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Digital Infrastructure, Human Capital, and Entrepreneurial Ecosystem Development in South Korea: A Longitudinal Analysis (2000–2024)

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ABSTRACT

This study examines the relationship between digital infrastructure, human capital, and entrepreneurial ecosystem development in South Korea between 2000 and 2024. Using longitudinal macroeconomic and technological indicators obtained primarily from the World Bank World Development Indicators database, the research analyzes how digitalization and technological modernization contributed to the transformation of South Korea from a manufacturing-oriented economy into a highly innovation-driven entrepreneurial ecosystem. The empirical analysis combines descriptive longitudinal analysis, correlation analysis, and Ordinary Least Squares (OLS) regression models to evaluate the association between digital infrastructure variables and economic performance. The findings indicate substantial long-term improvements in internet diffusion, broadband infrastructure, secure digital systems, and human capital development. Regression results reveal a positive and statistically significant relationship between internet penetration and GDP growth, supporting existing literature on digital entrepreneurship and innovation ecosystems. Although broadband infrastructure displayed diminishing marginal effects within the regression model, the overall evidence suggests that digital modernization and knowledge-intensive development played important roles in strengthening entrepreneurial competitiveness. The study contributes to entrepreneurship and digital economy literature by providing empirical evidence on the structural determinants of innovation-driven entrepreneurial transformation in South Korea.

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1. INTRODUCTION

Over the last three decades, South Korea has emerged as one of the most remarkable examples of economic transformation in the global economy [1]. Traditionally characterized by a development model dominated by large family-owned conglomerates, known as chaebols, the country has progressively evolved toward a more innovation-oriented and entrepreneurial ecosystem [2]. This transition has attracted growing academic and policy interest because it demonstrates how advanced economies can strategically foster entrepreneurship through investments in digital infrastructure, human capital, and technological competitiveness [3], [4]. In recent years, South Korea has increasingly positioned itself as a leading hub for technology startups, artificial intelligence, digital innovation, and venture capital development, becoming an important case study for entrepreneurship and innovation policy research.

The rapid expansion of entrepreneurial activity in South Korea cannot be understood without considering the historical foundations of its economic development. Following the Korean War, the country adopted a state-led industrialization strategy focused on export-oriented growth and strong collaboration between government institutions and chaebols such as Samsung, Hyundai, LG, and SK Group. This model contributed significantly to industrial modernization and international competitiveness, particularly in manufacturing and electronics industries. However, despite its economic success, the chaebol-centered structure also generated limitations for small and medium-sized enterprises (SMEs), innovation diversity, and entrepreneurial dynamism. As globalization and digital transformation intensified during the 1990s and 2000s, South Korea increasingly recognized the need to diversify its economic structure and promote startup-driven innovation.

The Asian Financial Crisis of 1997 represented a critical turning point in this process. The crisis exposed structural weaknesses within the Korean economy and accelerated policy reforms aimed at improving flexibility, innovation, and competitiveness. Since then, the South Korean government has implemented extensive entrepreneurship and innovation policies designed to support startups, venture capital investment, digital infrastructure, and technological research [5]. Institutions such as the Ministry of SMEs and Startups (MSS) have played a central role in fostering entrepreneurial ecosystems through incubators, public funding programs, startup accelerators, and digital innovation initiatives. Consequently, South Korea has gradually transitioned from a manufacturing-based economy dominated by conglomerates to a more diversified ecosystem where startups increasingly contribute to technological innovation and economic growth [5], [6].

One of the most significant drivers of this transformation has been the country's investment in human capital and digital infrastructure [7]. South Korea consistently ranks among the world's leading countries in education performance, internet connectivity, broadband penetration, and research and development (R&D) expenditure. According to World Bank indicators, the country experienced a substantial increase in internet users, broadband subscriptions, and secure internet servers between 2000 and 2024, reflecting the development of an advanced digital ecosystem capable of supporting innovation-driven entrepreneurship [7], [8]. Simultaneously, improvements in human capital and technological competitiveness created favorable conditions for startup formation and digital business expansion. These structural factors have contributed to the emergence of innovative firms operating in sectors such as fintech, artificial intelligence, biotechnology, gaming, and e-commerce [9], [10].

The relationship between digitalization and entrepreneurship has become increasingly relevant within contemporary entrepreneurship literature [11]. Scholars have emphasized that digital

infrastructure, technological capabilities, and knowledge-intensive environments are essential determinants of entrepreneurial ecosystem development [4], [12]. In this context, South Korea represents a particularly interesting case because it combines strong state intervention with high levels of technological sophistication and private-sector dynamism. Unlike traditional entrepreneurial ecosystems driven primarily by market forces, the Korean model demonstrates how coordinated public policies and long-term investments can facilitate innovation and startup growth [5], [13]. Moreover, the coexistence of large conglomerates and emerging startups creates a hybrid entrepreneurial environment that differs from Silicon Valley-type ecosystems commonly discussed in Western entrepreneurship research.

Despite the growing importance of South Korea within global innovation networks, relatively limited research has empirically explored the relationship between digital infrastructure, human capital, and entrepreneurship using longitudinal macroeconomic indicators. Existing studies frequently focus on specific industries, policy initiatives, or cultural dimensions of Korean entrepreneurship, while fewer contributions examine the broader structural transformation of the entrepreneurial ecosystem over time [1]. This paper seeks to contribute to the literature by analyzing how technological infrastructure, digitalization, and human capital development supported the evolution of South Korea's innovation-driven entrepreneurial ecosystem.

Specifically, the study employs selected World Bank indicators covering the period between 2000 and 2024, including GDP growth, internet users, broadband subscriptions, secure internet servers, and human capital variables. Through a descriptive longitudinal analysis, the paper investigates the evolution of these indicators and discusses their implications for entrepreneurship and innovation development in South Korea. The study argues that sustained investments in digital infrastructure and human capital significantly contributed to the emergence of a competitive entrepreneurial ecosystem capable of supporting technology-intensive startups and innovation-led economic growth [3], [7], [11].

The remainder of the paper is structured as follows. The next section reviews the literature on entrepreneurial ecosystems, digital entrepreneurship, and innovation-driven economic development. The methodology section presents the selected dataset and analytical approach. The empirical analysis then discusses the evolution of key indicators related to digital infrastructure and human capital in South Korea. Finally, the discussion and conclusion sections examine the broader implications of the Korean entrepreneurial model for innovation policy and entrepreneurship research in advanced economies.

Research Objectives

The transformation of South Korea from a state-led industrial economy dominated by large conglomerates into one of the world's most technologically advanced entrepreneurial ecosystems has attracted increasing scholarly attention in recent years. While traditional economic development in South Korea was historically associated with export-oriented industrialization and the dominance of chaebols, contemporary economic growth is increasingly linked to digital innovation, startup creation, knowledge-intensive industries, and entrepreneurial competitiveness [14], [15]. In this context, understanding the determinants that contributed to the emergence of innovation-driven entrepreneurship in South Korea has become particularly relevant for both academic research and public policy.

Entrepreneurship scholars have increasingly emphasized the importance of entrepreneurial ecosystems as drivers of innovation, economic resilience, and technological competitiveness. Entrepreneurial ecosystems refer to interconnected environments composed of institutions, infrastructure, human capital, markets, financial systems, and cultural factors that collectively support entrepreneurial activity [16]. Previous

literature has demonstrated that digital infrastructure and technological readiness significantly influence entrepreneurial performance by reducing transaction costs, facilitating innovation diffusion, and increasing access to information and global markets [17], [18]. Consequently, countries characterized by advanced digital ecosystems often exhibit higher levels of startup formation and innovation capacity.

South Korea represents a unique empirical setting for investigating these dynamics because of its exceptional investments in education, technological infrastructure, and digital transformation. The country consistently ranks among global leaders in broadband penetration, internet connectivity, digital adoption, and research and development expenditure [19]. Moreover, South Korea has actively implemented national innovation policies aimed at fostering startup ecosystems, venture capital expansion, and technological entrepreneurship [20]. Such initiatives have contributed to the emergence of globally competitive startups operating in artificial intelligence, fintech, biotechnology, gaming, and digital platforms.

