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Review Article

Interplay between Digital Connectivity and Smart Services in PEST Environment: Developing a Conceptual Framework

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Abstract

Background: Smart services have the potential to accelerate economic growth through enhanced citizen engagement and innovation. However, their adoption in developing economies is constrained by uneven digital connectivity and broader macro-environmental challenges. **Objective:** This study examines how Political, Economic, Social, and Technological (PEST) factors influence digital connectivity and smart service performance in emerging markets. **Methods:** A structured qualitative review of peer-reviewed literature and international policy documents was conducted. PEST and SWOT (Strengths, Weaknesses, Opportunities, Threats) analyses were systematically employed to identify and categorize key determinants, supporting the development of testable hypotheses. **Results:** The analysis indicates that non-technological determinants, including affordability, governance quality, digital skills, investment capacity, cybersecurity, and device accessibility, play a more influential role than technological infrastructure alone in enabling inclusive smart service outcomes. A conceptual framework and three testable hypotheses are proposed to explain the relationships among PEST factors, digital connectivity, and smart service performance. **Conclusion:** The findings provide a strong foundation for future quantitative validation and offer practical insights for policymakers and service providers seeking to strengthen digital connectivity and smart service ecosystems.

Keywords: *Digital Connectivity; Digital Inclusion; ICT Ecosystem; PEST Analysis; Smart Services*

Introduction

Smart services are increasingly driven by frontier digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), cloud computing, and big data analytics, which collectively shape contemporary service ecosystems (Kankanhalli *et al*., 2019). These services are characterized by converged, collaborative, responsive, predictive, and participatory functionalities that enhance user experience and operational efficiency (Koldewey *et al*., 2020; Bulut & Anderl, 2022). The effective functioning of such services largely depends on advanced digital connectivity, particularly high-speed and reliable networks capable of supporting real-time data exchange and automation (Kashef *et al*., 2021; Yarali, 2021).

Despite their potential, smart services remain concentrated in developed economies. In many developing countries, including Bangladesh, limitations in digital infrastructure, investment capacity, regulatory readiness, and societal preparedness constrain the diffusion of cutting-edge services (Hossain *et al*., 2023; Karim & Hosen, 2023). This uneven adoption persists even though smart services are widely recognized as catalysts for employment creation, market expansion, and digital economic

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growth (Strusani & Houngbonon, 2020). Existing studies largely examine smart services and digital connectivity as separate phenomena, leaving their interdependence insufficiently explored, particularly in emerging market contexts.

Recent global policy discourse further complicates this gap. International bodies such as the International Telecommunication Union (ITU) and the Alliance for Affordable Internet (A4AI) have shifted the focus of digital connectivity from infrastructure availability to meaningful connectivity, emphasizing affordability, device access, digital skills, security, and productive use (A4AI, 2020; ITU, 2023). These dimensions extend beyond technology and are deeply embedded within political, economic, and social environments. However, current policy frameworks neither adequately address how meaningful connectivity can support smart service ecosystems nor conceptualize a smart and inclusive digital network. Consequently, there remains a knowledge gap in recognizing a network that is both smart and inclusive.

Prior research highlights fragments of this relationship. Some studies emphasize advanced technologies such as IoT and 5G as prerequisites for smart services (Yarali, 2021), while others stress societal capacity, governance quality, and digital skills as decisive factors for successful implementation (Kaiser, 2024; Mazumder & Hossain, 2024). Similarly, while studying digital inequality, Islam and Inan (2021) identify PEST-related barriers to connectivity but do not link these constraints to smart service performance. As a result, the interplay between digital connectivity and smart services within a shared Political, Economic, Social, and Technological (PEST) environment remains conceptually underdeveloped. A joint study by ITU and the UN (Giusti, 2022) identified the impact of several PEST factors on meaningful connectivity, but their interrelationships were not examined. For instance, security and safety are linked to digital skills (ITU, 2023), while digital literacy influences device adoption rates (GSMA, 2023). The interaction of diverse PEST factors shapes the service ecosystem, where infrastructure, social inclusion, and economic capacity function collectively. Thus, a conceptual gap exists in linking digital connectivity and smart services from a digital inclusion perspective.

This study addresses this gap by examining digital connectivity and smart services as interrelated outcomes shaped by a common PEST environment in developing countries. Drawing on digital inclusion theory, the study argues that non-technological factors often exert a stronger influence than technological infrastructure alone in determining whether smart services can be deployed inclusively and effectively. Accordingly, the study seeks to identify the key PEST factors affecting both digital connectivity and smart services and to conceptualize their relationship within an integrated framework.

The key research question guiding this study is: what PEST factors influence digital connectivity and smart services in developing countries, and how do these factors shape the relationship between the two?

Aim of the Study

This study aims to analyze digital connectivity and smart services in developing countries through a political, economic, social, and technological (PEST) lens. It seeks to identify the key PEST factors shaping both phenomena and to examine how these factors condition their interaction within emerging market contexts. By integrating insights from digital inclusion theory, the study develops a conceptual framework linking PEST dynamics, digital connectivity, and smart service performance. The framework provides a basis for hypothesis development and future empirical testing. The findings are expected to inform policymakers, service providers, and researchers seeking to foster inclusive and sustainable smart service ecosystems.

Review of Literature

Existing research on smart services, digital connectivity, and digital inclusion is reviewed, with specific attention to developing economies where structural limitations affect the development of both concepts.

Smart Services

Smart services are defined by the integration of products and services through digital technologies, enabling value creation via efficiency, customization, and enhanced user experience (Lichtenthaler, 2020). Digital platforms play a central role by facilitating interaction among users, providers, and other stakeholders, enabling converged and collaborative service delivery (Bulut & Anderl, 2022; Koldewey *et al*., 2020). Prior studies emphasize predictive and responsive capabilities driven by data analytics and AI (Svitek & Kozhevnikov, 2023), alongside participatory value co-creation involving users and citizens (Kashef *et al*., 2021).

While frontier technologies such as IoT, cloud computing, and big data are widely recognized as technological enablers (Makeri *et al*., 2021), research also highlights the importance of non-technological factors, including user capacity, business model innovation, and stakeholder collaboration (Dreyer *et al*., 2019; Sabatini *et al*., 2023). However, existing literature provides limited guidance on how digital inclusion and connectivity constraints affect smart service deployment in developing countries.

