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DIGITAL CONNECTIVITY AND SOCIO-ECONOMIC DEVELOPMENT: EVIDENCE FROM SOUTH ASIA

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Abstract

This study provides insights into the factors impacting Internet accessibility and adoption across the South Asian Group of Countries (SAGC) by examining the drivers of Individuals using the Internet (IUI) throughout the region. This research examines data from 2001 to 2025 using fixed and random effect models to reveal complex links between social, technological, and economic aspects and IUI. The results indicate that although GDP per capita (GDPPC) exhibits a positive correlation with IUI, the effect is not statistically significant. This suggests that variables other than economic growth are required to boost individuals using Internet. On the other hand, Research and Development Expenditures (R&DEXP) show a strong positive correlation with IUI, underscoring the significance of financial investments in infrastructure development and technological advancements to support internet accessibility. The study points out the significance of targeted policy interventions aimed at reducing income disparities, promoting research and development, and enhancing digital literacy to foster universal and sustainable internet access across SAGC countries, thereby facilitating socio-economic development and digital inclusion within the region's borders. According to the study, income inequality (II), as measured by the Gini Index (GI) and Poverty Head Count Ratio (PHCR), additionally demonstrates a negative connection with IUI. These findings suggest that socioeconomic disparities may pose barriers to equitable internet access within the SAGC.

Keywords: Individuals Using the Internet (IUI), Research and Development Expenditures, Digital Literacy, Economic Growth, Technological Advancements, Poverty Head Count Ratio, Income Inequality, Socioeconomic Disparities

1. Introduction

1.1 Information and Communication Technology as a Driver of Development

The world has become a global village due to access to information's transitions traveling in seconds or its very appropriate for release under fingertips access of each and everything according to your tastes and preferences and behind the screen or invisible hands are off course advancement of information technology which has made as input and output accordingly in every sector of the country like banking, trading, e-commerce, institutions, and educations as well. A study realized by the OECD that ICT plays a pivotal position in decreasing poverty and creating new sources of jobs, incomes, and opportunities in the internet world while reducing the cost of talented poor and needy ones who get chances or opportunities to acquire knowledge and get higher or developed ways of education services and health access at optimized cost as well. ICT involves software, hardware, networks, media assortment, storage space, dispensation, broadcast, and presentation of information in the form of Voice, data, text, and descriptions as well. Accordingly, work on ICT in current years has amplified. Mobile phone and internet services generated the majority of income in developing economies. For instance, the highest wages were found in Bahrain, Jordan, Morocco, and Tunisia, while rates in "Qatar, Saudi Arabia, and the UAE" were comparatively stumpy because of their elevated GDP.

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Telecommunications earnings fell in practically all developing nations between 2010 and 2015, particularly in "Jordan, Morocco, Tunisia, Saudi Arabia, and Sudan", lowering their hand-outs to GDP. Surprisingly, Tunisia is regarded as the most advanced country in terms of ICT spread when compared to its neighbours. The indicator "Active mobile broadband subscriptions," reveals that Tunisia's ICT diffusion is substantially higher than the Arab average. Furthermore, for two reasons, ICT has a precedence zone in Tunisia. 1st, ICT is viewed as a growth vector for other cost-effective sectors. The ICT industry is a vibrant, innovative area with a focus on export, FDI, partnerships, and subcontracting, particularly with Africa's nations. The Canadian Trade Commissioner Service's report on Tunisia states that the industry contributed 7.5% of GDP and employed about 86,000 people in 2018. It consists of 2,120 private businesses, 219 shared service facilities, and 8 development facilities that cater to global corporations. Investigating the Tunisian ICT spread scenario can therefore be fruitful because it has consequences for both Tunisian and neighbouring country governments.

Arab nations as well as Tunisia Fixed-line phone contracts 9.0 10.77 Subscriptions to mobile-cellular telephones 84.4 105.24 (IT, WTI Database, July 2020) Active MBS 37.1 31.11. To developing nations, earlier studies (Dewan & Kraemer, 2000; Papaioannou & Dimelis, 2007.) have also been conducted (In 2015, Niebel et al. Niebel, 2018; Cheng et al. 2021) the impact of ICT on EG is a matter of mixed approach. Also, there is a dearth of studies that focus on developing nations. There are two possible reasons why the findings are not consistent. The connection between ICT and EG is based on aggregated statistics. Disaggregated data is insufficient to convey the potential integration of ICT into the economy or the diversity of economic sectors. ICT investment can negatively impact the profitability of most developing economy's poor ICT infrastructure, which is a common issue. Therefore, we recommend separating SR and LR impacts. The correlation flanked by ICT and ED is based on the capability of countries to attract tools by creating skilled workers. Sectorial analysis of a developing country is an intriguing method to fill the literature gap. ICT plays a significant role in driving EG in the present digital world (Lee & Brahmasrene, 2014; Rohman & Bohlin, 2014; Pradhan et al, 2019; Majeed & Ayub, 2018, Bilan, 2019).

