter, indicating that they are an important factor in the growth of GDP in the long run.

The results demonstrate that over a long period, when all other things are held constant, a 1% boost in the GFCF of ICT Investment will cause GDP to increase by 16.29%.

In the end, other factors fixed, if Education increases by 1%, the nation's GDP shrinks by 14.52%. Since GDP grows less as education improves, it appears that education is expanding but not always being delivered effectively or to students' advantage. As a result, there may be underemployment, brain drain and poor use of public funds which slows the boost to the economy (Pritchett, L. (2001). Where has all the education gone?. *The world bank economic review*, *15*(3), 367-391).

If Internet usage increases by 1% in the long run, with other things stable, GDP will fall by 12.08%. There is a concern in Pakistan that since much internet use is for entertainment or social media, it could end up reducing GDP over the long term. Besides, a lack of good internet services and knowledge in using technology do not let internet access lead to better economic results. Pakistani office workers lose around 40 percent of productive hours to non-work internet usage (PIDE 2022).

In the long-run, when MCS rises by 1%, other things unchanged, GDP is expected to rise by 19.58%.

Other things kept constant, if Trade Openness increases by 1%, there will be a 13.52% decrease in GDP over the long run. Increased trade in Pakistan may result in a fall in the country's GDP in the future, mainly due to importing many goods and causing consistent trade deficits. As it lacks great export products and strong competitive industries, the economy doesn't fully use open trade which hurts domestic production and growth.

From 1995 to 2023, MCS positively contribute to Pakistan's economy by improving communication, financial inclusion and productivity across all income levels. In contrast, Internet usage had a very limited or negative effect due to poor infrastructure, non-productive usage and absence of supportive and effective eco system. The way internet is being used may not be helping the Pakistan's economy, possibly hurting it or being inefficient in long-run. While internet usage has increased over time in Pakistan, it does not cause positive impact on GDP . These findings suggest that internet access alone is insufficient, the economic benefit depends on productive usage, digital literacy and supportive infrastructure (Sassi, S., & Goaied, M. (2013). Financial development, ICT diffusion and economic growth: Lessons from MENA region. *Telecommunications Policy*, *37*(4-5), 252-261).

4.4.3 Short Run and ECM Regression

Table 5: Short Run and ECM Regression

VARIABLE	COEFFICIENT	STD. ERROR	T-STATISTIC	P-VALUE
D(Ln GFCF)	0.054052	0.009296	5.814773	0.0007
D(Ln EDU)	0.549162	0.091655	5.991594	0.0005
D(Ln IU)	-0.066043	0.010951	-6.030778	0.0005
D(Ln MCS)	0.076332	0.018515	4.122654	0.0044
D(Ln TO)	-0.159348	0.049233	-3.236630	0.0143
COINTEQ(-1)*	-0.581899	0.039482	-14.73821	0.0000
R-squared			0.973078	
Adjusted R-squared			0.948227	
Durbin-Watson stat			2.271836	

Source: Eviews-12

Interpretation of Results:

In the table, we use ECM to show that the short-run view of the model highlights the link between how our dependent and independent variables approach equilibrium. The independent variables are all important, because they significantly affect GDP in the short run.

If in the short run, Other things held constant if GFCF specifically ICT Investment increases by 1%, GDP will expand by 5.41%.

For short-term influences, Other things kept steady, a 1% rise in Education is expected to increase GDP by 54.92%.

From 1995 to 2023, in case of Pakistan education positively influenced GDP in the short run by boosting employment, temporarily human capital gain and consumption. People also tend to experience the money illusion effect in the short run. However, in the long run, poor education quality, labor market mismatch and brain drain have weakened its impact on economic growth.

In the short-run, Other things being equal, a 1% rise in Internet usage decreases GDP by 6.60%. Many reasons play a role and one of these is when internet access alters the retail and media sectors, boosts imports of digital goods, leads to a lack in structures or confuses people in the informal sector (Bahrini, R., & Qaffas, A. A. (2019). Impact of information and communication technology on economic growth: Evidence from developing countries. *Economies*, *7*(1), 21).