Digital Connectivity

Digital connectivity has evolved from a focus on infrastructure provision to an emphasis on meaningful connectivity, defined by secure, affordable, and productive internet use (ITU, 2023). A4AI (2020) further identifies smartphone access, regular internet use, baseline broadband coverage, and unlimited connectivity as essential conditions. In developing economies, including Bangladesh, low smartphone penetration, limited internet adoption, high spectrum costs, and investment constraints remain persistent barriers (GSMA, 2023; Hossain *et al*., 2023).

Although advanced networks such as 5G are considered essential for frontier technologies (Yarali, 2021), international guidelines do not clarify how such infrastructure can support inclusive smart service ecosystems (ITU, 2023; A4AI, 2020). Consequently, the relationship between connectivity quality and smart service performance remains weakly conceptualized in the literature.

Digital Inclusion

Digital inclusion theory provides a critical analytical lens for this study. It conceptualizes inclusion as a multidimensional construct encompassing access, affordability, quality of access, digital skills, and supportive policy frameworks (Sharp, 2022). Thus, it reiterates the socio-economic, technological, and policy factors that are also relevant to smart services and digital connectivity, reinforcing the need to examine them jointly rather than in isolation.

Smart Service Provision in Developing Economies

Empirical evidence on smart service adoption in developing countries presents mixed findings. Some studies advocate the deployment of AI- and 5G-enabled services to accelerate economic growth (Khan, 2020; Deowan *et al*., 2022), while others argue that limited societal readiness, high investment costs, and weak digital skills undermine their effectiveness (Hossain *et al*., 2023). Regional experiences from South Asia illustrate that even where advanced infrastructure exists, smart service utilization remains uneven due to digital literacy gaps and socio-economic disparities (Sharma *et al*., 2022; Javed, 2020). Leelarathna *et al*. (2022) argued that the economy of South Asia was not robust enough in the post-COVID arena to foster 5G expansion. However, in 2025, the South Asian countries are inclined to 5G and smart ecosystems: two mobile operators initiated 5G in selected areas in Bangladesh (Prothomalo English, 2025).

Overall, existing research addresses smart services, digital connectivity, and digital inclusion largely as separate domains. The interdependencies among these concepts - particularly the role of non-technological PEST factors in shaping both connectivity and smart service outcomes - remain insufficiently explored. Addressing this conceptual gap is essential for designing inclusive and sustainable smart service ecosystems in developing countries.

It is evident that PEST factors articulate the service ecosystem, digital landscape, and digital cohesion of a country. Previous literature revealed these three phenomena separately, but their interplay is not researched sufficiently. To develop a favorable operating domain for smart services and cutting-edge digital infrastructure, this relationship is noteworthy. Nevertheless, the impact of non-technological elements must be analyzed for both digital connectivity and smart services. This study aims to relate digital connectivity with smart services from inclusive fabric. To address the knowledge gap and conceptual gap, the objectives of the study are formulated as follows:

i. To analyze smart services and digital connectivity from a PEST perspective.

ii. To identify the factors of digital connectivity to foster smart services.

iii. To develop a conceptual model to link digital connectivity with smart services.

The research questions to meet the objective are as follows:

R1: What political, economic, social, and technological factors influence the development of smart services and inclusive digital connectivity?

R2: How are smart services related to digital connectivity in the PEST domain in developing countries?

Methodology

This study adopts a qualitative, theory-driven research design to examine how macro-environmental factors shape digital connectivity and smart service outcomes in developing economies. A PEST analysis is employed to systematically identify political, economic, social, and technological determinants influencing both phenomena, while a complementary SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is used to contextualize internal capabilities and external constraints identified in prior studies.

To gain deeper insights into socio-economic culture, regulatory environments, and behavioral dimensions, qualitative research is considered more appropriate (Islam et al., 2022). The study follows an inductive approach to develop a conceptual framework and testable hypotheses by synthesizing evidence from peer-reviewed academic literature, international regulatory frameworks, and digital inclusion theory.

Qualitative Approach and Future Quantitative Research

The qualitative approach provides valuable theoretical insights that can be tested quantitatively in future studies. The findings help identify key variables, such as digital skills, policy support, and investment costs, which can be empirically tested using surveys and statistical methods in larger samples. This future quantitative research will validate the conceptual framework and relationships between PEST factors and smart service outcomes.

Analytical Procedure and Validation Criteria

The analysis was conducted in three sequential steps. First, relevant studies and policy documents were screened to extract factors associated with smart services and digital connectivity. Second, extracted factors were categorized under political, economic, social, or technological dimensions based on PEST logic. Third, each factor was validated against digital inclusion criteria, namely affordability, accessibility, skills readiness, security, and meaningful use (A4AI, 2020; Sharp, 2022). Factors were retained only if they demonstrated a clear enabling or constraining role across at least two of these criteria. To minimize researcher bias, findings were cross-validated using international regulatory guidelines (e.g., ITU, GSMA) and theoretical propositions from digital inclusion. Plurality of sources acted as the primary reliability criterion.