The objective of this study is to offer substantial insight into the underlying factors influencing internet accessibility and adoption patterns within SAGC by investigating the relationship between socioeconomic status and IUI. The study employs a rigorous methodology and empirical analysis to provide insights for policy interventions and strategic initiatives that aim to promote sustainable and inclusive internet access. This will ultimately promote digital inclusion and socio-economic development throughout the South Asian region. The practical ramifications and usefulness of DOI theory are what make it strong; they can be used for a broad range of situations. The diffusion process in the model captures the activity required for an innovation to spread from its inception to a broader population, regardless of the culture, social structure, or demographics (Atkin, Hunt, & Lin, 2015).

According to Kapoor, Dwivedi, and Williams (2014), who conducted a systematic review of the literature and a meta-analysis of papers on Rogers' innovation attributes, the majority of studies are retrospective and primarily focus on the adoption of an innovation, with little to no attention paid to implementation or post adoption actions. The primary source of quantitative data for DOI research comes from surveys and questionnaires that ask people to score the impacts and influences of the purported innovations' characteristics. The majority of researchers examined several characteristics, although many just take into account one innovation, usually in the context of an organization (Kapoor et.al, 2014).In media research, DOI theory is viewed as a procedure that incorporates practical and structural elements obtained from experts' contributions in many news creation domains (Lund, 2008; Micó, Masip, & Domingo, 2013).

Lawson-Borders (2003) determined the optimal management techniques for combining traditional and new media by utilizing the DOI theory in conjunction with case study outcomes from innovative media organizations. In today's digitally integrated, multiplatform world, striking a balance between simplicity and complexity is essential. In today's digitally integrated, multiplatform world, striking a balance between complexity and simplicity is essential. According to Atkin et al. (2015) and Lievrouw (2006), innovations arise not only in response to threats posed by the media market's instability, increased industry competition,

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and technological disruption but also because interactive audiences and social media are crucial in lowering uncertainty and encouraging early adoption.

1.2 Internet Adoption and Digital Inclusion in South Asia

Many factors explain the adoption decisions in information that could help advance or hinder innovative practices and processes within media companies, with a focus on how innovations are embraced by early adopters in digital newsrooms. These factors include the availability of information about technology (like relative advantage and compatibility), adopters' properties (like past experiences), characteristics of the social system (like management support and availability of change agents), and the communication process (Taylor 2018; UN News 2019). Internet access is becoming more and more essential for socioeconomic development and connectedness in a time of fast technological advancement and globalization. Because of its diversity, the South Asian Group of Countries (SAGC) has a lot of opportunities for using information and communication technology (ICT) to spur development and innovation. To promote inclusive growth and close the digital divide, policymakers, researchers, and stakeholders must have a thorough understanding of the dynamics of internet access inside SAGC. With an emphasis on Individual Internet Usage (IUI) as a stand-in for ICT penetration, this study aims to investigate the subtleties of internet usage among individuals within SAGC. The goal of the research is to shed light on the factors influencing internet accessibility and adoption patterns in the area by analysing the interactions between economic growth, income inequality, and technical advancements (ITU 2019b).

1.3 Socio-Economic Importance of Individual Internet Usage

This study uses fixed and random effect models to analyse data covering the years 2001--2025, to identify the underlying factors that influence the patterns in internet usage among South African-Americans. Through clarifying the intricate dynamics involved, the study aims to offer significant perspectives and fact-based suggestions for decision-makers and interested parties who are working to advance equitable and long-lasting internet connectivity in SAGC nations. This study adds to the larger conversation on ICT development and digital inclusion in the South Asian area against the backdrop of growing digitalization and the transformative potential of ICT. The current study aims to fill in knowledge gaps and provide empirical insights into the dynamics of internet usage; the study aims to guide strategic efforts that promote socio-economic development and connectedness in the South African general population. Within the South Asian Group of Countries (SAGC), individuals using the internet (IUI) is critical to socioeconomic growth and digital inclusion economies (Taylor 2018). It is crucial to comprehend the causes and effects of IUI for a number of reasons: The internet is a huge information source that makes it possible for anyone to obtain news, knowledge, and instructional materials regardless of where they live.