When MCS increases by 1%, GDP goes up by 7.63%, everything else being constant for the short-run.

Other things staying the same, a 1% rise in Trade Openness leads to a decrease of GDP by 15.93% in the short-run. It's possible because in the short term, local industries were unable to match the prices of imports and had to close down. Moreover, having greater openness meant Pakistan was subjected to shocks from oil prices and financial crises, it lacked many kinds of exports, so the gains from openness were not significant, its imports increased because of liberalization which made its trade deficit grow and lowered its domestic production.

The results demonstrate that the Error Correction Model has a negative value of 0.581899, showing that when disequilibrium happens, it will be corrected within 58.19% of a year.

There is an R-squared of 0.973078 which means that almost 97.3% of the changes in the dependent variable come from the independent variable.

An Adjusted R^2 of 0.948227 means the independent variables explain 94.8% of changes in the dependent variable in this model.

Because the Durbin-Watson stat shows 2.27, we can see that autocorrelation is mild in this model.

4.4.4 Summary of Short and Long run Results

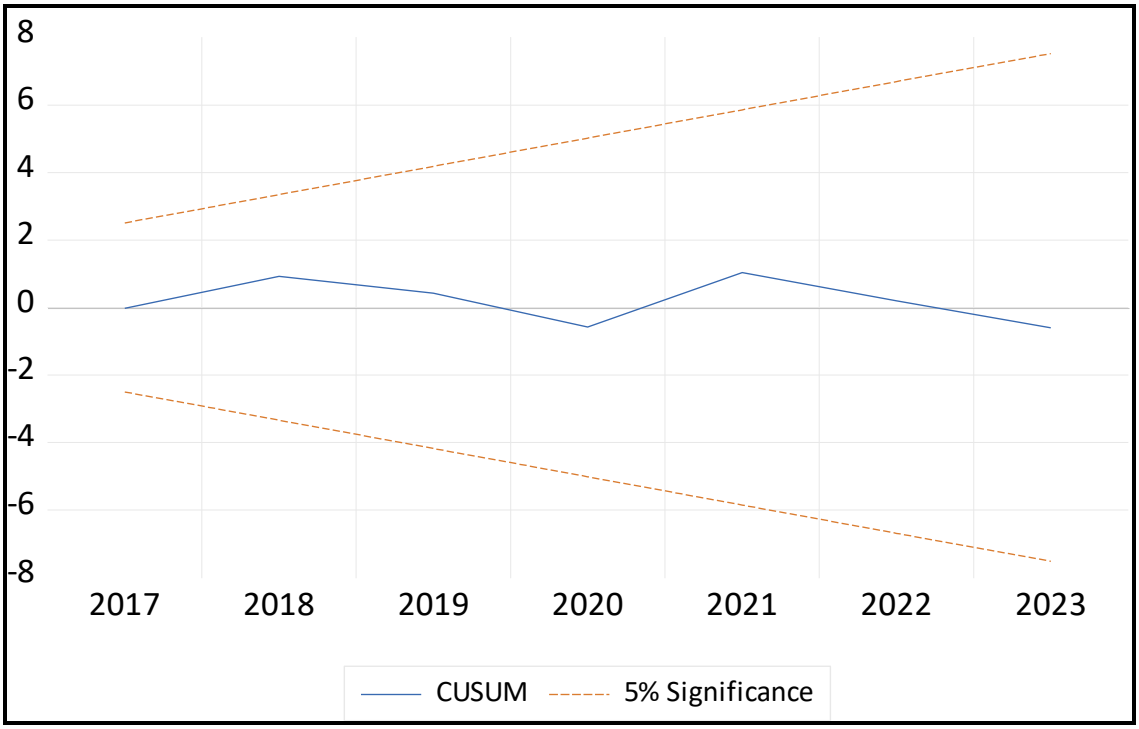
Table 6: Summary of Results

VARIABLE	LONG-RUN EFFECT	REASON	SHORT-RUN EFFECT	REASON
Education	Negative	Poor quality, outdated curriculum, mismatch with labour market needs	Positive	Job creation, money illusion, temporary human capital gain
Internet usage	Negative	Weak infrastructure, digital illiteracy, lack of digital ecosystem	Negative	Digital divide, use of internet for entertainment purposes, cybersecurity issues
MCS	Positive	Broad mobile access supports digital inclusion ,communication and other mobile based services.	Positive	Increased connectivity, easier access to market information leads to improved productivity
ICT Investment	Positive	Improves digital infrastructure	Positive	Immediate Job creation, Boost