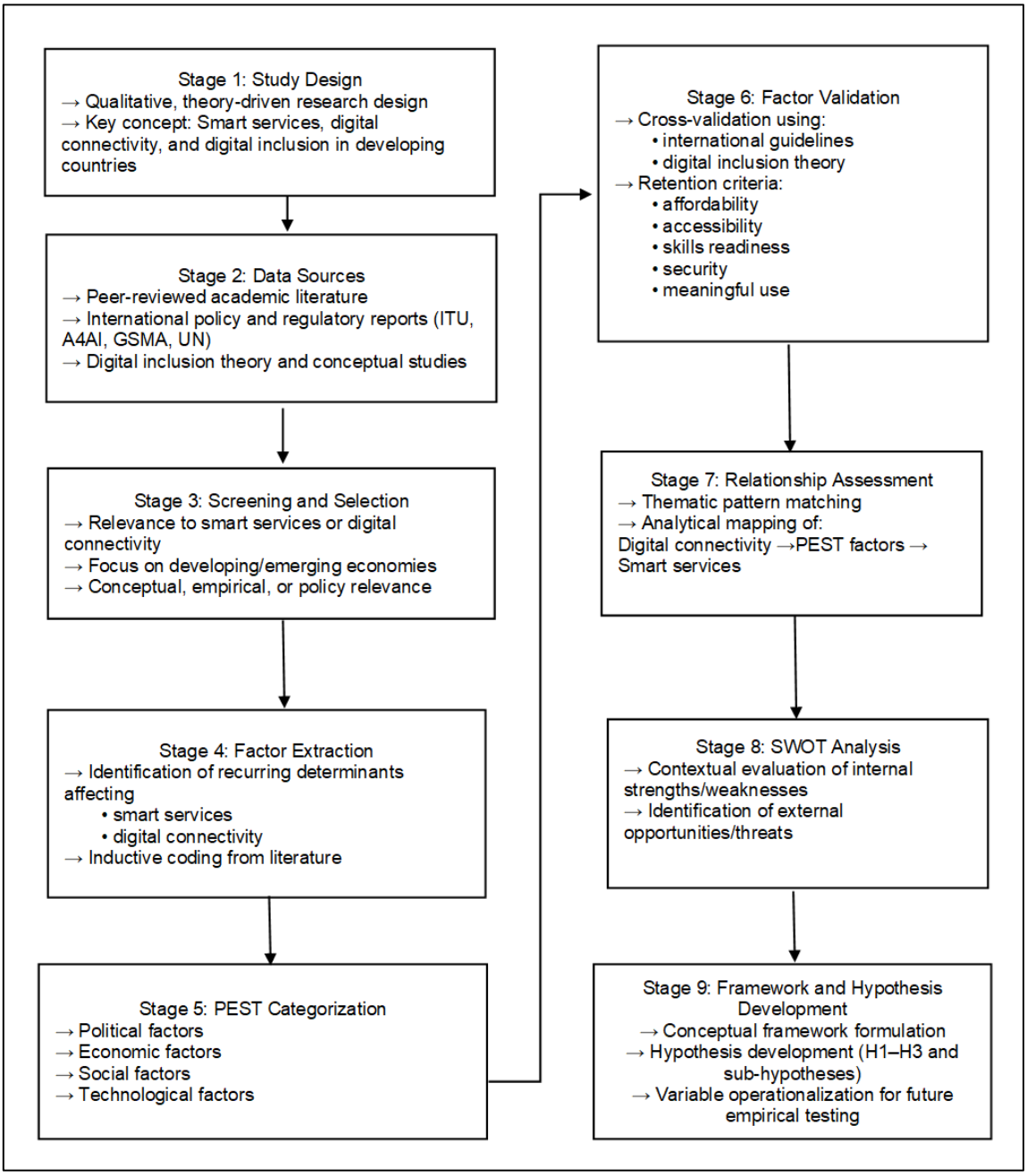

Figure 1: Flow Chart of Analytical Procedure

PEST Analysis of Smart Services and Digital Connectivity

PEST analysis extracts the factors of both smart service and digital connectivity in the broader operating environments through the lens of digital inclusion. Eventually, the factors are organized in four folds: political, economic, social, and technological. The role of each factor - either constraining or driving - determines their influence on smart service proliferation and digital connectivity transformation. Every factor is validated against its capacity to ensure digital inclusion. How the factors control the three phenomena measure the relationship between digital connectivity and smart services.

Political Factors

The political dimension revolves around regulatory frameworks, international guidelines, and policy interventions for digital transformation. Collaboration is the key attribute of smart services that demand coherent governance settings where the stakeholders cooperate and collaborate effectually in the intermediary digital platform (Koldewey *et al*., 2020; Bulut & Anderl, 2022). Likewise, international

regulation necessitates policy support to promote affordable, secure, and meaningful use of digital services (ITU, 2023). Digital inclusion theory also validates appropriate policy to promote inclusive access (Sharp, 2022). Eventually, policy is considered as the political parameter that controls both digital connectivity and smart services for digital inclusion.

Political and regulatory frameworks predominantly build the operating domain of smart services and digital connectivity. Policy is a fundamental component of digital inclusion, influencing digital skills, affordability, and accessibility (Sharp, 2022). In the emerging markets of Bangladesh, where smartphone and internet penetration is significantly low (GSMA, 2023; BBS, 2022), policy is catalytic to alleviate the structural barriers embedded in the PEST domain. As ITU (2023) emphasizes secure, affordable, and functional digital access, government support and regulatory frameworks constitute the basis of safe internet penetration. Nevertheless, policy intervention is compelling to meet A4AI's (2020) recommendation for minimum 4G coverage and economical and regular use of the internet with smartphones. Collaboration of stakeholders for cross-functional smart services (Bulut and Anderl, 2022) also stands on strong policy support. Hence, policy intervention comprises broadband policy for affordable prices, spectrum policy for low investment costs for higher bandwidth, cybersecurity policy for safe internet and data governance, and AI, IoT, and cloud-management policy for frontier technology penetration. Thus, policy appeared as a significant political factor that has a positive impact on smart services and digital connectivity.

Economic Factors

Affordability, investment decisions, and tariff structure shape the economic dimensions. Smart service ecosystems underpin extensive investment in emerging technologies – IoT, big data, cloud computing, and so on (Shan *et al*., 2021). These frontier technologies call for high-speed 5G network deployment (Yarali, 2021). Capital investment is considered a critical bottleneck for developing economies (Strusani & Houngbonon, 2020). Furthermore, innovative business models – an essential parameter for smart services – also demand resources for capacity and infrastructure development (Heinz, 2023; Sabatini *et al*., 2023). Nevertheless, several parameters restrain digital connectivity, resulting in a significant digital access gap: smartphone price, spectrum price, and broadband internet penetration (A4AI, 2020; GSMA, 2023). Likewise, Hossain *et al*. (2023) urged for infrastructure development. Digital access is an important parameter for digital inclusion too (Sharp, 2022). Thus, the economic factors to foster digital connectivity and inclusive smart services are investment cost for digital infrastructure and frontier technology penetration, smartphone price, internet tariff, and spectrum price.

Both smart services and digital access are constrained by market readiness and economic disparity. A4AI (2020)'s recommendation for regular use of high-speed internet through smartphones is largely connected to the economic abilities of the society. Investment in state-of-the-art infrastructure, frontier technology, and innovative business models shapes the economic scalability of smart services in developing markets. Spectrum price and internet tariff determine the degree of investment cost and digital penetration, respectively. Thus, investment cost, spectrum price, and the cost of internet and smartphones are strong factors – if reduced, they can trigger the digital transformation substantially even in a growing economy.