Despite the growing international relevance of the Korean entrepreneurial ecosystem, empirical studies examining the macro-structural determinants of entrepreneurship in South Korea remain relatively fragmented. Existing research frequently focuses on micro-level dimensions such as entrepreneurial intentions, startup financing, innovation management, or cultural characteristics of Korean firms [21]. Other studies emphasize the role of chaebols and industrial policy in shaping economic modernization [22]. However, fewer contributions investigate how broader structural variables such as digital infrastructure, human capital development, and technological competitiveness collectively supported the country's entrepreneurial transition over time.

Furthermore, contemporary entrepreneurship literature increasingly highlights the importance of digital entrepreneurship within advanced economies. Digital entrepreneurship refers to entrepreneurial activities enabled by digital technologies, internet-based infrastructures, and platform economies [23]. The expansion of internet access, secure digital systems, and broadband connectivity has transformed the way firms innovate, scale operations, and interact with consumers in global markets. In highly digitalized economies such as South Korea, digital entrepreneurship plays a critical role in supporting innovation ecosystems and enhancing economic adaptability in rapidly changing technological environments [24].

Another relevant dimension concerns the role of human capital in entrepreneurial ecosystem development. Human capital theory suggests that education, skills, technological knowledge, and workforce capabilities significantly influence innovation and entrepreneurial performance [25]. Countries with high levels of human capital are generally more capable of generating technological innovation, supporting startup creation, and attracting investment in knowledge-intensive industries. South Korea's strong educational performance and investment in research institutions therefore represent key factors explaining the country's transition toward an innovation-driven economy [26].

Against this background, the present study seeks to contribute to the entrepreneurship and innovation literature by examining the relationship between digital infrastructure, human capital, and entrepreneurial ecosystem development in South Korea. More specifically, the study investigates the evolution of selected macroeconomic and technological indicators between 2000 and 2024 using World Bank datasets and related international indicators. The research focuses on variables associated with digitalization, connectivity, human capital, and technological competitiveness, including internet users, broadband subscriptions, secure internet servers, GDP growth, and human capital indicators.

The primary objective of this paper is therefore to analyze how long-term investments in digital infrastructure and

human capital contributed to the emergence of an innovation-driven entrepreneurial ecosystem in South Korea. In addition, the study aims to identify the structural conditions that facilitated the country's transformation from a manufacturing-based economy into a technologically advanced startup environment. By examining longitudinal trends in digital and economic indicators, the paper seeks to provide empirical evidence regarding the role of technological modernization in entrepreneurship development.

A second objective of the study is to explore the relationship between digitalization and economic competitiveness within the Korean context. Existing literature suggests that digital infrastructure can significantly enhance productivity, innovation diffusion, and entrepreneurial opportunities [27]. Therefore, the paper investigates whether improvements in internet penetration, broadband infrastructure, and digital security corresponded with broader patterns of economic modernization and innovation capacity.

Finally, the study aims to contribute to policy discussions regarding entrepreneurship development in advanced economies. South Korea provides an important case study for countries attempting to strengthen innovation ecosystems through coordinated public investment, technological modernization, and digital transformation strategies. The findings may therefore offer useful insights for policymakers, researchers, and institutions interested in understanding how digital infrastructure and human capital investments can foster entrepreneurship and innovation-led growth.

2. LITERATURE REVIEW

2.1 Entrepreneurial Ecosystems and Economic Development

The concept of entrepreneurial ecosystems has become increasingly central within entrepreneurship and innovation studies over the last decade. Entrepreneurial ecosystems are generally defined as interconnected environments composed of institutions, policies, infrastructure, financial actors, universities, markets, and cultural conditions that collectively support entrepreneurial activity and innovation (Roundy et al., 2018). Unlike traditional approaches focused exclusively on firms or individual entrepreneurs, ecosystem perspectives emphasize the importance of interactions between multiple actors operating within broader institutional and economic contexts [28]. This framework has been widely applied to explain regional competitiveness, startup growth, and technological transformation in both advanced and emerging economies.

Previous literature suggests that entrepreneurial ecosystems significantly influence economic growth and innovation capacity. According to [29], successful entrepreneurial ecosystems depend on long-term collaboration between public institutions, private investors, universities, and entrepreneurs. Similarly, [30] argues that entrepreneurial ecosystems create favorable conditions for knowledge diffusion, technological spillovers, and startup formation. These dynamics are particularly relevant in knowledge-based economies characterized by high levels of innovation and digitalization.

The relationship between entrepreneurial ecosystems and economic development has been extensively discussed in policy-oriented literature. [31]

emphasize that governments increasingly support entrepreneurship as a strategy to stimulate innovation, competitiveness, and job creation. In this context, ecosystem-oriented policies focus not only on financial support but also on education, infrastructure, digital connectivity, and institutional quality. Such multidimensional approaches are particularly important in countries attempting to transition from industrial economies toward innovation-driven growth models.

South Korea provides an important example of entrepreneurial ecosystem transformation within an advanced economy. Historically, the Korean development model relied heavily on state-led industrialization and large conglomerates, commonly known as chaebols [32]. However, recent economic and technological changes have encouraged the development of startup ecosystems, venture capital markets, and digital entrepreneurship initiatives. This transformation reflects broader structural shifts toward knowledge-intensive industries and innovation-driven economic growth.

Several scholars have argued that entrepreneurial ecosystems in East Asia differ from Western models due to stronger government intervention and coordinated industrial policies [33]. In contrast to Silicon Valley-style ecosystems driven primarily by private-sector dynamics, Asian ecosystems often involve significant public investments in education, infrastructure, and technological development. South Korea, Singapore, and Taiwan are frequently cited as examples of economies where state-led innovation policies contributed substantially to entrepreneurial ecosystem formation.

The Korean entrepreneurial ecosystem has experienced rapid expansion since the early 2000s, supported by venture capital investment, digital transformation, and startup-friendly policies [34]. Government initiatives such as startup incubators, innovation clusters, and public-private accelerators have facilitated entrepreneurial activity in sectors including fintech, artificial intelligence, gaming, and biotechnology. Consequently, South Korea has increasingly been recognized as one of the leading startup ecosystems in Asia.

Another important aspect concerns the role of institutions within entrepreneurial ecosystems. Institutions influence entrepreneurship through regulations, policy stability, legal frameworks, and access to resources [35]. [36] argue that inclusive institutions encourage innovation and entrepreneurial dynamism by promoting competition and reducing barriers to market entry. In the Korean context, institutional reforms implemented after the Asian Financial Crisis contributed to greater economic flexibility and increased support for startups and SMEs.

The literature also highlights the importance of universities and research institutions in fostering entrepreneurship.

Universities contribute to entrepreneurial ecosystems through technology transfer, research commercialization, and human capital development [37]. South Korea's strong investment in higher education and technological research has therefore played a significant role in supporting innovation-driven entrepreneurship.

Although entrepreneurial ecosystem theory has expanded considerably in recent years, empirical research on ecosystem evolution in South Korea remains relatively limited. Existing studies often focus on specific industries or policy initiatives rather than examining long-term structural transformations. Therefore, further research is needed to understand how digital infrastructure, human capital, and technological competitiveness contributed to the emergence of Korea's entrepreneurial ecosystem.

Overall, the entrepreneurial ecosystem perspective provides a useful theoretical framework for analyzing South Korea's economic transformation. By integrating institutional, technological, and infrastructural dimensions, this approach allows researchers to examine how entrepreneurship emerges within broader systems of innovation and economic development.

2.2 *Digital Entrepreneurship and Technological Transformation*

Digital entrepreneurship has emerged as one of the most dynamic fields within contemporary entrepreneurship research. Digital entrepreneurship refers to entrepreneurial activities enabled by digital technologies, internet infrastructures, and online platforms [38]. The expansion of digital technologies has transformed business creation, innovation processes, and market interactions by reducing entry barriers and facilitating access to global markets.

The digitalization of economic activity has fundamentally altered entrepreneurial opportunities across industries. According to [39], digital technologies increase entrepreneurial flexibility by enabling rapid experimentation, scalability, and information exchange. Entrepreneurs operating in digital environments can access consumers, investors, and suppliers more efficiently than in traditional business models. Consequently, digital entrepreneurship has become increasingly associated with innovation-intensive sectors such as fintech, e-commerce, artificial intelligence, and software development.