		and supports long term gain.		in efficiency of businesses, Attracts FDI.
Trade Openness	Negative	Import-led trade deficit, Weak export base, currency depreciation, inflation	Negative	Political and economic instability, IMF programs, SAPs

4.5 Stability Test

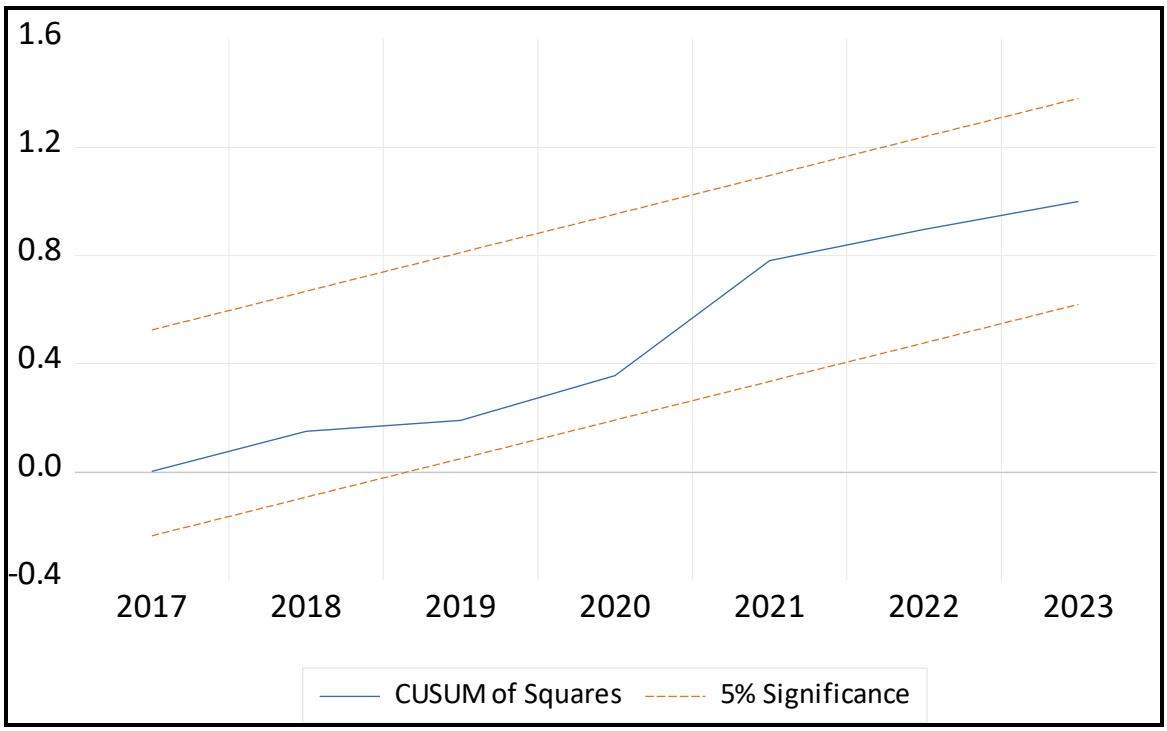
- CUSUM



Source: Eviews-12

Figure 2: CUSUM

- CUSUM OF SQUARES



Source: Eviews-12

Figure 3: CUSUM of Squares

Interpretation of Results:

It is clear from the lines of recursive residuals or CUSUM and the CUSUM that the data is stable since none of the lines go outside the limits.

CHAPTER 05

CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction

The chapter concludes the study and offers some suggestions about the main idea it focused on.