Social Factors

Social determinants implicate user capacity and the extent of citizen participation in smart service value creation. In the smart service ecosystem, citizens co-create value through active participation and customization of services at the user end that require digital literacy for both user and provider (Kashef *et al*., 2021; Sabatini *et al*., 2023). Sabatini *et al*. (2023) argued that user skill and willingness to adopt cutting-edge technology are critical factors for service outcome. Regular and functional use of the internet as recommended for universal and meaningful connectivity also demands digital skill, tech savviness, and trust of the user (A4AI, 2020; ITU, 2023). Similarly, digital literacy, access, and socio-economic capacity define the magnitude of digital inclusion (Sharp, 2022).

Although digital connectivity appears to be solely a technological factor, the social elements impact it with multiple dimensions: user capacity, societal culture, access pattern, and degree of digital readiness (A4AI, 2020; Sabatini *et al*., 2023). In the developing economy, a considerable percentage of the population do not use the internet despite living in 4G mobile coverage (Giusti, 2022).

Smart services values, participation, collaboration, prediction, responsiveness, and cross-functionality, revolve around digital literacy (Koldewey *et al*., 2020; Bulut & Anderl, 2022). Nevertheless, personal data privacy is the critical social issue for smart services (TrustArc, 2025). In a developing market in Bangladesh, lack of trust and tech-savviness lead to cyber threats (Islam & Inan, 2021). TrustArc (2025) argued that data governance and cybersecurity must be reinforced with social awareness and digital know-how for a safe and reliable cyberspace. Because of its immense social impact, cybersecurity is more a social factor than any other dynamic for smart services, especially in developing countries. Hence, digital literacy and cybersecurity are considered as the potential social factors for the digital revolution. Digital skills and cyber awareness contribute positively to smart service adoption.

Technological Factors

The technological sphere predominantly considers intermediary platforms, competencies, and infrastructure for frontier technology penetration – an essential element for smart services. A cross-functional digital platform is the cornerstone for converged, predictive, participatory, and responsive smart services (Lichtenthaler, 2020; Svitek & Kozhevnikov, 2023). Similarly, an intermediary digital platform is proposed to deliver smart services and associated subservices (Bulut & Anderl, 2022; Koldewey *et al*., 2020). Digital connectivity must cater to cutting-edge technological capabilities – 4G broadband, smartphone ownership, and provision for AI and IoT integration – to sustain future need for the “Internet of Thinking” (Khalid, 2023; Shan *et al*., 2021). Sharp (2022) supported the need for universal digital access to include the last mile in smart service benefits.

Cross-functionality demands omnipresent interaction among all the stakeholders in the digital platform to create value (Bulut and Anderl, 2022). Data-driven decision-making for predictive and responsive services (Koldewey *et al*., 2020; Svitek & Kozhevnikov, 2023) also requires high-speed seamless connectivity. 5G or minimum 4G is recommended for IoT and AI-enabled services (Yarali, 2021; A4AI, 2020). Hence, high-speed seamless networks (4G or 5G) and digital platforms are considered as the potential technological factors for smart services. Emerging markets suffer from unreliable internet and insufficient broadband speed. IoT and AI will shape the future socio-economic activities of mankind (Khalid, 2023). Evidently, high-speed networks have a positive impact on digital connectivity upgrades to foster smart services.

In all, PEST analysis implicates that both smart services and digital connectivity are deep-rooted in the broader PEST environment. While strong socio-political and technological factors are encouraging, economic factors, e.g., internet tariffs and investment costs, regulate smart services inversely. Reshaping political priorities, economic capacity, social dynamics, and technological ability will prepare the digital connectivity to cater to cutting-edge service functionality. Inclusive, converged, participatory, responsive, and predictive service structures require a paradigm shift of the PEST atmosphere.

SWOT Analysis of Developing Countries

The mode and intensity of the PEST parameters in developing nations can be analyzed through SWOT (strength, weakness, opportunity, and threat) analysis. It is discerned from the literature review that the developing nations in South Asia are dedicated to high-speed network expansion for frontier technology penetration, but the rural and poor are excluded from existing digital services (Hossain *et al*., 2023; Sri Lanka Telecom PLC, 2019). In Pakistan and India, the digital services are concentrated in metropolitan areas, excluding the rural community (Sharma *et al*., 2022; Javed, 2020). Government willingness is the strength, while digital exclusion is a structural weakness of developing countries. Nevertheless, people also have started adopting IoT and AI-based services because of their operational efficacy and global offerings (Khalid, 2023; Strusani & Houngbonon, 2020). In South Asia, Bangladesh has the potential to implement smart services in healthcare, education, transportation, and other inclusive

services (Haque *et al*., 2021; Khan, 2020). These are the internal strengths of the growing markets. However, there is a significant rural-urban gap, and many users are excluded because of low digital skills and high-cost devices (BBS, 2022; GSMA, 2023). User capacity, or digital literacy, is emphasized in several pieces of literature (Giusti, 2022; Sabatini *et al*., 2023). Nevertheless, interoperability issues are prominent, and concerted actions of all the stakeholders for data security are insufficient in developing nations (Criado & Gil-García, 2019; Erunkulu *et al*., 2021). Without a safe cyberspace, no emerging service can be propagated efficiently. Data governance and cybersecurity are the critical challenges in developing countries (Erunkulu *et al*., 2021; TrustArc, 2025). Hossain *et al*. (2023) opined that the investment decision is challenging in the developing countries, like Bangladesh, because of the fragmented market. Persistent digital inequality is the key threat for emerging markets.

Digital incompetency is another systematic threat in the peripheral ecosystem in the growing market (Sabatini *et al*., 2023). It is an inherent obstacle for which a large proportion of the community remain underserved despite living in high-speed network coverage (Giusti, 2022). However, Strusani and Houngbonon (2020) argued that frontier technology has the potential to leapfrog the economy in developing countries. Similarly, platform-based services with stakeholder collaboration have the potential to accelerate smart service benefits (Bulut & Anderl, 2022; Koldewey *et al*., 2020). The opportunity of digital connectivity can be enhanced by nourishing the external environment with conducive policy and smart technology. Policy support strengthens affordability and digital penetration, while smart technology produces operational excellence and economic acceleration in the society (ITU, 2023; Sharp, 2022).