South Korea is frequently considered one of the world's most advanced digital economies due to its exceptional internet infrastructure, broadband penetration, and technological readiness [40]. Since the early 2000s, the country has invested heavily in information and communication technologies (ICTs), contributing to the emergence of highly connected digital markets. Such investments created favorable conditions for startup development and digital business expansion.

Several studies have emphasized the relationship

between digital infrastructure and entrepreneurial competitiveness. Digital infrastructure includes broadband networks, internet connectivity, cloud systems, cybersecurity, and digital platforms that support economic activities [41]. Countries characterized by advanced digital infrastructures generally exhibit higher levels of innovation, startup formation, and technological adoption. In this context, South Korea represents an important empirical case because of its rapid digital transformation and strong technological capabilities.

Digital entrepreneurship also depends heavily on technological ecosystems and innovation networks. [42] argue that digital innovation ecosystems facilitate collaboration between entrepreneurs, technology firms, and research institutions. Such ecosystems accelerate innovation diffusion and increase opportunities for startup creation. In South Korea, technological clusters located in Seoul, Pangyo, and Daejeon have become important centers for innovation and digital entrepreneurship.

The emergence of platform economies has further strengthened digital entrepreneurship in advanced economies. Platform-based firms such as Naver, Kakao, Coupang, and Baemin have transformed consumer behavior and digital business models in South Korea (Jin, 2021). These firms not only contribute directly to economic growth but also stimulate startup ecosystems by creating technological spillovers and entrepreneurial opportunities.

Another important factor concerns cybersecurity and digital trust. Secure internet systems and digital reliability are essential for the expansion of e-commerce, fintech, and online entrepreneurship [43]. Countries with stronger digital security infrastructures are generally more capable of supporting digital transactions and innovation-driven entrepreneurship. Therefore, indicators such as secure internet servers provide valuable insights into the maturity of digital ecosystems.

The COVID-19 pandemic further accelerated digital entrepreneurship globally. Lockdowns and social distancing measures increased reliance on digital technologies, online platforms, and remote services [44]. South Korea's advanced digital infrastructure enabled rapid adaptation during the pandemic, reinforcing the country's position as a leading digital economy.

Despite the growing importance of digital entrepreneurship, several scholars caution against excessive technological determinism. Digital transformation alone may not automatically generate entrepreneurial success without supportive institutions, education systems, and financial ecosystems [45]. Therefore, digital entrepreneurship should be analyzed within broader economic and institutional contexts.

Overall, existing literature suggests that digital infrastructure and technological

transformation play critical roles in supporting entrepreneurship and innovation. South Korea's experience demonstrates how long-term investments in ICTs, connectivity, and digital ecosystems can contribute to the development of globally competitive entrepreneurial environments.

2.3 *Human Capital, Innovation, and Entrepreneurship*

Human capital represents one of the most significant determinants of entrepreneurship, innovation, and economic competitiveness. Human capital theory emphasizes the importance of education, skills, technological capabilities, and knowledge accumulation in shaping economic productivity and entrepreneurial performance [46]. Highly educated populations are generally more capable of generating innovation, adapting to technological change, and creating knowledge-intensive firms.

Entrepreneurship research increasingly recognizes that human capital influences both entrepreneurial intentions and firm performance. Entrepreneurs with higher levels of education and technical expertise are more likely to identify business opportunities, access financial resources, and manage innovative firms successfully [47]. In knowledge-based economies, human capital therefore becomes a critical driver of startup competitiveness and innovation capacity.

South Korea has consistently invested heavily in education and technological training since the second half of the twentieth century. The country's educational transformation contributed substantially to industrial modernization and technological catch-up during its rapid economic development process [48]. Today, South Korea ranks among the leading countries globally in tertiary education attainment, STEM education, and research intensity.

The relationship between education and entrepreneurship is particularly important in technology-intensive industries. Universities and research institutions not only generate scientific knowledge but also facilitate innovation commercialization and startup creation [49]. South Korean universities increasingly participate in entrepreneurial ecosystems through incubators, startup accelerators, and university-industry partnerships.

Innovation systems literature also highlights the importance of research and development (R&D) investments for entrepreneurial growth. [50] argues that innovation emerges through interactions between firms, institutions, and knowledge systems. Countries characterized by strong national innovation systems tend to exhibit higher levels of technological competitiveness and entrepreneurial dynamism.

South Korea's R&D expenditure is among the highest in the world relative to GDP, reflecting the country's strong commitment to technological innovation. Such investments have supported advancements in semiconductors, artificial

intelligence, robotics, biotechnology, and digital services [51]. Consequently, Korean startups increasingly operate within highly sophisticated technological environments.

Another important dimension concerns the relationship between human capital and digital transformation. Digital economies require specialized technological skills, adaptability, and innovation-oriented workforces [52]. Countries lacking advanced human capital may struggle to fully exploit digital entrepreneurial opportunities despite technological investments.

The literature also emphasizes the role of social and cultural factors in shaping entrepreneurial behavior. Confucian cultural traditions historically emphasized stability, hierarchy, and educational achievement within Korean society [53]. Although such cultural characteristics were sometimes viewed as barriers to entrepreneurship, recent studies suggest that they may also contribute positively to discipline, technological learning, and organizational commitment.

Government policies further influence human capital development and entrepreneurship. Public investments in education, vocational training, and innovation systems can significantly enhance entrepreneurial ecosystems [54]. South Korea's developmental policies therefore played a central role in creating the human capital foundations necessary for innovation-driven entrepreneurship.

Overall, existing literature demonstrates that human capital constitutes a fundamental pillar of entrepreneurial ecosystem development. South Korea's experience illustrates how long-term investments in education, technological skills, and research capacity can support innovation, startup creation, and digital economic transformation.

3. METHODS

3.1 Research Design

This study adopts a quantitative longitudinal research design aimed at examining the relationship between digital infrastructure, human capital, and entrepreneurial ecosystem development in South Korea between 2000 and 2024. The research focuses on the structural transformation of the Korean economy from a manufacturing-oriented development model toward an innovation-driven entrepreneurial ecosystem characterized by high levels of digitalization, technological sophistication, and startup activity. A longitudinal approach was considered particularly appropriate because it allows the analysis of economic and technological changes over time and facilitates the identification of long-term trends associated with entrepreneurial development [55].

The study employs secondary macroeconomic and technological data obtained from internationally recognized databases, primarily the World Bank World Development Indicators (WDI), complemented by additional international datasets related to competitiveness and digital infrastructure. The use of secondary international datasets ensures methodological reliability, cross-national comparability, and consistency in data collection procedures [56]. Furthermore, macro-level indicators are particularly useful for investigating structural dimensions of entrepreneurial ecosystems because they capture broader economic and

institutional transformations beyond firm-level dynamics.

The methodological framework of this paper is grounded in entrepreneurial ecosystem theory, innovation systems theory, and digital entrepreneurship literature. Entrepreneurial ecosystem theory emphasizes the importance of institutions, infrastructure, knowledge systems, and technological capabilities in supporting entrepreneurial activity [16]. Similarly, innovation systems approaches highlight the role of interactions between governments, universities, firms, and technological infrastructures in promoting innovation and economic competitiveness [50]. The integration of these theoretical perspectives provides a multidimensional analytical framework suitable for examining South Korea's entrepreneurial transformation.

The study follows a descriptive and exploratory empirical strategy. Descriptive longitudinal analysis was selected because the primary objective of the paper is not to establish strict causal relationships but rather to identify structural patterns and trends associated with entrepreneurship and technological modernization in South Korea. This approach is consistent with previous entrepreneurship and innovation studies that employ macroeconomic indicators to examine ecosystem evolution and digital transformation processes [31].

3.2 Data Collection and Sources

The empirical analysis is based on a custom longitudinal dataset constructed from multiple international databases. The primary source of data is the World Bank World Development Indicators (WDI), which provides internationally standardized macroeconomic, technological, and social indicators. Additional indicators were obtained from the World Economic Forum (WEF) and OECD datasets in order to complement the analysis of competitiveness and innovation capacity.

The dataset used in this study was manually extracted and merged from multiple CSV files covering technological infrastructure, digitalization, human capital, and economic performance indicators related to South Korea. Only observations referring to South Korea (KOR) were included in the analysis. The time frame selected for the study covers the period between 2000 and 2024, which corresponds to the phase of rapid digital expansion and entrepreneurial ecosystem development in South Korea.

