

## Inclusive digital connectivity for smart service value-chain: a systematic literature review

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Article Info	ABSTRACT
<p>Received December 12<sup>th</sup>, 2025 Revised January 19<sup>th</sup>, 2026 Accepted February 16<sup>th</sup>, 2026</p>	<p>Smart services are vital for economic development and improved user experience, yet digital inequality continues to constrain their effective deployment in emerging economies. While prior studies emphasize smart technologies and digital connectivity, limited evidence explains how connectivity is transformed into value-creating smart services. This study addresses this gap by examining the relationship between digital connectivity and the smart service value chain through a digital inclusion lens. Using a qualitative approach, a systematic literature review guided by the PSALSAR framework is conducted. Academic and international regulatory sources are analysed through content analysis and pattern recognition. The findings show that political, economic, social, and technological (PEST) factors embedded in the connectivity ecosystem are critical to smart service value creation, with socio-economic factors exerting greater influence than technology alone. The study informs conceptual development, service design, and digital policy reform for inclusive smart service ecosystems.</p>
<p><b>Keywords:</b> <i>Smart Services; Digital Connectivity; Value-Creation; PEST Analysis; Digital Inclusion; Emerging Economies.</i></p>	
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<p><b>*Correspondent Author:</b> Rownak Tahmina Email: <a href="mailto:rownak_tahmina@yahoo.com">rownak_tahmina@yahoo.com</a></p>	<p>© 2026 The Authors. Published by PT Pustaka Intelektual Sutajaya. This is an open access article under the CC BY license (<a href="https://creativecommons.org/licenses/by/4.0/">https://creativecommons.org/licenses/by/4.0/</a>)</p>

## INTRODUCTION

The Fourth Industrial Revolution (4IR) has accelerated the integration of digital and physical systems, positioning smart services as a key driver of socio-economic transformation. Enabled by frontier technologies such as the Internet of Things (IoT), artificial intelligence (AI), cloud computing, and big data analytics, smart services enhance user participation, service efficiency, and economic inclusiveness (Kankanhalli et al., 2019; Brill & Nissen, 2022). Despite their growing relevance, the diffusion of smart services in emerging economies remains uneven, largely due to persistent digital inequality and fragmented connectivity ecosystems.

Smart services are inherently dependent on digital connectivity, where the scale, quality, and inclusiveness of connected populations directly influence service adoption and value creation. While advanced economies have successfully leveraged high-capacity networks to scale smart services, many

developing countries face structural constraints that limit such progress. Although fifth-generation (5G) networks are widely promoted as a foundational enabler of smart service ecosystems (Yarali, 2021), empirical evidence suggests that countries such as Bangladesh are not yet prepared for large-scale 5G deployment due to infrastructural, institutional, and socio-economic barriers (Halder et al., 2023; Karim, 2023; Hossain et al., 2023). Moreover, prior research demonstrates that digital divides in emerging economies are shaped not only by technological readiness but also by broader socio-economic conditions embedded within the connectivity ecosystem (Islam & Inan, 2021).

Existing scholarship has extensively examined smart technologies and digital connectivity as independent drivers of development. Smart services are commonly characterized as participatory, predictive, responsive, and cross-functional, facilitated through integrated digital platforms and data-driven decision-making processes (Bulut & Anderl, 2022; Svítek & Kozhevnikov, 2023). However, limited attention has been paid to how connectivity ecosystems are transformed into inclusive and value-generating smart services. International policy frameworks proposed by organizations such as the International Telecommunication Union (ITU, 2023) and the Alliance for Affordable Internet (A4AI, 2020) emphasize universal and meaningful connectivity, yet provide minimal guidance on how connectivity conditions can be strategically aligned with smart service value creation. Consequently, the linkage between connectivity-related political, economic, social, and technological (PEST) factors and smart service value chains remains insufficiently conceptualized, particularly in the context of emerging economies. There is a knowledge gap to conceptualize the role of connectivity to cater smart services, especially for developing markets where multifarious factors shape the service ecosystem.

In response to this gap, the present study aims to examine how inclusive connectivity ecosystems shape smart service value creation in emerging markets. Specifically, the study investigates the role of political, economic, social, and technological (PEST) factors embedded within connectivity systems in influencing smart service outcomes. Guided by the research question—How does the connectivity ecosystem influence smart service value creation?—this study synthesizes existing literature to develop a conceptual understanding of the connectivity–smart service nexus. By articulating the interplay between inclusive connectivity and smart service value chains, the study contributes to theoretical advancement, informs service design and digital policy formulation, and provides a foundation for future empirical research on inclusive smart service ecosystems.

## **RESEARCH METHODS**

This qualitative research uses systematic literature review (SLR) as the key technique for this study to obtain insights about the key phenomena: smart services, connectivity ecosystem and digital inclusion. SLR examines the existing researches, studies, publications, policy regulations and international standards with pre-defined inclusion and exclusion criteria. SLR allowed PSALSAR (protocol, search, appraisal, synthesis, analysis, and report) framework to collect data from four renowned databases: Emerald Insight, IEEEExplore, Science Direct (Elsevier), Wiley Online Library. However, for relevance and significance, literatures from other renowned sources are also included, e.g. MDPI and Springer. The PSALSAR framework used in this study is summarized in Table 1.