Raising IUI promotes a better informed and capable society by improving the flow of information and empowering people with the means to make smart choices. The internet provides a wealth of opportunities for employment, such as remote work, e-commerce, online learning, and freelancing. A higher IUI encourages people to engage in the digital economy, which promotes entrepreneurship, the creation of jobs, and economic expansion in SAGC. The internet is an essential instrument for communication, enabling cross-border real-time engagement and teamwork. In SAGC, increased IUI promotes social cohesiveness and cross-cultural interaction by fostering interpersonal relationships, networking possibilities, and social connectivity. Within SAGC, individual internet usage creates the conditions for technological innovation and digital transformation. The availability of online materials, forums, and platforms encourages innovation in a variety of fields, including healthcare, education, agriculture, and governance. It also facilitates creativity, teamwork, and problem-solving.

1.4 Empowerment of Marginalized Communities through Internet Access

Understanding the significance of Individual Utilization Internet (IUI) is essential for policymakers, researchers, and stakeholders seeking to promote inclusive and sustainable development within the South Asian region. By addressing barriers to internet access and fostering digital literacy, SAGC can harness the transformative power of the internet to advance socio-economic development. Women, rural populations, and disadvantaged groups are among the marginalized communities that require empowerment through bridging

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the digital divide through increased IUI household wealth, and the social implications of internet diffusion (Haenssgen 2018; Haenssgen and Ariana 2017).

1.5 Socio-Economic Conditions and Internet Accessibility

In today's digitally connected society, the internet plays a crucial role in driving socio-economic progress by providing individuals and communities with vital information, communication tools, and growth opportunities. By studying the complex relationship between socioeconomic factors and internet usage, we can gain valuable insights into how individuals and communities are empowered through internet access, communication, and development opportunities. By delving into the complex relationship between socioeconomic conditions and individual internet usage, we can gain insights into the factors that shape the accessibility and adoption of internet technologies in our modern world. Access to the internet is a driver for socio-economic development in today's technologically advanced, interconnected world, providing people with opportunities, competence, and communication (Faris 2015; Intermedia 2018; ITU 2019a). Clarifying the mechanisms that affect internet accessibility and adoption within the South Asian Group of Countries (SAGC) requires an understanding of the complex link between socioeconomic factors and Individual Internet Usage (IUI).

1.6 Economic Growth, R&D Expenditure, and Internet Usage

IUI is influenced by a variety of socioeconomic factors, including education, work possibilities, income levels, and the development of infrastructure. Higher GDP per capita (GDPPC) levels of economic prosperity are frequently positively correlated with IUI, reflecting more accessible and affordable internet and digital apparatus options. Furthermore, Research and Development Expenditures (R&DEXP) is an essential component that accelerates technical advancement and infrastructural growth, which ultimately leads to increased individual internet access and adoption.

1.7 Income Inequality, Poverty, and the Digital Divide

Moreover, disparities in income, as measured by the Poverty Head Count Ratio (PHCR) and the Gini Index, have a notable impact on IUI in the SAGC. Increased income disparities may make the gaps in internet access worse, making marginalized people more unable to connect. Therefore, it is crucial to address income disparities through focused interventions and inclusive policies to advance fair internet access and close digital divides throughout the region's socioeconomic strata. The following are some ways that economic growth and income disparities may affect people's internet use: 1. Accessibility: Differences in income might restrict access to digital literacy instruction, internet connectivity, and gadgets with internet capabilities.2. Affordability: Income disparities and economic growth may have an impact on the cost of digital services, gadgets, and internet plans.3. Digital literacy: The ability to learn digital skills can be impacted by income inequality, which can make it more difficult for certain people to make the most of the internet.4. Online opportunities: Access to online job opportunities, e-commerce platforms, and education can be impacted by economic growth and income inequality. 5. Digital divide: The gap in internet adoption and usage that already exists can be made worse by income inequality. This will cause certain people to fall behind. 6. Information access: The availability of high-quality information, internet resources, and expertise can be impacted by economic growth and socioeconomic inequality. 7. Online services: Access to online government, financial, and healthcare services can be impacted by income disparities. 8. Digital entrepreneurship: The capacity to launch and expand internet firms may be impacted by economic growth and socioeconomic disparities. These channels demonstrate how the ability of people to fully utilize the internet and take part in the digital economy may be significantly impacted by economic growth and socioeconomic inequality. (Rogers 1998; Ali, Naz & Andleeb 2017).