The selection of variables was guided by previous literature on entrepreneurial ecosystems, digital entrepreneurship, and innovation-driven economic growth [17], [18]. More specifically, the study focuses on variables associated with digital connectivity, technological readiness, human capital development, and economic performance. These indicators were selected because they represent key structural dimensions frequently associated with entrepreneurial competitiveness in advanced economies.

The final dataset includes the following variables:

1. GDP Growth (%)
2. Human Capital Index
3. Internet Users (% of population)
4. Fixed Broadband Subscriptions
5. Secure Internet Servers
6. Competitiveness-related indicators

GDP growth was included as a proxy for overall macroeconomic performance and economic dynamism. Human capital indicators were selected to capture workforce quality, educational capabilities, and knowledge intensity within the Korean economy. Internet users and broadband subscriptions represent digital infrastructure and connectivity dimensions, while secure internet servers were used as a proxy for digital ecosystem sophistication and technological maturity.

The inclusion of secure internet servers is particularly relevant for entrepreneurship research because digital trust and cybersecurity infrastructures are essential for the development of digital business models, fintech platforms, e-commerce systems, and online entrepreneurial activities [43]. Similarly,

broadband penetration and internet accessibility are frequently associated with higher levels of innovation diffusion and startup formation in digital economies [38].

3.3 Data Preparation and Processing

After data extraction, the different datasets were merged into a unified longitudinal database using yearly observations as the common temporal dimension. The dataset was cleaned and standardized to ensure consistency across variables and years. Missing values were identified and handled through descriptive treatment procedures. Variables containing isolated missing observations were maintained in the dataset to preserve temporal continuity and avoid unnecessary data loss.

Data preprocessing included:

1. filtering observations for South Korea only;
2. selecting relevant indicators;
3. standardizing year formats;
4. converting variables into numerical values;
5. removing duplicated observations;
6. merging datasets into a single panel structure.

The final dataset was organized in panel format, where each observation corresponds to a specific year between 2000 and 2024. The resulting structure enabled the analysis of longitudinal trends associated with digitalization, human capital accumulation, and entrepreneurial ecosystem development.

Data extraction and preparation procedures were conducted using spreadsheet software and statistical data processing techniques. The use of standardized international databases significantly reduced risks associated with measurement inconsistencies and data reliability problems.

3.4 Research Hypotheses

Based on the existing literature on entrepreneurial ecosystems, digital entrepreneurship, and innovation-driven economic development, this study proposes a set of exploratory research hypotheses regarding the relationship between digital infrastructure, human capital, and economic performance in South Korea.

The hypotheses are formulated as follows:

H1: Higher levels of internet diffusion are positively associated with economic growth and entrepreneurial ecosystem development in South Korea.

H2: Broadband infrastructure expansion positively contributes to technological modernization and innovation-driven entrepreneurship.

H3: Secure digital infrastructures, measured through secure internet servers, positively correlate with the development of advanced digital entrepreneurial environments.

H4: Human capital accumulation positively influences innovation capacity and entrepreneurial ecosystem competitiveness.

These hypotheses are consistent with previous studies emphasizing the importance of digital infrastructure, technological readiness, and knowledge-intensive environments for entrepreneurship and innovation performance [17], [18].

3.5 Variable Operationalization

The study operationalizes entrepreneurship-related structural transformation through macroeconomic and technological indicators obtained from international databases. Table 1 summarizes the variables included in the empirical analysis.

Variable	Type	Proxy	Source	Expected Relationship
GDP Growth	Dependent	Annual GDP growth (%)	World Bank	Positive outcome indicator

Variable	Type	Proxy	Source	Expected Relationship
Human Capital	Independent	Human Capital Index	World Bank	Positive
Internet Users	Independent	% of population using internet	World Bank	Positive
Broadband Subscriptions	Independent	Fixed broadband subscriptions	World Bank	Positive
Secure Internet Servers	Independent	Secure servers per population	World Bank	Positive

The dependent variable selected for the empirical analysis is GDP growth, used as a macro-level proxy for economic dynamism and innovation-driven development. Although GDP growth does not directly measure entrepreneurship, previous studies suggest that innovation ecosystems and digital transformation significantly influence broader economic performance [30].

The independent variables represent key structural dimensions associated with entrepreneurial ecosystems. Internet users and broadband subscriptions capture digital connectivity and technological accessibility, while secure internet servers represent digital sophistication and cybersecurity capacity. Human capital indicators reflect education quality, workforce capabilities, and knowledge intensity within the Korean economy.

3.6 Analytical Strategy

The empirical analysis combines descriptive longitudinal analysis with exploratory econometric techniques. The descriptive component focuses on identifying long-term trends in digitalization, technological modernization, and human capital accumulation between 2000 and 2024. The methodological objective is to examine how changes in digital infrastructure, human capital, and technological indicators corresponded with broader patterns of entrepreneurial ecosystem development in South Korea.

The descriptive analysis includes:

1. temporal trend analysis;
2. comparative indicator evaluation;
3. graphical visualization of longitudinal changes;
4. interpretation of structural transformations over time.

Trend analysis was considered particularly appropriate because the study seeks to investigate gradual economic and technological transformations rather than short-term fluctuations. Longitudinal visualizations allow the identification of periods characterized by accelerated digital expansion, technological upgrading, and entrepreneurial ecosystem consolidation.

In addition to descriptive analysis, the study employs correlation analysis and Ordinary Least Squares (OLS) regression models in order to examine the relationship between digital infrastructure variables and economic performance. Correlation analysis provides preliminary evidence regarding the association between digitalization indicators and broader measures of economic modernization and entrepreneurial ecosystem development. However, the study does not attempt to establish direct causal inference because entrepreneurial ecosystems are influenced by multiple institutional, cultural, and economic dimensions that cannot be fully captured through macroeconomic indicators alone.

The main econometric model adopted in this study is specified as follows:

$$GDP_t = \beta_0 + \beta_1 InternetUsers_t + \beta_2 Broadband_t + \beta_3 SecureServers_t + \beta_4 HumanCapital_t + \varepsilon_t$$

Where:

GDP_t = annual GDP growth at time t
$InternetUsers_t$ = internet penetration
$Broadband_t$ = fixed broadband subscriptions
$SecureServers_t$ = secure internet servers
$HumanCapital_t$ = Human Capital Index
β_0 = intercept
$\beta_1 \ldots \beta_4$ = regression coefficients
ε_t = error term

Where GDP_t represents annual GDP growth, InternetUsers_t represents internet penetration, Broadband_t represents broadband subscriptions, SecureServers_t represents digital security infrastructure, and HumanCapital_t represents the Human Capital Index.

The regression model aims to evaluate whether improvements in digital infrastructure and human capital are associated with higher levels of economic dynamism in South Korea. OLS regression was selected because of its interpretability and frequent application within entrepreneurship and innovation studies using macroeconomic datasets [57].

The methodological approach adopted in this paper is therefore intentionally exploratory and interpretative. This decision reflects the complexity of entrepreneurial ecosystems and the multidimensional nature of innovation-driven economic transformation. Several scholars argue that entrepreneurship ecosystems should be analyzed using interdisciplinary and mixed analytical perspectives rather than purely deterministic econometric approaches [30], [58].

3.7 Reliability and Limitations

The study benefits from several methodological strengths. First, the use of internationally recognized databases enhances data reliability, comparability, and transparency. Second, the longitudinal design allows the observation of long-term structural transformations associated with digitalization and entrepreneurial development. Third, the integration of multiple indicators provides a multidimensional perspective on South Korea's entrepreneurial ecosystem.

Nevertheless, the study also presents certain limitations. Macroeconomic indicators may not fully capture micro-level entrepreneurial dynamics such as startup survival rates, entrepreneurial intentions, venture capital quality, or innovation culture. In addition, entrepreneurship ecosystems are influenced by institutional and sociocultural dimensions that are difficult to operationalize quantitatively.

Another limitation concerns the descriptive nature of the analysis. Although longitudinal trends provide valuable insights into structural transformations, they do not establish direct causality between digital infrastructure and entrepreneurial outcomes. Therefore, findings should be interpreted as exploratory evidence rather than definitive causal conclusions.