Table 1: SWOT Matrix for Developing Countries (Based on Existing Literature)

Strength (Internal Positive Factors)	**Weakness (Internal Negative Factors)**
Government willingness for digitalization (Hossain *et al*., 2023; Sharma *et al*., 2022; Sri Lanka Telecom PLC | Annual Report 2019, no date; Javed, 2020). Operational efficiency of smart services (Strusani, D. and Houngbonon, 2020) Growing adoption of frontier technology, e.g., cloud services, fintech, and mobile platforms (Khalid, 2023; Strusani & Houngbonon, 2020). Potential to deliver inclusive services (healthcare, transportation, education and so on) (Khan, 2020 and Haque *et al*, 2021).	Access gap in rural areas (BBS, 2022; GSMA, 2023; Giusti, 2022) Cost of access (high cost of infrastructure, broadband, and device) (GSMA, 2023) Unreliable network, poor broadband quality (Hossain *et al*., 2023; GSMA, 2023). Low digital skill and limited user readiness (Sabatini, *et al*., 2023). Interoperability issues, segmented ecosystem, and obsolete legacy platforms (Criado & Gil-Garcia, 2019; Erunkulu *et al*., 2021). Weak data governance, and insufficient cybersecurity (Erunkulu *et al*., 2021; TrustArc, 2025).
Opportunity (External Positive Factors)	**Threat (External Negative Factors)**
Expansion of high-speed network connecting the last mile effectively (Yarali, 2021). Rising demand for digital inclusion, smart cities, and digital government services (Strusani & Houngbonon, 2020). Potential to leapfrog traditional infrastructure using cloud, mobile, and IoT-based solutions (Strusani & Houngbonon, 2020). Expansion of digital entrepreneurship with collaboration and innovative business design and platform-based services (Bulut & Anderl, 2022; Koldewey *et al*., 2020) Conducive policy intervention for fintech, AI and IoT based services (ITU, 2023; Sharp, 2022).	Inherent digital inequality, exclusion of rural community and urban poverty (GSMA, 2023; Giusti, 2022). Cyberattacks, data breaches, identity theft, and critical infrastructure risks (Erunkulu *et al*., 2021; TrustArc, 2025). Economic challenges for investment (Hossain *et al*., 2023; Strusani & Houngbonon, 2020). Uncertain return on investment (Hossain *et al*., 2023). Regulatory deficit to address data sovereignty, taxation, and digital services (Erunkulu *et al.*, 2021; TrustArc, 2025).

Based on the critical analysis, the SWOT matrix for developing countries is derived in Table 1. It is evident that strong government will include the urban poor and the dwellers in the rural areas. Data breaches and cyberattacks, interoperability challenges, unstable networks, high costs of digital access,

insufficient digital literacy, and other weaknesses should be mediated with appropriate policy formulation. The strengths and opportunities listed in Table 1 underscore potential interventions to outpace the threats and weaknesses. Inherent productivity, emerging technology, and inclusive application are capable of outweighing the economic fragmentation in developing countries. Digital inclusion should be maximized with skilled human capital and the introduction of frontier technologies in public service delivery.

Research Hypotheses Formulation

The diverse PEST factors have their influences in different ways; some are triggers, while others act as barriers. Based on this relationship, hypotheses are formulated to recognize the role of digital connectivity in smart services.

Established on the evidence in the existing literature, three hypotheses are formed: the relationship between the PEST environment and smart services, PEST factors' impact on digital connectivity, and finally, the linkage between digital connectivity and smart services.

PEST Factors and Smart Service Outcome

The theoretical background depicts that the broader macro-environment shapes the success of smart services. Social factors, e.g., digital literacy of the user and ability of the government and businesses, are favorable for citizen engagement (Sabatini *et al*., 2023; Svitek & Kozhevnikov, 2023). Smart technology and high-speed networks drive data-driven processes leading to predictive and cross-functional services, and they require investment in high-speed networks and frontier technology (Sharp, 2022; Yarali, 2021). Collaboration and convergence add value to smart services (Bulut & Anderl, 2022; Koldewey *et al*., 2020). Nevertheless, cybersecurity, interoperability, and tech-savviness determine the social and technological ability of the ecosystem and promote citizen participation (Erunkulu *et al*., 2021; TrustArc, 2025).

In addition, investment in cutting-edge technology and affordability implicate the economic capacity of the country for smart services (Hossain *et al*., 2023; Strusani & Houngbonon, 2020). Collaboration, a critical variable for smart service value creation, is obtained through policy intervention for smooth interaction among the stakeholders and their digital know-how (Koldewey *et al*., 2020; Sabatini *et al*., 2023). Leadership is identified as a potential factor for successful smart agriculture (Haque *et al*., 2021), while Kaiser (2024) emphasized governance for a smart nation. Thus, PEST factors develop an enabling environment for smart service proliferation. Based on this argument, the following hypothesis is formulated:

H1: PEST (Political, Economic, Social, and Technological) factors have a significant effect on smart service outcomes.

To test this broad hypothesis statistically, it is divided into sub-hypotheses, and the variables are operationalized based on the mentioned literature.

H1a: Digital skill, investment cost, and smart technology have a positive impact on cross-functional services.

H1b: Policy support and user capacity are correlated with collaborative services.

H1c: Enhanced user capacity and cybersecurity are positively linked to participatory services.

H1d: Smart technology and high-speed internet are positively related to predictive services.

PEST Factors and Digital Connectivity

ITU (2023) and A4AI (2020) advocated for the political and socio-economic elements over technological factors for universal meaningful access. Affordability, accessibility, availability, and quality of access allow user participation in the service ecosystem (Sharp, 2022). A wider socio-economic sphere for digital connectivity encompasses policy regulation, regulatory framework, spectrum regulation, market readiness, societal capacity, cybersecurity, frontier technology penetration, and cutting-edge network

capacity (Erunkulu *et al*., 2021; Giusti, 2022). Digital literacy and inclusive broadband penetration are the key success factors for digital inclusion (Sharp, 2022). Hence, a high-speed network must be reinforced with the socioeconomic and political factors for a successful outcome of digital connectivity. In all, digital literacy, investment, policy regulation, infrastructure, cybersecurity, and smart technology have a conducive impact on digital connectivity. Grounded on this reasoning, the second hypothesis is formulated as follows:

H2: PEST factors have a significant impact on digital connectivity.

Notably, PEST analysis identified several PEST factors, e.g., digital literacy, internet tariff, smartphone price, investment cost, spectrum price, cyber security, and smart technology, that regulate both smart services and digital connectivity directly or indirectly. For instance, low internet tariffs and smartphone prices directly influence broadband internet, while enhanced digital skills and policy support moderate internet penetration (GSMA, 2023; Sharp, 2022). Likewise, investment cost and spectrum price drive high-speed network expansion and are reinforced with favorable policy (Hossain *et al*., 2023).