1.8 Theoretical Foundation: Diffusion of Innovation Theory

In the article's background, Rogers' Innovation Theory provides a fundamental framework for comprehending how internet technologies are spreading throughout the South Asian Group of Countries (SAGC). This theory, which was created by Everett M. Rogers, explains how innovations proliferate over time within civilizations by highlighting how adoption processes are influenced by innovation attributes, communication channels, social systems, and time. The paper uses Rogers' theory to look into the dynamics

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of internet uptake and diffusion within SAGC nations. The study attempts to clarify the dynamics driving internet usage and provides insights into methods for fostering digital inclusion and socio-economic development in the region by fusing this theoretical framework with empirical data and methodology. Through the theoretical lens of Rogers' Innovation Theory, scholars can examine the phases, contributing causes, and dynamics of internet uptake in SAGC nations. This theoretical framework guides the examination of how innovations, like internet technologies, disperse within various socio-cultural contexts (OECD 2001, p5), and drives the study's research questions, hypotheses, and analytical approach. While other definitions of the digital divide are available in the literature,

All things considered, Rogers' Innovation Theory provides an essential contextual framework for comprehending the spread of internet technologies across SAGC nations, offering insights into the mechanisms, factors, and consequences of internet adoption in the area. It fits absolutely with the Diffusion of Innovation Theory! Everett Rogers' thesis describes how new concepts and innovations become ingrained in the minds and bodies of people. It can be useful to comprehend how breakthroughs such as digital technologies spread and how access and adoption are impacted by income inequality in the context of internet use. The theory backs up the claim that disparities in affluence and economic growth have an impact on people's capacity to adopt and use the Internet (Wei et al. 2011). The following statistics show how economic growth and income disparity affect people who use the Internet (Sabi et al. 2018). - Internet growth contributed 21 percent of GDP growth in developed economies during the previous five years. - 800 million Facebook members globally including renowned businesses, if the Internet were a sector, its GDP would be higher than that of utilities or agriculture. - It is anticipated that the Internet will boost GDP by 2.5% and generate 2.4 million new employments in major economies over the next five years. - By 2025, it is anticipated that South Asia's internet economy will reach $250 billion. - By 2025, the internet economy in Europe is projected to reach $2.5 trillion. By 2025, it is anticipated that: - The internet economy in developed nations will reach $4.2 trillion; - South Asia's internet penetration will reach 50%; - Europe's internet penetration will reach 85%; - The internet penetration rate in developed nations will reach 90% (UNDP,2025).

The rest of the study is organized as follows. Section 2 provides empirical literature. Section 3 explains data sources and descriptions of variables. Model specification and methodology are expressed in section 4. The penultimate section 5 presents the results of the study, its conclusion, and policy implications.

2. Literature Review

Noh and Yoo (2007) expressed the II, internet, and EG. Covering the period of 1995 to 2002, 60 panels were applied to pure overlapping generation model countries for checking empirical findings. Found effect of internet adoption on EG positive for low-income inequality. The study suggested due to positive impact b/w ICT and EG required redistribution of income. Awais et al. (2025) experienced the impact of internet penetration on II levels and poverty levels, using data from 86 countries from 2005 to 2020. This study employed robust systematic GMM to check synergy, linear, and nonlinear effects models. Internet access results expressed different impacts on different level income groups and low-income countries showed a positive association b/w II and ICT and low-income groups were much affected by micro and macro factors of ICT. Toader et al. (2018) reported the ICT assessment in European countries on EG for a period of 18 years 2000 to 2017 from panel estimations within estimates. The study found a strongly +IVE impact on EG in EU member states but the magnitude was different based on the type of technology employed. At the EU level GDP per capita is affected by the degree of trade openness, unemployment rate, inflation rate, government expenditures and FDI. Findings were similar to theoretical predictions as well ICT along with economic factors was the important driver for EG in the EU. Kaleem, Mir, and Idrees (2018) enlisted the effects of infrastructure and institutional quality on the industrial sector of Pakistan.

The study covered the time series data from 1984 to 2012, employed ARDL and measured infrastructure and institutional quality by distinct proxies which expressed both variables positively correlated to industrial growth of observed countries. The research found that it is strong enough and needs more investment to increase infrastructure development. Kallal and Haddaji (2020) added to the literature on the diffusion of ICT and EG by performing sectorial scrutiny for a developing country, Tunisia. Principally, the

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study used to consider the r/s b/w EG and ICT diffusion which was developed as a sectorial ICT diffusion index for Tunisia. The research distinguished between SR and LR sound effects of ICT diffusion on EG to stay away from investment bias, as developing countries are typically characterized by poor ICT infrastructure, which affected development effectiveness in the SR. The study used the panel PMG form of the ARDL for the period 1997 to 2015. The investigation yielded two key findings. First, ICT diffusion had a +IVE effect on Tunisia's EG. Second -IVE SR outcomes attributable to extensive investment bias. These findings had vital policy implications for investors as well as policymakers. Undeniably, the sectorial index helped investors to recognize the sector with the highest prospective growth after ICT expansion. Supplementary, analysis could serve as a control panel for policymakers to encourage the growth of ICT transversely sectors.