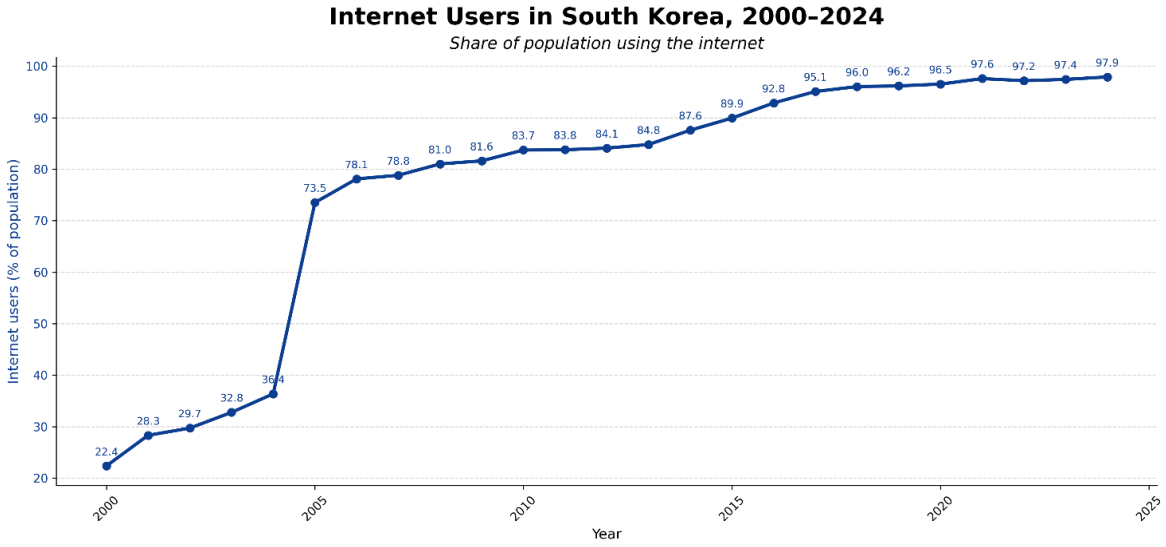
Despite these limitations, the methodological approach adopted in this study remains appropriate for investigating South Korea's entrepreneurial transformation from a macro-structural perspective. The integration of digital infrastructure indicators, human capital measures, and longitudinal analysis provides a robust framework for understanding how technological modernization contributed to the emergence of an innovation-driven entrepreneurial ecosystem.

4. RESULTS AND DISCUSSION

The empirical analysis demonstrates the substantial transformation of South Korea into a highly digitalized and innovation-driven economy between 2000 and 2024. The longitudinal evidence reveals consistent improvements in internet connectivity, broadband infrastructure, cybersecurity capacity, and human capital development, supporting the argument that South Korea progressively strengthened the structural foundations necessary for the emergence of an advanced entrepreneurial ecosystem. These findings are consistent with entrepreneurial ecosystem theory, which emphasizes the importance of technological infrastructure,

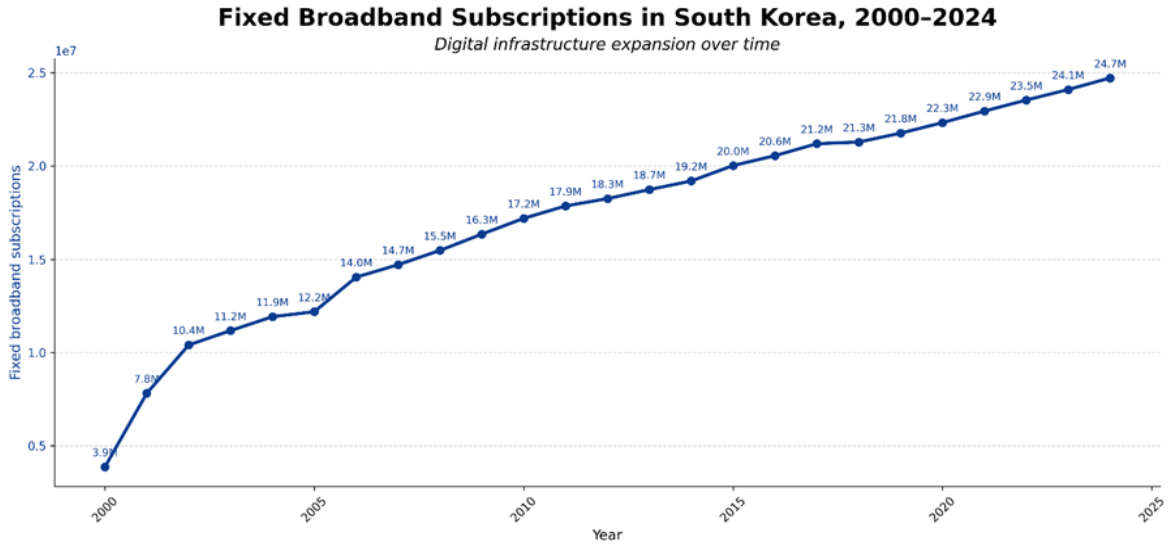
institutional support, and knowledge-intensive environments for innovation and startup development [16], [18].

The descriptive analysis indicates a substantial increase in internet diffusion during the observed period. Internet users expanded continuously between 2000 and 2024, reflecting South Korea's long-term investments in information and communication technologies (ICTs), digital infrastructure, and technological modernization. The diffusion of internet connectivity is particularly important within digital entrepreneurship literature because digital access reduces market frictions, facilitates opportunity recognition, and enhances entrepreneurial scalability within innovation-driven economies [17]. In the Korean context, the expansion of internet accessibility likely contributed to the growth of platform economies, online business models, fintech ecosystems, and technology-intensive startups.



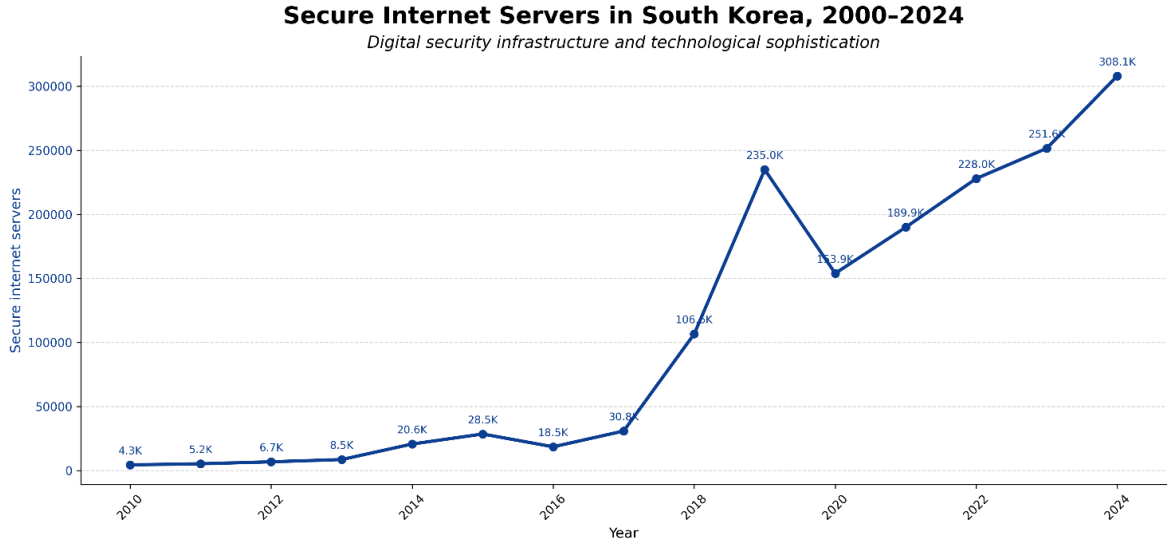
Note. The indicator captures digital adoption and connectivity, used as a proxy for digital entrepreneurship readiness.
Source. World Bank – World Development Indicators.

Broadband infrastructure also exhibited substantial growth throughout the observed period. Broadband subscriptions increased significantly over time, demonstrating the expansion of high-quality digital connectivity across the Korean economy. From a theoretical perspective, broadband diffusion represents a critical enabling factor for digital entrepreneurship because it improves access to information, cloud systems, digital platforms, e-commerce services, and innovation networks [38]. The Korean experience suggests that sustained investments in broadband infrastructure facilitated the development of highly connected entrepreneurial environments capable of supporting technological innovation and startup competitiveness.