Deployment of smart technology and cybersecurity are the key factors for productive use of the internet, while digital literacy will enhance the usage (Yarali, 2021; Shan *et al*., 2021). Thus, internet tariff, smartphone price, investment cost, spectrum price, smart technology, and cybersecurity are identified as independent variables, whereas broadband internet, high-speed network, and meaningful use are dependent variables. Nevertheless, digital literacy and policy support are considered the moderators for these variables. This relationship is critically analyzed for digital connectivity: internet penetration, network, and degree of functional usage of the internet. Thus, based on previous research, the sub-hypotheses to test H2 can be derived as

H2a: Internet tariff and smartphone price are inversely related to broadband internet penetration, while digital skill and policy support moderate this relationship.

H2b: Investment cost and spectrum price are inversely related to high-speed network development, and conducive policy moderates this relationship.

H2c: Safe cyberspace and use of smart technology are directly related to meaningful use of the internet, while digital skill positively moderates this relationship.

Digital Connectivity and Smart Services

Smart services depend on the degree to which all potential stakeholders, such as users, institutions, manufacturers, and suppliers, are digitally connected. Data governance, seamless digital interaction, platform interoperability, and digital service access are all governed by high-quality digital connectivity (Criado & Gil-Garcia, 2019; Makeri *et al*., 2021). Thus, connectivity is fundamental to building and delivering smart services that are predictive, participatory, and responsive. The success of smart services depends on the extent of digital integration, which leads to reduced transaction time, enhanced user satisfaction, and effective participation.

It is evident that the operating PEST configuration of a country determines both smart service performance and digital transformation. Strong and robust digital connectivity is essential for smart service adoption within a given ecosystem. Following the reasoning presented in Hypotheses 1 and 2, the third hypothesis is formulated as follows:

H3: Digital connectivity has a significant role in smart services in the PEST environment.

Operationalization of the Variables

Grounded on H1 and H2, the variables are operationalized as shown in Table 2. This builds the foundation for collecting empirical data. The relationship between H1 and H2 will establish H3 that will demonstrate the degree and orientation of the influence of digital connectivity on smart services in the PEST environment. The correlation of the variables in H1 and H2 will measure H3.

Table 2: Operationalization of the Variables

Hypothesis	Independent Variables	Dependent Variables	Moderators
H1	Digital skills Investment cost Smart technology	Cross-functionality	
	Policy support Digital skill	Collaboration	
	Digital skills Cybersecurity	Participation	
	Smart technology High-speed internet	Prediction	
H2	Internet tariff Smartphone price	Broadband internet penetration	Digital skill Policy
	Investment cost Spectrum price	High-speed network	Policy
	Cybersecurity Smart technology	Meaningful use	Digital skill

Results

PEST and SWOT Analysis

PEST analysis of smart services and digital connectivity identified several PEST factors for both phenomena. The analysis is carried out primarily in digital inclusion fabric in developing countries. After critical analysis, the PEST factors for smart services are listed in Table 3.

Table 3: PEST Analysis of Smart Services (Based on Existing Literature)

Smart Service Attributes	Key Issues	Critical Insights from Existing Literature	PEST Factor	PEST Perspective
Collaborative (Koldewey *et al*.,2020)	Digital integration of stakeholders Policy support for digital access and interaction	Success depends on collaborative environment (Koldewey *et al*., 2020) Coordination is required among government, users, providers, suppliers, and intermediaries (Bulut & Anderl, 2022)	Policy Support	Political
		Smooth interaction or collaboration between user and provider depends on technological know- how	User capacity	Social
Cross-functional (Bulut & Anderl, 2022)	Investment in smart technology Business model innovation Cost of digital platforms	Bulut & Anderl (2022) advocated for a digital platform to integrate sub-services (digital payment, personal authentication in cyberspace)	Investment Innovative business model	Economic
		Makeri *et al.* (2021): smart services require emerging technologies (AI, big data, cloud)	Smart Technology	Technological
		Sabatini, *et.al*., 2023 (2023): innovative business design and user capacity are critical for scaling smart services	User capacity	Social
Participatory (Kashef *et al*., 2021)	User participation and co-creation User readiness and	Smart services are participatory (Kashef *et al*., 2021)	User capacity Cybersecurity	Social

	skill Trust & acceptance	User capacity significantly affects adoption (Sabatini, *et.al*., 2023) Social collaboration is central (Dreyer *et al*., 2019) Tech-savviness Cybersecurity awareness is decisive social factors (Erunkulu *et al.,* 2021)		
Predictive (Koldewey *et al.*, 2020)	Converged digital platforms Product-service integration Data-driven capabilities (predictive/responsive) High-speed network	Product-service integration enhances value (Lichtenthaler, 2020) Digital platform enables cross-functional services (Bulut & Anderl, 2022) Predictive and responsive services rely on data-driven decision making and eventually require high-speed internet (Koldewey *et al.*, 2020; Svitek & Kozhevnikov, 2023; Bulut & Anderl, 2022; Yarali, 2021)	Smart Technology High-speed internet	Technological

PEST analysis conducted for digital connectivity also uncovers some relevant factors in the macro-environment. After assessing the existing literature, these factors are listed in Table 4.

Table 4: PEST Analysis of Digital Connectivity (Based on Existing Literature)

Digital Connectivity Attributes	Key Issues	Critical Insights from Existing Literature	PEST Factor	PEST Perspective
Universal and meaningful access (ITU, 2023)	Regulatory standards for meaningful connectivity Inclusion mandates	ITU (2023) recommends safe, productive, affordable use of internet. Policymaking is essential for digital inclusion and preventing inequality (Sharp, 2022).	Conducive Policy for broadband internet, spectrum, smart technology and cybersecurity	Political
Affordability (ITU, 2023; A4AI, 2020)	Affordability of internet and devices (ITU, 2023; GSMA, 2023) Costs of 4G/5G infrastructure and spectrum (Strusani & Houngbonon, 2020; Hossain *et al*., 2023) Market capability to adopt emerging technology (Hossain *et al*., 2023)	Unlimited broadband internet and smartphone adoption (A4AI, 2020; GSMA, 2023) are critical for high-speed and inclusive internet penetration. Bangladesh market has low smartphone ownership (50%) and low internet penetration (38.1%) (BBS, 2022; GSMA, 2023; Hossain *et al*., 2023) Affordability is central for digital access (Strusani & Houngbonon, 2020; Islam & Inan, 2021)	Internet tariff Smartphone Price Infrastructure investment Spectrum price	Economic
Societal readiness for digital inclusion (Sharp, 2022; Hossain *et al*., 2023)	Digital skills & literacy Social readiness for emerging technologies (Hossain *et al*., 2023) Inequality in access (Strusani & Houngbonon, 2020; Islam & Inan, 2021) Cybersecurity awareness	Digital skill is critical to access internet (Sharp, 2022) Socio-economic gaps hinder connectivity (GSMA, 2023; BBS, 2022).	Digital Skill	Social