Ahmed et al. (2021) expressed transport infrastructure like roads, railways, ports, airways, and industrial growth in Pakistan. This paper applied contemporary time series modelling techniques to show long run associations. Labor, capital, roads, and ports infrastructure increased industrial value added by 0.36 percent, and 0.28 % respectively. The research found a weak association b/w railways and industrial development but the airway showed neutral actions. This study suggested that in the wake of CPEC future investment in the transport sector especially railways more effectively can increase the growth of a country. Kocsis (2025) probed ICT and II. From 1980, II reduced in the USA that drew the attention of researchers and the public but entrepreneurs and managers got many benefits from ICT than middle and bottom classes. In Iceland they meanwhile improved the wellbeing's their citizens by reducing II. The study found significant -IVE r/s b/w ICT and II, especially in emerging economies but varied r/s results in the USA region.

3. Data Source and Description

Our empirical analysis for the South Asian Group of Countries (SAGC) is based on a carefully selected dataset that includes all nine countries in the region. To ensure its accuracy and reliability, this dataset has been painstakingly assembled from numerous reliable sources. The goal of the SAGC region's country selection process is to represent the variety of socioeconomic and technological environments that are present there. Establishing a solid empirical foundation for our analysis requires meticulous data collection.

All nine of the variables that we used in our research have data from the World Bank-managed World Development Indicators. Our dataset, which spans the years 2001 to 2025, has 198 panel observations in total, with nine cross-sections accessible for the majority of the periods (22 included). The information and communication technology (ICT) proxies FTS, FBBS, IUI, and MCS are included as dependent variables in a model for the South Asian Group of Countries (SAGC) and were taken into consideration in our research.

Furthermore, we use GI and PHCR as proxies for income inequality and GDPPC and R&DEXP as proxies for economic growth (EG). Brain drain is represented by net migration. The use of yearly data for these variables ensures the precision and dependability of our analysis, permitting an all-encompassing investigation of the elements impacting the spread of ICT and economic growth in the SAGC area.

4. Results and Analysis

Adequate panel data methodologies, like fixed effects or random effects models, are employed in the model estimation process to handle time-invariant country-specific effects and unobserved heterogeneity. To further guarantee the accuracy and dependability of the findings, robustness tests and diagnostic exams are carried out. By using this methodology, the study anticipates learning more about the variables that affect the spread of ICT and the economic growth of the South Asian Group of Countries. This knowledge will help us to better inform policy interventions and initiatives that are meant to advance digital inclusion and socioeconomic development in the area.

4.1. Model Specifications

The model is specified as follows:

Model

Panel Data Model: The Relationship between Information and Communication Technology Individuals Using Internet (IUI) and Economic Factors in South Asia (SA)

Log IUI=f log (GDPPC, GI, PHCR, R&DEXP)

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In IUI~it~ = *β*~0~ + *β*~1~In *GDPPC~it~* + *β*~2~In *GI~it~* + *β*~3~In *PHCR~it~* + *β*~4~In *R&DEXP~it~* + *α~i~* + *u~it~*

The Panel Data Model, a significant tool in our research, delves into the relationship between the ICT Use Index (IUI) and key economic factors in South Asia (SA) over time. This concise equation homes in on the core relationships and country-specific fixed effects (*αi*), providing a comprehensive understanding of the topic.

- *β*1 measures the impact of Gross Domestic Product per Capita (GDPPC) on IUI in SA. A positive *β*1 suggests that higher GDP per capita is associated with greater ICT use, as reflected in the IUI.
- The negative *β*2 reveals a clear relationship between the Gini Index (GI) and IUI in SA. It indicates that higher income inequality, as measured by the Gini Index, is inversely proportional to ICT use in SA. This finding underscores the role of income distribution in shaping ICT adoption patterns in the region and gauges the relationship between the PHCR and IUI in SA. A negative *β*3 implies a higher poverty rate is associated with lower ICT use.
- *β*4 evaluates the influence of R&DEXP on IUI in SA. A positive *β*4 suggests that the IUI indicates increased investments in R&D.

This panel data model provides a concise analysis of the relationship between economic factors and ICT use in South Asia over time that can interpret the coefficients to understand the direction and strength of these relationships, aiding policymakers and stakeholders in making informed decisions about ICT adoption and economic development strategies specific to the SA region. DSCA is explained in Table.

4.2 Descriptive Statistics and Correlation Analysis

DSCA is recounting variables statistics in Table 1.