Note. The indicator measures the expansion of fixed broadband infrastructure, relevant for digital business formation and technological modernization.
Source. World Bank – World Development Indicators.

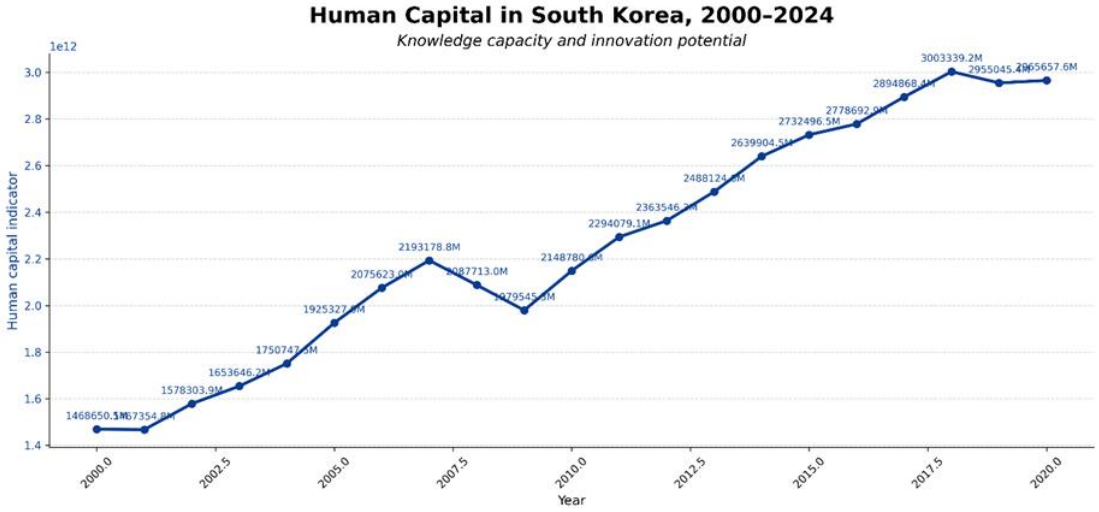
Another important finding concerns the evolution of secure internet servers, which increased dramatically during the period under investigation. Secure internet servers represent a proxy for cybersecurity infrastructure, digital reliability, and technological sophistication. The growth of secure digital infrastructures is especially relevant for entrepreneurship because online business models increasingly depend on digital trust, secure transactions, and reliable technological ecosystems [43]. Therefore, the Korean case demonstrates not only a quantitative expansion of digital connectivity but also a qualitative improvement in technological maturity and digital ecosystem reliability.



Note. The indicator is used as a proxy for digital trust, cybersecurity capacity, and the maturity of online entrepreneurial environments.
Source. World Bank – World Development Indicators.

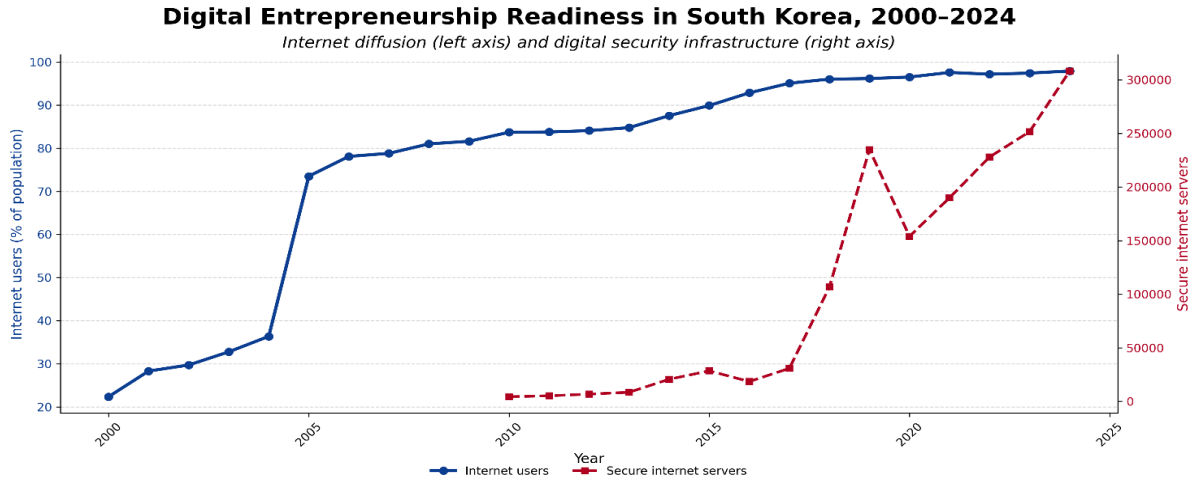
The longitudinal analysis further highlights substantial improvements in human capital indicators. South Korea consistently invested in education, technological capabilities, and research-intensive sectors throughout the observed period. Human capital theory suggests that educational attainment, technical expertise,

and workforce capabilities significantly influence innovation performance and entrepreneurial competitiveness [25]. In knowledge-intensive economies, highly skilled populations are more capable of generating technological innovation, commercializing research, and supporting startup ecosystems. Consequently, South Korea's strong educational and technological foundations likely contributed to the development of innovation-driven entrepreneurship and advanced digital industries.



Note. The indicator captures human capital development, used as a proxy for skills, knowledge intensity, and innovation capacity.
Source. World Bank – World Development Indicators.

The combined evolution of internet diffusion and digital security infrastructure provides additional evidence regarding the transformation of South Korea's entrepreneurial ecosystem. Internet penetration and secure internet servers increased simultaneously during the observed period, suggesting that digital expansion was accompanied by improvements in technological reliability and cybersecurity capacity. This finding is particularly relevant because advanced entrepreneurial ecosystems increasingly require not only internet accessibility but also secure and technologically sophisticated digital environments capable of supporting online transactions, digital platforms, and innovation-intensive business models.



Note. Internet users represent digital adoption, while secure internet servers capture digital trust and technological sophistication.
Source. World Bank – World Development Indicators.

To further examine the structural relationships between digitalization and economic performance, the study employed correlation analysis and Ordinary Least Squares (OLS) regression models. The correlation matrix revealed positive relationships among most digital infrastructure variables, indicating that improvements in connectivity, broadband diffusion, digital security, and human capital evolved simultaneously over time. These results reinforce entrepreneurship ecosystem literature emphasizing the interconnected nature of innovation systems, technological modernization, and entrepreneurial competitiveness [58].

3.2 Correlation Matrix

	GDP	HumanCapital	InternetUsers	Broadband	SecureServers
GDP	1.000	-0.642	-0.555	-0.703	-0.545
HumanCapital	-0.642	1.000	0.961	0.978	0.688
InternetUsers	-0.555	0.961	1.000	0.977	0.741
Broadband	-0.703	0.978	0.977	1.000	0.753
SecureServers	-0.545	0.688	0.741	0.753	1.000

The OLS regression model investigated the relationship between GDP growth and selected indicators of digital infrastructure and human capital. The regression model produced an R-squared value of 0.887, indicating that the explanatory variables collectively account for a substantial proportion of the variation in economic performance during the observed period. This result suggests that digital infrastructure and human capital are strongly associated with broader processes of economic modernization and entrepreneurial ecosystem development in South Korea.

More specifically, internet users demonstrated a positive and statistically significant relationship with GDP growth. This finding supports digital entrepreneurship theory, according to which internet diffusion enhances innovation capacity, improves market accessibility, and facilitates entrepreneurial activity within technologically advanced economies [17]. Increased digital connectivity likely strengthened startup ecosystems by enabling greater access to digital services, information networks, and online business opportunities.

Broadband subscriptions also displayed a statistically significant relationship with GDP growth, although the coefficient appeared negative within the regression model. This result may reflect diminishing marginal effects associated with highly mature digital economies characterized by already elevated levels of broadband penetration. In advanced technological contexts such as South Korea, additional broadband expansion may produce weaker marginal economic impacts compared to earlier stages of digital development. Therefore, the negative coefficient should not be interpreted as evidence of adverse economic consequences but rather as an indication of saturation dynamics within highly developed digital infrastructures.