5.2 Conclusion

Gross Fixed Capital Formation, representing ICT investment and other core digital economy indicators (Education, Internet Use, Collaborative Mobile Cellular Subscriptions and Trade Openness) were used here to assess Pakistan's economic growth by running the ARDL model for the years 1995 to 2023. In the analysis, both long-term balances and changes in the short term were studied by looking at how digital transformation affects real GDP in Pakistan and providing evidence for how this process has affected its overall economy.

The data displays that digital society has both positive and negative effects on economic growth. The results indicate that gross fixed capital formation in the ICT area and mobile cellular subscriptions have a large and significant impact on GDP, proving that having better technology and more connectivity is essential for the economy. These results point out that money and banking services online and increased use of mobile phones may allow more people to join the official economy and access useful financial and informational resources.

In contrast, the research indicates that, over the long run, education is slowing down the growth of the Pakistani economy which is surprising but consistent with common concerns about education in the country. Such a negative link might result from problems at the national level such as low relevance between qualifications and workplaces, old teaching methods, poor spending or slow progress in using human capital. This suggests that mere raise in years of studies may not increase the economy, unless digital literacy, advanced technology skills and learning to meet the demands of the market is included (Iqbal, K. (2018). Human development and economic growth in Pakistan).

At the same time, high levels of internet use may harm GDP growth in the long run, showing that people use the internet less for work. Even as more people go online, most of their activity is invested in talking to others, using social media and enjoying entertainment instead of using the internet in business, learning or innovative ways. Additionally, these problems can be made

worse by a lack of technical knowledge, weak connections online, risks related to cybersecurity and ineffective efforts to develop e-commerce and digital businesses.

Other important factors such as trade openness, are also associated with lower long-term GDP. The main reason for this outcome is Pakistan's dependency on imports, continual trade deficits and a limited amount of exports that bring high returns. By opening the economy as it does now, India risks becoming weaker rather than stronger by lacking important domestically grown industrial or digital capabilities.

For the short run, the results from the ARDL model reveal that ICT investment, education and mobile subscription have a positive contribution to economic growth, but the effects are generally unstable. Yet, using the internet and trade openness and moving forward with trade agreements still negatively impact businesses in a short period which raises doubts about efficient uses of digital resources and issues with import and export.

In general, the results prove that there is much potential in Pakistan's digital economy, though neither the potential nor its benefits are guaranteed. Currently, expanding the digital transition is held back by not having clear policies, missing skills, non-symmetric infrastructure and weak teamwork between different institutions. For the digital economy to bring about lasting and fair growth, reforms must focus on better learning opportunities, encourage useful use of digital devices, improve trade standing and link public funds to key national objectives. Pakistan can only realize the full benefits of digitalization for its economy if diverse groups work closely together.

5.3 Limitations

While this research contributes meaningfully to the understanding of digital transformation in Pakistan, it is important to acknowledge several limitations that may affect the interpretation and generalization of its findings:

- **Data Constraints:** The availability of high-quality, consistent, and comprehensive time-series data for digital economy indicators in Pakistan is limited. Especially for earlier years in the study period (1995 to 2000s), data coverage is weak, which required the use of proxy variables in some cases. This limitation may introduce measurement error or reduce the reliability of trend analysis.

- **Variable Selection Bias:** The study includes a limited number of digital economy indicators mobile subscriptions, internet usage, and ICT investment to maintain a manageable scope. However, excluding other potentially relevant variables such as digital literacy, broadband speed, online banking penetration, and regulatory quality may limit the depth of the analysis.
- **Causality vs. Correlation:** The econometric approach identifies statistical associations between digital indicators and GDP but does not fully establish causality. It is possible that higher GDP may itself lead to increased digital adoption, creating endogeneity issues. Although techniques such as Vector Error Correction Models (VECM) are used to explore short- and long-run dynamics, they cannot entirely eliminate the risk of reverse causality or omitted variable bias.
- **Generalizability of Results:** The findings are specific to Pakistan's unique institutional, demographic, and economic environment. Therefore, the conclusions drawn may not be readily applicable to other developing countries with differing digital infrastructure, governance quality, or economic structures.
- **Time Lag in Digital Transformation:** The impact of digital investments often takes several years to materialize. Some indicators, such as internet usage, may show delayed benefits due to complementary factors like skills development, policy alignment, and infrastructure readiness. The study's timeframe may not fully capture these long-run transformations