Table 1

Descriptive Statistics of Key Variables (2001-2025)

	LIUI	LGDPPC	LGI	LPHCR	LR_D_EXP
MX	2.263	1.407	1.275	4.025	-0.830
MID	2.338	1.431	1.291	4.233	-0.793
Mix	4.456	4.346	1.332	4.570	0.279
Min	0.114	-0.053	1.126	1.366	-2.911
Std. Dev.	1.218	0.701	0.046	0.646	0.552
Skewness	-0.141	0.703	-0.857	-2.258	-0.741
Kurtosis	2.022	4.937	3.092	8.758	3.863
JB	8.544	47.309	24.333	441.953	24.286
Probability	0.013	0.000	0.005	0.000	0.005
Sum	448.076	278.608	252.616	797.084	-164.49
Sum Sq. Dev.	292.696	96.896	0.420	82.442	60.142

Author's calculation

Table 1 depicts the DSA of LIUI, GDPPC, GI, IUI, and PHCR. The average value of IUI is 1.48 with 1.44 MID. Maxi is 3.43 with a min value of 0.21.S.D is 0.89 with low fluctuations around the MX. Kurtosis is 2.75 which is platy-kurtic with medium top and skewness is -0.34 and MX is > than med so IUI is +IVELY skewed distribution. The p-value of IUI is 0.104 greater than 0.05 or 5% which is significant and normal distributed data.

Table 2

Correlation Matrix of Key Variables (2001-2025)

	LIUI	LGDPPC	LGI	LPHCR	LR_D_EXP
LIUI	1.000				
LGDPPC	0.103	1.000			
LGI	-0.232	-0.057	1.000		
LPHCR	-0.551	-0.095	-0.156	1.000	
LR_D_EXP	0.166	0.138	-0.210	0.122	1.000

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Author's calculation

Table 2 reports the correlation results of GDPPC, GI, and IUI per 100 people, R&DEXP, and PHCR. GDPPC is +IVE joined with IUI which indicates a very weak correlation b/w GDPPC and IUI. GI and IUI are also -IVELY associated with each other. The correlation b/w GI and IUI is -0.23. Association b/w PHCR and IUI is -0.55 which articulates the low correlation b/w PHCR with IUI. The results report +IVE and week relationship b/w GDPPC with IUI, GI with IUI, and also PHCR exclusively interrelated with IUI but IUI +IVELY linked with R&DEXP.PURT is explained in Table 3.

4.3 Panel Unit Root Test

The study explains PURT to check the stationarity of the data set in Table 3.

Table 3

PURT Summary

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.10154	0.0000	9	171
Null: Unit root (assumes individual unit root process)				
Im, BP and Shin W-stat	-6.00657	0.0000	9	171
ADF - Fisher Chi-square	75.3650	0.0000	9	171
PP - Fisher Chi-square	132.517	0.0000	9	180

Author's calculation

Table 3 depicts that all concern variables like GDPPC, GI, IUI, R&DEXP, and PHCR are stationary in their 1st difference form and the results of such test reports, it clear that the H0 of unit roots for all the panel unit root tests are rejected at their first difference with individual intercept and Mix lags one, while accepting alternate hypothesis. Table 4 expresses POLS.

4.4 Panel Ordinary Least Squares

The study explores POLS to run a regression of the following panel in Table 4.

Table 4

Panel Least Squares Sample: (2001 to 2025)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDPPC	0.004956	0.095309	0.052002	0.9586
LGI	-7.682225	1.468689	-5.230670	0.0000
LPHCR	-1.166160	0.104003	-11.21273	0.0000
LR_D_EXP	0.397505	0.123386	3.221636	0.0015
C	17.08217	1.978587	8.633517	0.0000
R^2	0.439421	MIDV		2.263013
Adjusted R^2	0.427803	S.D. dependent var		1.218920
S.E. of regression	0.922037	Akaike info criterion		2.700465
Sum squared resid	164.0793	Schwarz criterion		2.783502
Log likelihood	-262.3460	Hannan-Quinn criter.		2.734076
F-statistic	37.82172	DW		0.152015
Prob(F-statistic)	0.000000			

Author's calculation

In Table 4, this is the 7th model in which IUI per 100 people is used as dependent VARI with GDPPC, GI, R&DEXP, and PHCR for independent variables. GDPPC is positively connected with 1 % ↑ DGPPC will 0.004 % ↑ in IUI which is insignificant at 0.95 (t- stat,-0.05).GI is significant with an IUI of 0.000 and 1 % ↑ in GI will be 7.6% ↓ in IUI.PHCR is significant (Prob 0.000) with IUI as 1% ↑ in PHCR will ↓ 1.16 % in IUI. R&DEXP is highly significant as 1%↑ R&DEXP will be 0.5% ↑ in IUI. So, R^2 is 0.43, adjusted R squared 0.42, S.E of regression 0.92, HQC 2.73, AIC 2.70, SC 2.78 and D-W 0.15. As whole model is significant which is shown as Prob 0.0000 with 37.8 F --statistic. Table 5 includes FEM.