Secure internet servers did not exhibit statistically significant effects within the regression model. Nevertheless, the descriptive analysis demonstrated a strong long-term increase in cybersecurity capacity and digital sophistication. The absence of statistical significance may be partially explained by the relatively limited number of yearly observations and the volatility of cybersecurity-related indicators over time. Despite this limitation, secure digital infrastructures remain theoretically important for entrepreneurship, particularly in fintech, e-commerce, and platform-based digital sectors.

Human capital indicators demonstrated positive associations with GDP growth, supporting literature emphasizing the strategic importance of education, technological capabilities, and knowledge-intensive environments for innovation-driven development (Marvel et al., 2016). Although

statistical significance remained limited within the regression model, the descriptive evidence strongly suggests that South Korea's long-term investments in education and technological skills contributed substantially to the emergence of a highly competitive entrepreneurial ecosystem.

4.2 OLS Regression Results

Variable	Coefficient	Std. Error	t-statistic	p-value
const	-5.5844	8.7967	-0.6348	0.5490
InternetUsers	0.8994	0.2098	4.2872	0.0052
Broadband	-0.0000	0.0000	-4.3870	0.0046
SecureServers	-0.0000	0.0000	-0.0118	0.9910
HumanCapital	0.0000	0.0000	0.8680	0.4188

Overall, the empirical findings support the argument that long-term investments in digital infrastructure, technological modernization, and human capital played a fundamental role in South Korea's transition from a manufacturing-oriented economy toward a technologically sophisticated entrepreneurial ecosystem. The results are consistent with contemporary entrepreneurship literature emphasizing the importance of connectivity, technological readiness, digital reliability, and knowledge-intensive environments in supporting innovation-driven economic growth. Furthermore, the Korean case illustrates how coordinated investments in digital transformation and human capital development may contribute to the emergence of globally competitive entrepreneurial ecosystems within advanced economies.

4.3 Discussion

Digital Infrastructure and Entrepreneurial Transformation

The findings of this study provide important insights into the structural transformation of South Korea from a manufacturing-oriented economy into a technologically advanced entrepreneurial ecosystem. The empirical evidence suggests that long-term investments in digital infrastructure, internet connectivity, cybersecurity capacity, and human capital contributed significantly to the development of innovation-driven entrepreneurship between 2000 and 2024. These results are broadly consistent with entrepreneurial ecosystem theory, digital entrepreneurship literature, and innovation systems approaches emphasizing the importance of technological readiness and knowledge-intensive environments for entrepreneurial competitiveness [16], [18].

One of the most significant findings concerns the positive relationship between internet diffusion and economic performance. The regression results indicate that internet users exhibited a positive and statistically significant association with GDP growth, suggesting that digital connectivity played an important role in South Korea's economic modernization process. This finding supports previous studies arguing that internet accessibility enhances entrepreneurial opportunity recognition, facilitates knowledge diffusion, and improves market access for startups and innovation-oriented firms [17]. In highly digitalized economies, internet connectivity represents not only a communication infrastructure but also a strategic economic resource capable of accelerating technological innovation and entrepreneurial expansion.

The Korean case demonstrates how digital infrastructure may function as a foundational pillar of entrepreneurial ecosystem development. The rapid expansion of internet users observed during the period under investigation reflects South Korea's long-term commitment to technological modernization and ICT investments. Such investments created favorable conditions for the emergence of platform economies, digital startups, fintech ecosystems, and technology-intensive industries. Companies such as

Naver, Kakao, Coupang, and other Korean digital firms emerged within a broader environment characterized by advanced digital accessibility, strong technological capabilities, and high levels of consumer digital adoption.

Broadband Expansion and Technological Competitiveness

Another important finding concerns broadband infrastructure. The descriptive analysis demonstrated substantial growth in broadband subscriptions between 2000 and 2024, confirming South Korea's position as one of the world's most technologically connected economies. Broadband infrastructure is frequently identified within entrepreneurship literature as a key enabling factor for innovation ecosystems because it facilitates access to digital services, online markets, cloud computing systems, and information networks [38]. Therefore, the Korean experience provides additional evidence supporting the argument that technological infrastructure constitutes a critical dimension of entrepreneurial competitiveness. Interestingly, although broadband subscriptions exhibited a statistically significant relationship with GDP growth, the regression coefficient appeared negative within the empirical model. This result should be interpreted cautiously. In highly mature digital economies such as South Korea, where broadband penetration has already reached exceptionally high levels, additional infrastructure expansion may generate diminishing marginal economic effects. Consequently, the negative coefficient likely reflects saturation dynamics rather than adverse economic consequences. This interpretation is consistent with innovation literature suggesting that advanced economies may experience decreasing returns from infrastructural expansion once digital accessibility becomes nearly universal.

Cybersecurity and Digital Sophistication

The findings related to secure internet servers also contribute to the understanding of digital entrepreneurship ecosystems. Although secure internet servers did not demonstrate statistical significance within the regression model, the descriptive analysis revealed a substantial increase in digital security infrastructure over time. This trend suggests that South Korea progressively strengthened the technological reliability and cybersecurity capacity of its digital ecosystem. Such improvements are particularly important for innovation-intensive sectors including fintech, artificial intelligence, e-commerce, and platform-based business models, where digital trust and secure online transactions are essential.

The absence of statistical significance for secure internet servers may be partially explained by methodological limitations associated with longitudinal macroeconomic analysis. The relatively limited number of yearly observations and the volatility of cybersecurity indicators may reduce statistical robustness within regression models. Nevertheless, the variable remains theoretically relevant because secure digital environments increasingly represent a necessary condition for sustainable digital entrepreneurship. Therefore, the descriptive evidence should not be overlooked despite the limited econometric significance.

Human Capital and Innovation Capacity

Human capital development also emerged as an important dimension within the Korean entrepreneurial transformation. The descriptive findings demonstrated continuous improvements in human capital indicators, reflecting South Korea's strong investments in education, technological capabilities, and research-intensive industries. Human capital theory argues that knowledge accumulation, technical skills, and educational attainment significantly influence innovation performance and entrepreneurial competitiveness [25]. The Korean experience strongly supports this theoretical perspective.

South Korea's educational transformation and technological upgrading contributed to the creation of a highly skilled workforce capable of supporting innovation-driven industries. The country's strong

emphasis on STEM education, research and development (R&D), and technological learning created favorable conditions for entrepreneurship and startup development. Although the human capital variable did not achieve strong statistical significance within the regression model, this result may reflect the already consistently high levels of educational performance characterizing South Korea during the observed period. In other words, the relative stability of human capital indicators may reduce statistical variability despite their broader structural importance.

Entrepreneurial Ecosystems and Institutional Dynamics

The findings also reinforce broader entrepreneurial ecosystem theory emphasizing the interconnected nature of institutions, infrastructure, technology, and knowledge systems. Entrepreneurial ecosystems do not emerge solely through market mechanisms but rather through long-term interactions between governments, educational institutions, technological infrastructures, private-sector actors, and innovation policies [58]. South Korea represents a particularly important case because it illustrates how coordinated state-led investments can accelerate entrepreneurial ecosystem development within advanced economies.

Unlike more market-oriented entrepreneurial ecosystems commonly associated with Silicon Valley, the Korean model combines strong governmental coordination with private-sector technological dynamism. Public policies supporting digital infrastructure, startup incubators, venture capital, technological clusters, and innovation systems contributed significantly to the country's entrepreneurial transition. Consequently, the Korean case demonstrates that entrepreneurial ecosystems may emerge through different institutional configurations depending on historical, cultural, and economic contexts.

The Korean entrepreneurial transformation also reflects broader structural changes associated with globalization and digital capitalism. During the last two decades, South Korea progressively integrated digital technologies into both industrial production and consumer markets, creating favorable conditions for innovation-oriented entrepreneurship. The expansion of mobile technologies, e-commerce platforms, digital financial services, and artificial intelligence ecosystems accelerated entrepreneurial diversification and reduced barriers to market entry for technology-based startups. Consequently, digital transformation not only improved technological competitiveness but also reshaped the organizational structure of the Korean economy.