5.4 Policy Recommendations

- Make education more useful and more fit for its learners.
- Add digital skills, entrepreneurship and ICT training to the school curriculum.
- Join industry and academic resources to guarantee that students graduate with the abilities needed for employment.
- Make digital skills education available to a larger number of students.
- Help People Use the Internet Effectively.
- Guide people toward starting digital businesses, working remotely and using e-commerce platforms with tax breaks and training help.
- Poignant awareness on digital literacy should reach both city areas and rural locations.

- Use reliable methods in cybersecurity, payments and strong broadband access to avoid losing customer trust on digital platforms.
- Build and upgrade technology infrastructure and invest more in it.
- Make it a priority to invest in digital infrastructure, mainly in rural areas that need it.
- Support alliances between government and private companies in 5G, fiber optic and cloud projects.
- Give start-ups and SMEs the chance to use digital technologies by financing them affordably.
- Improve the way mobile devices can communicate.
- Do what is needed to ensure that mobile markets are fair and affordable for everyone.
- Further support new technologies for mobile banking, health and education to provide access for those who do not have banking services.
- Make Trade Policies Reasonable.
- Focus on making the ICT and digital services industries a major part of the export sector.
- Consider removing other trade barriers and focus on making agreements for digital trade.
- Make the customs process digital and update logistics technology to make things cheaper.
- Changes in institutions and regulations.
- Set up a national digital economy strategy that aims to help all parts of society.
- Set rules that define how companies should protect data, do business digitally and deal with fin-tech.
- Obtain better communication among public, private and academic organizations for making digital policy decisions.

Policy makers should prioritize improving digital infrastructure and education quality, keeping in mind the financial and institutional challenges that may arise during implementation.

Financial constraints like chronic deficits, debt traps, elite tax evasion starving budget and institutional challenges like fragmented governance, capacity gaps across federal provision tiers and corruption. Together, these create a vicious cycle where underfunded policies collide with bureaucratic inertia, patronage network and coordination failures derailing even well designed reforms. These issues must be kept in mind while implementing policies to avoid chaos.

5.5 Suggestions for Future Research

- **Explore Other Digital Indicators**: Future studies can include additional variables such as digital payment systems, e-commerce penetration, cybersecurity, or digital governance to provide a broader view of the digital economy.
- **Use Alternative Methodologies:** Applying techniques like panel data analysis, structural equation modelling (SEM), or machine learning approaches may offer deeper insights and predictive accuracy.
- **Compare Across Countries or Regions:** Conducting comparative studies between Pakistan and other developing or South Asian countries can help understand regional differences and common challenges.
- **Focus on Sector-Specific Impact:** Future research could investigate the digital economy's effect on specific sectors like agriculture, manufacturing, education, or services.
- **Include Quality Dimensions:** It would be valuable to include quality-related measures (e.g., quality of internet, education outcomes, skill levels) instead of only quantity-based proxies.
- **Micro-Level Analysis:** Conducting micro-level or firm-level studies (e.g., SME digital adoption and performance) can offer practical insights for business and policy development.
- **Long-Term Policy Impact Studies:** Assessing the long-term effects of digital policy initiatives like "Digital Pakistan" can help evaluate the success and shortcomings of government strategies.

REFERENCES

Ahmed, E. M. (2010). Human capital and ICT per capital contribution to East Asian productivity growth. *International Social Science Review*, *85*(1/2), 40-55.

Ahmed, E. M. (2011). Assessing the impact of ICT and human capital impact on productivity of ASEAN-5 economies. *Journal of Global Management*, *1*(1), 23-36.

Aijaz, U., Lodhi, K. S., Shamim, M. A., & Mughal, S. (2024). Economics of education and digital learning for human capital development in Pakistan: A critical review. *Qlantic Journal of Social Sciences*, *5*(1), 217-234.