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4.5 Fixed Effect Method

The study explores FEM/REM by Micro panel in Table 5.

Table 5

Fixed Effect Method Sample: (2001 to 2025)

Dependent Variable: IUI per 100 people

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDPPC	0.061991	0.087764	0.706332	0.4809
LGI	-15.16307	2.247685	-6.746085	0.0000
LPHCR	-0.642349	0.157718	-4.072765	0.0001
LR_D_EXP	0.669742	0.153903	4.351721	0.0000
	Effects Specification			
Cross-section fixed (dummy variables)				
R^2	0.595528	MIDV		2.263013
Adjusted R^2	0.569292	S.D. dependent var		1.218920
S.E. of regression	0.799958	Akaike info criterion		2.454886
Sum squared resid	118.3874	Schwarz criterion		2.670782
Log likelihood	-230.0337	Hannan-Quinn criter.		2.542274
F-statistic	22.69885	DW		0.270064
Prob(F-statistic)	0.000000			

Author's calculation

In Table 5, the Intercept is 24.8. R&DEXP (0.0000) PHCR (0.0001) and GI (0.000) are significant but GDPPC (0.48) is insignificant. The coefficient of GDPPC ↑ 1% IUI ↑ by 0.06 % which expresses 0.08 S.E and 1% ↑ in GI will be 15.16% ↓ in dependent IUI with 2.24 S.E. As PHCR ↑ or changes 1%, 0.64% ↓ in IUI with 0.15 S.E. Model is good fit R^2 0.59 with S.E 0.79, MIDV 2.26, and AIC 2.45, SC 2.6, HQC 2.54 and DW 0.27. The empirical results are coordinated with Noh and Yoo (2007), Younsi (2025), Soava (2020), and Detschew (2007). Table 6 shows RFET.

4.6. Redundant Fixed Effects Test

To use POLS/ FEM or REM constructs RFET in Table 5.6.

Table 6

Test CS FE Sample: (2001- 2025)

Effects Test	Statistic	d.f.	Prob.
CSF	8.925137	(8,185)	0.0000
CSC	64.624658	8	0.0000

Author's calculation

In Table 6, both CSF and CSC-square are highly significant, in this case, FEM/REM is chosen by the HM test. Table 5.7 is unfolding RE.

4.7 Random Effect

To apply HME is required RE in Table 5.7.

Table 7

Cross-section Random Effects Sample (2001- 2025)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDPPC	-0.040492	0.086835	-0.466313	0.6415
LGI	-11.58206	1.863339	-6.215757	0.0000
LPHCR	-0.912074	0.130925	-6.966378	0.0000
LR_D_EXP	0.639572	0.141527	4.519079	0.0000
C	21.29993	2.264829	9.404653	0.0000

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Effects Specification			
			S.D.	Rho
Cross-section random			0.400543	0.2005
Idiosyncratic random			0.799958	0.7995
	Weighted Statistics			
R^2	0.455340	MIDV		0.886568
Adjusted R^2	0.444051	S.D. dependent var		1.104437
S.E. of regression	0.823490	Sum squared resid		130.8801
F-statistic	40.33732	DW		0.226982
Prob(F-statistic)	0.000000			
	Unweighted Statistics			
R^2	0.370507	MIDV		2.263013
Sum squared resid	184.2502	DW		0.161234

Author's calculation

Table 7 explains REM in which the intercept is 21.2. GDPPC (0.64) is insignificant than R&DEXP (0.0000) GI (0.0000) and PHCR (0.0000). Effect specification shows CSR 0.200 and IR 0.79 along with weighted R^2 0.19 F-stat 12.01 Prob F-stat 0.000000 DW 0.27. Unweighted statistics state R^2 0.45 DW 0.22. HME is shown in Table 8.

4.8 Correlated Random Effects - Hausman Test

CRE-HMT is explained to choose FEM/REM in Table 8.

Table 8

Test Cross-Section Random Effects Sample (2001-2025)

Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		15.521783	4	0.0037
	Cross-section random effects test comparisons:			
Variable	Fixed	Random	Var(Diff.)	Prob.
LGDPPC	-0.061991	-0.040492	0.000162	0.0914
LGI	-15.163073	-11.582063	1.580054	0.0044
LPHCR	-0.642349	-0.912074	0.007734	0.0022
LR_D_EXP	0.669742	0.639572	0.003656	0.6178

Author's calculation

In Table 8, the Hausman test(HM) is applied to choice b/w FEM and REM. Cross-section random effect's Prob 0.0037 which is < 0.05, can reject HN and accept alternative. So, FEM is applicable to IUI model. Table 9 is expressing RCSDT.