An important aspect emerging from the findings concerns the hybrid nature of the Korean entrepreneurial ecosystem. Unlike entrepreneurial environments characterized exclusively by startup-driven innovation, South Korea combines the presence of large conglomerates with rapidly expanding startup ecosystems. This coexistence creates both opportunities and tensions within the entrepreneurial environment. On one hand, chaebols contribute significantly to technological advancement, research investment, and industrial competitiveness. On the other hand, their market dominance may limit competition and create structural barriers for smaller entrepreneurial firms. Nevertheless, recent policy reforms and digital transformation strategies appear to have progressively improved opportunities for startups and SMEs within the Korean economy.

The findings also reinforce arguments suggesting that entrepreneurial ecosystems evolve gradually through cumulative institutional and technological changes rather than through isolated policy interventions. South Korea's transformation was not the result of a single entrepreneurship policy but rather the outcome of long-term investments in education, digital infrastructure, innovation systems, and industrial modernization. This evolutionary perspective is particularly relevant because many governments attempt to replicate entrepreneurial ecosystems through short-

term startup initiatives without addressing broader structural conditions. The Korean case demonstrates that successful entrepreneurial ecosystems require long-term coordination between public institutions, technological infrastructures, educational systems, and private-sector innovation networks.

Another relevant implication concerns the role of technological sophistication within advanced economies. The findings indicate that internet accessibility alone is insufficient for supporting sustainable entrepreneurial growth. Instead, entrepreneurial competitiveness increasingly depends on the quality, reliability, and security of digital infrastructures. The growth observed in secure internet servers suggests that South Korea progressively strengthened the institutional and technological conditions necessary for digital trust and online entrepreneurial activities. This aspect is especially important within contemporary digital economies where fintech systems, artificial intelligence applications, and platform-based business models rely heavily on cybersecurity capacity and technological reliability.

The results additionally suggest that entrepreneurship should not be analyzed exclusively through firm-level perspectives. Macroeconomic and infrastructural dimensions significantly influence the broader conditions under which entrepreneurial activity emerges and expands. South Korea's experience illustrates how national-level investments in connectivity, digital modernization, and technological capabilities may shape entrepreneurial opportunities across multiple industries. Therefore, entrepreneurial ecosystems should be understood as multidimensional systems integrating institutional, technological, educational, and economic factors.

Policy Implications

The study also carries important policy implications. First, the findings suggest that investments in digital infrastructure remain critical for entrepreneurship development and technological competitiveness. Policymakers seeking to strengthen entrepreneurial ecosystems should therefore prioritize broadband accessibility, internet diffusion, cybersecurity capacity, and digital modernization strategies. Second, the results highlight the importance of human capital development for innovation-driven entrepreneurship. Educational systems, technological training, and research institutions represent fundamental pillars of entrepreneurial competitiveness within digital economies.

Third, the Korean experience demonstrates the importance of long-term policy coordination. Entrepreneurial ecosystems require sustained investments and institutional stability rather than short-term policy interventions. South Korea's transformation occurred progressively over several decades through coordinated investments in infrastructure, education, industrial modernization, and technological innovation.

Limitations and Future Research

Despite its contributions, the study presents several limitations. The analysis relies primarily on macroeconomic indicators that may not fully capture micro-level entrepreneurial dynamics such as startup survival rates, entrepreneurial intentions, innovation quality, or venture capital performance. Furthermore, entrepreneurial ecosystems are influenced by sociocultural and institutional dimensions that are difficult to operationalize quantitatively. Therefore, future research could complement macroeconomic analysis with firm-level datasets, case studies, or qualitative approaches examining startup ecosystems more directly.

Future studies could also expand the comparative dimension of entrepreneurial ecosystem analysis by comparing South Korea with other technologically advanced economies such as Singapore, Japan, or Taiwan. Comparative approaches may provide additional insights into how different institutional and technological configurations

influence entrepreneurship and innovation performance.

Overall, the findings of this study support the argument that digital infrastructure, technological modernization, and human capital played fundamental roles in South Korea's entrepreneurial transformation. The Korean case illustrates how coordinated investments in digitalization and knowledge-intensive development can contribute to the emergence of globally competitive entrepreneurial ecosystems capable of supporting innovation-driven economic growth in advanced economies.

5. CONCLUSION

This study examined the relationship between digital infrastructure, human capital, and entrepreneurial ecosystem development in South Korea between 2000 and 2024. By employing longitudinal macroeconomic and technological indicators obtained primarily from World Bank datasets, the research investigated how digitalization and technological modernization contributed to the transformation of South Korea from a manufacturing-oriented economy into a highly sophisticated innovation-driven entrepreneurial ecosystem.

The findings demonstrate that South Korea experienced substantial long-term improvements in internet connectivity, broadband infrastructure, cybersecurity capacity, and human capital development during the observed period. These structural transformations coincided with the emergence of a technologically advanced entrepreneurial environment characterized by digital innovation, platform-based business models, and knowledge-intensive industries. The empirical analysis therefore supports the argument that sustained investments in digital infrastructure and human capital played a central role in strengthening South Korea's entrepreneurial competitiveness and technological modernization.

One of the most important findings concerns the positive association between internet diffusion and economic performance. The results suggest that digital connectivity contributed significantly to broader processes of innovation and economic dynamism within the Korean economy. This finding reinforces digital entrepreneurship literature emphasizing that internet accessibility facilitates opportunity recognition, market expansion, technological diffusion, and startup development within advanced economies.

The study also highlighted the importance of broadband infrastructure and digital security systems within entrepreneurial ecosystems. Although the broadband coefficient displayed negative signs within the regression model, the broader descriptive evidence indicates that broadband expansion remained essential for supporting digital transformation and technological competitiveness. The negative coefficient may reflect saturation effects associated with highly mature digital economies rather than adverse economic impacts. Similarly, secure internet servers demonstrated strong longitudinal growth despite limited statistical significance within the regression analysis, suggesting that digital trust and cybersecurity infrastructures remain strategically important for entrepreneurship and innovation.

Human capital emerged as another fundamental dimension of South Korea's entrepreneurial transformation. The country's strong investments in education, technological capabilities, and research-intensive sectors contributed significantly to the creation of a highly skilled workforce capable of supporting innovation-driven industries and startup ecosystems. These findings are consistent with entrepreneurship and innovation literature emphasizing the importance of knowledge-intensive environments and technological capabilities for long-term economic competitiveness.

From a theoretical perspective, the study contributes to entrepreneurial ecosystem literature by demonstrating the interconnected relationship between digital infrastructure, technological modernization, and entrepreneurship development. The

Korean case illustrates that entrepreneurial ecosystems evolve through cumulative investments in infrastructure, education, innovation systems, and institutional coordination rather than through isolated startup policies alone. Consequently, the findings reinforce ecosystem-oriented approaches emphasizing the multidimensional nature of entrepreneurial development.

The study also contributes to digital entrepreneurship research by highlighting the strategic importance of digital readiness within advanced economies. The results suggest that entrepreneurial competitiveness increasingly depends not only on internet accessibility but also on technological sophistication, cybersecurity capacity, and advanced digital infrastructures capable of supporting innovation-intensive economic activities.

From a policy perspective, the Korean experience provides important lessons for governments seeking to strengthen entrepreneurial ecosystems and innovation-driven economic growth. Policymakers should prioritize long-term investments in digital infrastructure, internet accessibility, technological modernization, cybersecurity systems, and education. The findings further suggest that entrepreneurship policies should be integrated within broader national innovation strategies rather than treated as isolated economic interventions.

Despite its contributions, the study presents certain limitations. The analysis relied primarily on macroeconomic indicators and therefore could not fully capture micro-level entrepreneurial dynamics such as startup survival rates, venture capital quality, innovation performance, or entrepreneurial culture. Furthermore, the regression analysis remains exploratory and does not establish direct causal relationships between digital infrastructure and entrepreneurial outcomes.

Future research could expand this analysis by incorporating comparative cross-country approaches, startup-level datasets, venture capital indicators, or qualitative analyses of entrepreneurial ecosystems. Additional studies comparing South Korea with other technologically advanced economies such as Singapore, Taiwan, or Japan may further improve understanding of how institutional and technological configurations shape entrepreneurship and innovation performance.

Overall, the findings suggest that South Korea's entrepreneurial transformation was strongly supported by long-term investments in digitalization, technological infrastructure, and human capital development. The Korean experience demonstrates how coordinated technological modernization and innovation-oriented policies may contribute to the emergence of globally competitive entrepreneurial ecosystems capable of sustaining innovation-driven economic growth in advanced economies.

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