High-speed Network	Minimum 4G Network capacity (A4AI, 2020) Smartphone availability (A4AI, 2020; GSMA, 2023) Capability to integrate AI/IoT (Khalid, 2023; Shan *et al*., 2021) Need for robust infrastructure (Halder *et al*., 2023, Hossain *et al*., 2023)	Daily use of unlimited broadband with smartphone and minimum 4G network (A4AI, 2020). Future "Internet of Thinking" requires stronger infrastructure and smart technology will drive the society and economy (Khalid, 2023). Maximum utilization of 4G network for smart technology compatibility in growing economy (Halder *et al*., 2023, Hossain *et al*., 2023)	High-speed network (baseline 4G) Smart technology (IoT, AI)	Technological

Table 2 and Table 3 identified several factors in the operating domain categorized in the PEST aspect. These factors are validated with SWOT analysis that depicts the enablers and barriers for digital transformation in the developing countries. The combination of PEST and SWOT reveals the factors pertinent to the developing world that impact digital connectivity to foster smart services. Nevertheless, the blend of PEST and SWOT reflects the exact picture of the ecosystem. The factors extracted from Table 1, Table 2, and Table 3 are as follows: digital skill, policy support, cost of access or affordability (internet tariff, spectrum price, investment cost), and access and network quality (high-speed network, data governance, cybersecurity, smart technology).

Conceptual Framework and Hypotheses

The conceptual framework proposes a sequential causal structure. First, PEST factors exert a direct influence on smart service value creation, influencing participatory, predictive, collaborative, cross-functional, and responsive service features (H1). Second, PEST factors exert a direct impact on digital connectivity by shaping affordability, access, skills development, and policy support (H2). Third, digital connectivity exerts a direct influence on smart service value creation in the given PEST environment, reflecting institutional, economic, and social constraints (H3). Together, these pathways position digital macro-environmental conditions as a partial mediator between digital connectivity and smart service outcomes.

The hypotheses and the derived relationship of digital connectivity and smart services develop the conceptual framework as shown in Figure 2.

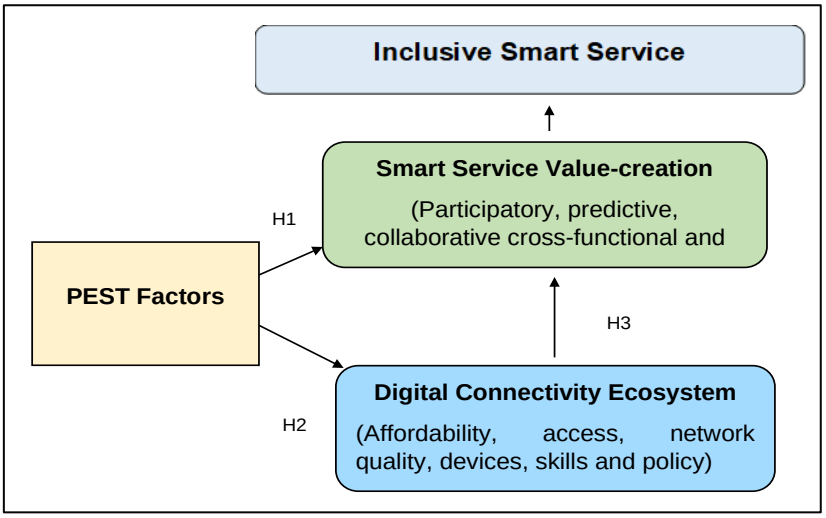

Figure 2: Conceptual Framework to Link Digital Connectivity with Smart Services

Figure 3 illustrates the interconnectedness between smart services, digital connectivity, and digital inclusion within the broader PEST environment. This diagram highlights the key factors that influence both digital connectivity and smart service outcomes, including affordability, digital skills, policy support, and technology infrastructure.

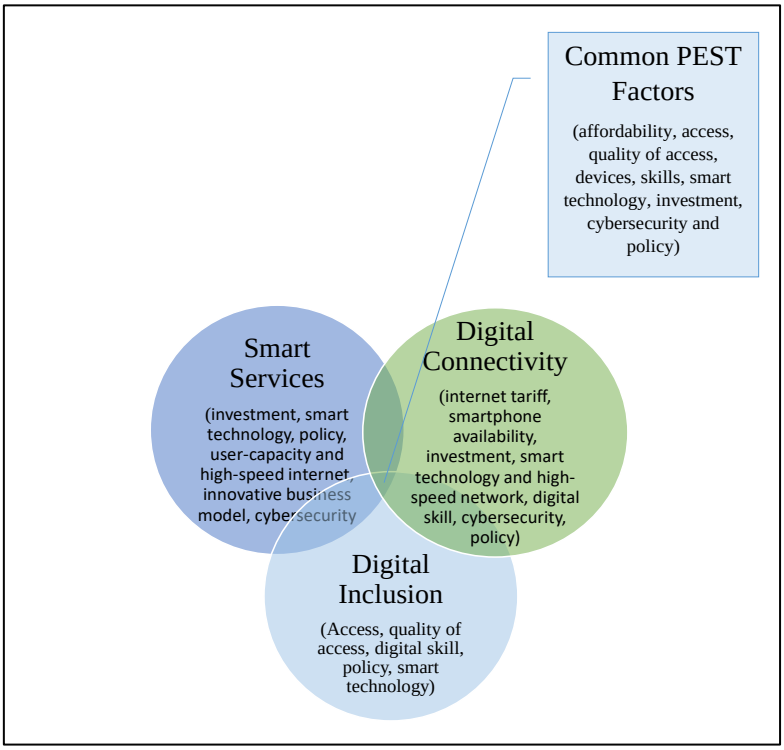

Figure 3: Smart Services, Digital Connectivity and Digital Inclusion in the PEST Environment

As shown in Figure 3, key PEST factors such as policy support, digital skills, and investment in technology play pivotal roles in shaping both digital connectivity and smart service outcomes. For example, policy support is shown to positively influence both smart service implementation and inclusive digital access, highlighting the central role of governance in these processes.