Arif, M. (2018). ICTs and development in Pakistan: A review. *Journal of Innovations and Sustainability*, *4*(3), 7-25.

Arif, S. R., Bhatti, M. U., Ali, M., & Malik, A. M. (2024). Impact Of Digital Economy on Pakistan's Economic Growth. *Pakistan Research Journal of Social Sciences*, *3*(4).

Bahrini, R., & Qaffas, A. A. (2019). Impact of information and communication technology on economic growth: Evidence from developing countries. *Economies*, *7*(1), 21.

Baldwin, R. (2016). *The great convergence: Information technology and the new globalization*. Harvard University Press.

Baldwin, R. (2016). *The great convergence: Information technology and the new globalization*. Harvard University Press.

Bhatti, A., Akram, H., Basit, H. M., Khan, A. U., Raza, S. M., & Naqvi, M. B. (2020). E-commerce trends during COVID-19 Pandemic. *International Journal of Future Generation Communication and Networking*, *13*(2), 1449-1452.

Cesaroni, F. M., & Consoli, D. (2015). Are small businesses really able to take advantage of social media?. *Electronic Journal of Knowledge Management*, *13*(4), pp257-268.

Davies, R. (2015). Industry 4.0: Digitalisation for productivity and growth.

Gomes, S., Lopes, J. M., & Ferreira, L. (2022). The impact of the digital economy on economic growth: The case of OECD countries. *RAM. Revista de Administração Mackenzie*, *23*, eRAMD220029.

Grimes, A., Ren, C., & Stevens, P. (2012). The need for speed: impacts of internet connectivity on firm productivity. *Journal of productivity analysis*, *37*(2), 187-201.

Iftikhar, P. Pakistan and the Digital Economy: Future Directions.

Iqbal, K. (2018). Human development and economic growth in Pakistan.

Jabeen, M., Aakif, Z., & Afridi, H. A. (2024). Unlocking Pakistan's digital potential: A roadmap for workforce digitalization and economic transformation. *Journal of Information Technology Teaching Cases*, 20438869241280980.

Javed, A. (2020). The scope of information and communication technology enabled services in Promoting Pakistan Economy. *Asian Journal of Economics, Finance and Management*, 165-173.

Javed, A., & Ahmed, V. (2022). Digital Trade as Engine of Growth for Pakistan. *Pakistan Journal of Social Issues*, *13*, 71-83.

Kundi, G. M., Shah, B., & Nawaz, A. (2008). Digital Pakistan: opportunities & challenges. *JISTEM-Journal of Information Systems and Technology Management*, *5*, 365-390.

Pritchett, L. (2001). Where has all the education gone?. *The world bank economic review*, *15*(3), 367-391.

Qalati, S. A., Li, W., Ahmed, N., Mirani, M. A., & Khan, A. (2020). Examining the factors affecting sme performance: the mediating role of social media adoption. *Sustainability*, *13*(1), 1-24.

. Sassi, S., & Goaied, M. (2013). Financial development, ICT diffusion and economic growth: Lessons from MENA region. *Telecommunications Policy*, *37*(4-5), 252-261.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics*, *70*(1), 65-94.

Szeles, M. R. (2018). New insights from a multilevel approach to the regional digital divide in the European Union. *Telecommunications Policy*, *42*(6), 452-463.

Tapscott, D. (1996). Six themes for new learning from: the digital economy: promise and peril in the age of networked intelligence. *Educom Review*, *31*, 52-54.

Yushkova, E. (2014). Impact of ICT on trade in different technology groups: analysis and implications. *International Economics and Economic Policy*, *11*, 165-177.

Zhang, J., & Danish. (2019). The dynamic linkage between information and communication technology, human development index, and economic growth: evidence from Asian economies. *Environmental Science and Pollution Research*, *26*, 26982-26990.

Zhang, J., Zhao, W., Cheng, B., Li, A., Wang, Y., Yang, N., & Tian, Y. (2022). The impact of digital economy on the economic growth and the development strategies in the post-COVID-19 era: evidence from countries along the “Belt and Road”. *Frontiers in public health*, *10*, 856142.