4.9 Residual Cross-Section Dependence Test

RCSD is explained to check correlation in weighted resides in Table 9.

Table 9

Dependency Test

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	20.15131	36	0.9847
BP scaled LM	-2.928446		0.0034
BP CD	1.033764		0.3012

Author's calculation

Table 9 expresses no CCD b/w variables exist and P values are also > 0.05 according to BP test and PCD tests by accepting HN. Table 9 shows NT.

4.10 Normality Test (NT)

The research explored NT to check the normality in data sets in Table 10.

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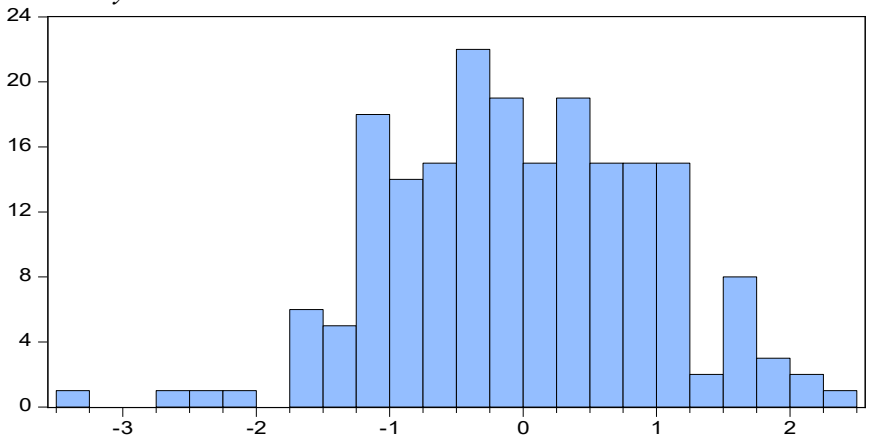
Table 10

Normality Test



Series: Standardized Residuals	
Sample 2001 2022	
Observations 198	
Mean	6.06e-17
Median	-0.048573
Maximum	2.411799
Minimum	-3.482928
Std. Dev.	0.974535
Skewness	-0.166493
Kurtosis	3.192742
Jarque-Bera	1.221239
Probability	0.543014

In Table 10, Prob is 0.543 which is > 0.05 rejecting HA/accept HN which indicates normal data. So, data satisfies the normality test. Conclusion and discussion are expressed in section 6.

5. Conclusion and Discussion

To better understand the dynamics of internet access within the South Asian Group of Countries (SAGC), this study focused on individuals using the internet (IUI), which serves as a proxy for the implementation of ICT. After a thorough analysis with fixed and random effect models, the study revealed important information about the factors affecting internet usage in this area. Although there was a positive correlation between GDPPC and IUI, the effect was not statistically significant, suggesting that economic growth might not be sufficient to ensure a ↑ in the number of people using the internet. Research and Development Expenditures (R&DEXP) on the other hand, showed a significant positive correlation with IUI, illustrating the significance of financing infrastructure development and technical innovation to advance internet accessibility.

Additionally, the research demonstrated a negative correlation between Income Inequalities and IUI, as determined by the Poverty Head Count Ratio (PHCR) and the Gini Index. These findings imply that greater income disparity may impede fair access to the Internet for all residents in SAGC. Overall, the results highlight how intricately social, technological, and economic issues interact to shape internet usage trends in South Asia. The report emphasizes how crucial it is to implement focused policy changes that support R&D, lessen financial disparities, and improve digital literacy to provide equitable and long-lasting internet access for all SAGC nations.

Several important legislative initiatives are suggested to guarantee affordable internet access and promote digital inclusion within the South Asian Group of Countries (SAGC). Initial and foremost, to increase internet coverage in both urban and rural areas, governments should give priority to investing in digital infrastructure. Simultaneously, it is imperative to establish all-encompassing digital literacy initiatives to provide people with the essential abilities to successfully navigate the virtual realm. Supporting innovation and digital entrepreneurship is also essential for promoting economic growth and creating new jobs. Promoting inclusive and sustainable internet access throughout SAGC also requires actions to lower internet service costs, address gender and rural-urban disparities, bolster cyber security measures, engage local communities, assess the efficacy of policies, and promote regional cooperation.

Author Contributions

All authors participated in ideation, development, and writing the manuscript. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

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Informed Consent

Informed consent was obtained from all participants prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without any consequences. The confidentiality and anonymity of respondents were guaranteed throughout the research process.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. The authors are committed to transparency and will provide detailed methodological information and analysis protocols upon request.

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