PEST analysis of smart services and digital connectivity meets the first objective of this study. It explores the common factors that regulate both digital connectivity and smart services: affordability, devices, skills, smart technology, investment, cybersecurity, policy, infrastructure investment (access), high-speed network (quality of access), and smart technology. Eventually, these factors constitute digital connectivity factors influencing smart services, and thus it meets the second objective of the study.

Three hypotheses and sub-hypotheses to test H1 and H2 are formed that are listed below:

H1: PEST (Political, Economic, Social, and Technological) factors have a significant effect on smart service value creation.

H1a: Digital skill, investment cost, and smart technology have a positive impact on cross-functional services.

H1b: Policy support and user capacity are correlated with collaborative services.

H1c: Enhanced user capacity and cybersecurity are positively linked to participatory services.

H1d: Smart technology and high-speed internet are positively related to predictive services.

H2: PEST factors have a significant impact on digital connectivity.

H2a: Internet tariff and smartphone price are inversely related to broadband internet penetration, while digital skill and policy support moderate this relationship.

H2b: Investment cost and spectrum price are inversely related to high-speed network development, and conducive policy moderates this relationship.

H2c: Safe cyberspace and use of smart technology are directly related to meaningful use of the internet, while digital skill positively moderates this relationship.

H3: Digital connectivity has a significant role in smart services in the PEST environment.

Thus, the hypotheses and the conceptual framework build the foundation to recognize the role of digital connectivity on smart services. The relationship of H1 and H2 will establish H3 that will demonstrate the degree and orientation of the influence of digital connectivity on smart services in the PEST environment.

These hypotheses are scalable and replicable to any country-specific settings. Thus, the conceptual framework provides insightful reflection regarding the macro-environment that triggers or inhibits smart services proliferation in developing countries. It guides the stakeholders to transform the digital connectivity in the operating landscape. The conceptual model and the hypotheses are universal and can be optimized according to the PEST domain.

Discussion

From the PEST analysis, it is noteworthy that smart services, digital connectivity, and digital inclusion have some common determinants in the operating ecosystem. Access, affordability, digital skill, policy, and quality of digital access (internet speed) are essential parameters to prepare the network for inclusive state-of-the-art services. The factors for digital connectivity, internet tariff, smartphone availability, investment, smart technology, and high-speed network, will ensure access quality, while digital skill and policy are central socio-political factors to encompass the grassroots in the smart service system. Likewise, the factors, e.g., investment, smart technology, policy, user capacity, and high-speed internet, are decisive for both smart services and digital inclusion. Manzoor *et al*. (2025) also demonstrated that for digital agriculture, social, behavioral, institutional, and technological terms are more discussed for low- and middle-income countries. Hence, PEST factors are the key determinants for digital penetration in growing economies. Convergence of AI, cloud computing, and blockchain leads to social inclusion and digitally secured systems with technological scalability for predictive services (Singh *et al*., 2025).

An innovative business model is considered central for viable smart service businesses; however, it is not directly related to digital infrastructure transformation but rather is linked to service design. Similarly, smart technology is crucial for smart services and smart networks but not fundamental for digital inclusion as per inclusion theory. However, to prevent further inequality in developing markets, where emerging technology adoption is inevitable in the society, smart technology is considered an essential parameter for digital inclusion. Likewise, cybersecurity is a fundamental societal parameter without which social inclusion for smart services is not possible. Thus, the indispensable PEST factors comprise affordability, access, quality of access, devices, skills, smart technology, investment, cybersecurity, and policy that belong to all three phenomena (Nyamboga, 2024).

Nevertheless, as smart services and digital connectivity merge with some PEST factors, smart services are evidently linked to digital connectivity in the PEST domain. This proposition forms the basis to develop the conceptual framework. Theoretical evidence identifies the coherence of digital connectivity and smart services in the political priorities, socio-economic capacity, and technological competency. Thus, a country's PEST configuration shapes the outcome of smart services (Heeb *et al.*, 2019).

Conclusion

To conclude, the PEST analysis uncovered the diverse factors of the operating domain. Most of the service providers largely focus on the technological aspect of the smart services, the government emphasizes high-end infrastructure development, and the regulators center on technology-driven policies. However, this study uncovered that political will, social priorities, and economic capabilities are strong determinants for smart service penetration. SWOT analysis illustrated that, collectively, non-technological parameters outperform the technological competencies in diverse ways. The conceptual framework will guide the service providers to select the interventions required in a given ecosystem.

Nevertheless, as smart service is relatively a new phenomenon, the conceptual framework will be beneficial for the academic researchers to tailor it in a specific PEST environment.

The conceptual model connects the performance of smart services to the macro environmental conditions. The results emphasize the need for policymakers and regulators to shift from infrastructure-led strategies to well-rounded interventions that address cybersecurity, affordability, talent development, and governance quality. The framework helps industry stakeholders and service providers make more context-sensitive investment and service innovation decisions by providing strategic recommendations for ecosystem design. From an academic standpoint, the study offers a well-organized theoretical framework and precisely specified notions that can be applied in subsequent empirical investigations. From an academic perspective, the study provides a structured theoretical foundation and clearly defined constructs that can be operationalized in future empirical research.

This qualitative study is based on literature review only. It analyzed the PEST domain from a theoretical perspective and previous research. The qualitative approach certainly explained the inherent characteristics of the phenomenon, smart services and digital connectivity, but it is confined to theoretical structure. Nevertheless, it evaluated these phenomena from the broader sphere of digital inclusion only. Future research can be conducted on the rural-urban gap and gender disparity. It may reveal a different set of PEST factors for such a configuration.

Furthermore, the PEST domain is different in different country configurations. This study focuses on developing countries as a whole. For a deeper insight, a country-specific SWOT analysis can be applied to recognize the contextual factors more rigorously. This study provides an impression of how the macro-environment impacts digital transformation. To enhance the conceptual model, the analysis must be validated by empirical data from the key stakeholders of an explicit industry. A deductive and quantitative research approach may be adopted with a cross-sectional survey for future research. It will escalate the methodology towards mixed-method research and can be tailored to a sector-specific setting.

Conflict of Interest

The authors affirm that there are no conflicting objectives.

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