**Table 1.** PSALSAR Framework (Source: Andriuškevičius, Štreimikienė and Alebaitė, 2022)

Steps	Outcomes	Methods
Protocol	<ul style="list-style-type: none"> <li>Define study scope</li> </ul>	<ul style="list-style-type: none"> <li>Only searching strings on smart services attributes and inclusive connectivity ecosystem</li> </ul>
Search Appraisal	<ul style="list-style-type: none"> <li>Searching database</li> <li>Selecting studies</li> <li>Quality assessment of papers.</li> </ul>	<ul style="list-style-type: none"> <li>Search databases</li> <li>Inclusion and exclusion criteria using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).</li> <li>Each paper is assessed first with abstract and then with full-text guided by exclusion and inclusion criteria.</li> </ul>
Synthesis	<ul style="list-style-type: none"> <li>Extract data</li> <li>Categorize data</li> </ul>	<ul style="list-style-type: none"> <li>Arranging data for further analysis.</li> <li>Quantitative categories, description and narrative analysis of organized data.</li> </ul>
Analysis	<ul style="list-style-type: none"> <li>Data analysis</li> <li>Result and discussion</li> </ul>	<ul style="list-style-type: none"> <li>Trend analysis, gap identification and result comparison</li> </ul>
Report	<ul style="list-style-type: none"> <li>Conclusion</li> <li>Report generation</li> </ul>	<ul style="list-style-type: none"> <li>Conclusion and recommendation using</li> <li>PRISMA Methodology</li> <li>Publication</li> </ul>

This study adopts qualitative approach to extract insights on smart service attributes and inclusive connectivity. Qualitative research is suitable to explore in-depth knowledge about a social phenomenon: behavior, attitude and practices of a society (Islam, Khan and Baikady, 2022). Along with the listed databases, inclusion and exclusion criteria guide the screening of papers. Google scholar is selected as the search engine.

Both smart services and connectivity ecosystems are multidisciplinary phenomena. Combinations of social research and engineering publications are studied for broader insights. Furthermore, inclusion criterion for SLR permits contemporary literatures (publications after 2020) for the relatively new concept: smart services. As both smart services and digital connectivity are ever-changing phenomena it is recommended to select publications not older than five years. However, exception is applied to some studies to extract definitions, concepts and theories. For instance, two literatures, are included for their strong relevance to this study where Dreyer et al. (2019) defines smart services and Booth et al. (2016) explained PICOC (protocol, intervention, comparison, outcome and context) method to extract qualitative data in SLR. Nevertheless, for comprehensive review, the search was not confined to high-ranked journal only. Along with listed databases, websites of international organizations, e.g. ITU and A4AI are also included in PSALSAR framework. It allows insights about global policy regulations and guidelines. Apart from selected databases, some literatures are also included for their valuable implications for this study after manual screening of title, abstract and texts. The literatures that are not written in English, published before 2020, non-academic, and not peer-reviewed literatures are excluded. As smart services is a global phenomenon, it is perceived that publications not written in English will not be pertinent to this study. Notably, each step of PSALSAR framework follows PICOC (protocol, intervention, comparison, outcome and context) method to acquire data with transparency and validity (Andriuškevičius, Štreimikienė and Alebaitė, 2022). The quality criterion is set to transferability of data to apply it to desired settings. PICOC framework for this study is tailored according to Booth et al. (2016) in Table 2.

**Table 2.** PICOC (Protocol, Intervention, Comparison, Outcome and Context) For Data Collection and Analysis

Concept	Definition (Booth et al., 2016)	SLR application
Population	<ul style="list-style-type: none"> <li>Contemporary literatures on smart service value chain, connectivity ecosystem, digital inclusion, and international policy regulations and guidelines.</li> </ul>	<ul style="list-style-type: none"> <li>Academic researches that are not older than 2020 are accumulated on smart service value chain.</li> <li>Connectivity ecosystem will be examined from academic researches, global standards and policy regulations.</li> <li>Academic literatures on digital inclusion and its theoretical propositions will also be studied.</li> </ul>
Interventions	<ul style="list-style-type: none"> <li>Search and select the studies.</li> </ul>	<ul style="list-style-type: none"> <li>Search the database with preselected keywords.</li> <li>Inclusion and exclusion criteria.</li> </ul>
Comparison	<ul style="list-style-type: none"> <li>To measure the factors that affect both smart service attributes and connectivity ecosystem for digital inclusion.</li> </ul>	<ul style="list-style-type: none"> <li>Identify the factors for inclusive connectivity and smart service attributes.</li> <li>Recognize the gap.</li> </ul>
Outcomes	<ul style="list-style-type: none"> <li>Extract data</li> <li>Gap analysis</li> </ul>	<ul style="list-style-type: none"> <li>Streams of literature that analyze the factors of connectivity and smart service value chain.</li> <li>Attributes of smart services and factors of connectivity ecosystem will be listed for assessment.</li> <li>The inherent factors and features are evaluated and compared.</li> <li>Data synthesis relates the factors of smart services with that of connectivity ecosystem.</li> </ul>
Context	<ul style="list-style-type: none"> <li>Compilation of findings</li> </ul>	<ul style="list-style-type: none"> <li>Concluding the report</li> </ul>

PSLASR framework with PICOC approach yields further research questions. Hence for ease of data collection, the key research question is segregated into research sub-questions:

- i. What are the attributes of smart services?
- ii. What factors constitute the connectivity ecosystem?
- iii. Is there any relationship between smart service attributes and factors of connectivity ecosystem?
- iv. If relationship exists, how connectivity factors are associated with smart services value chain?

### Search

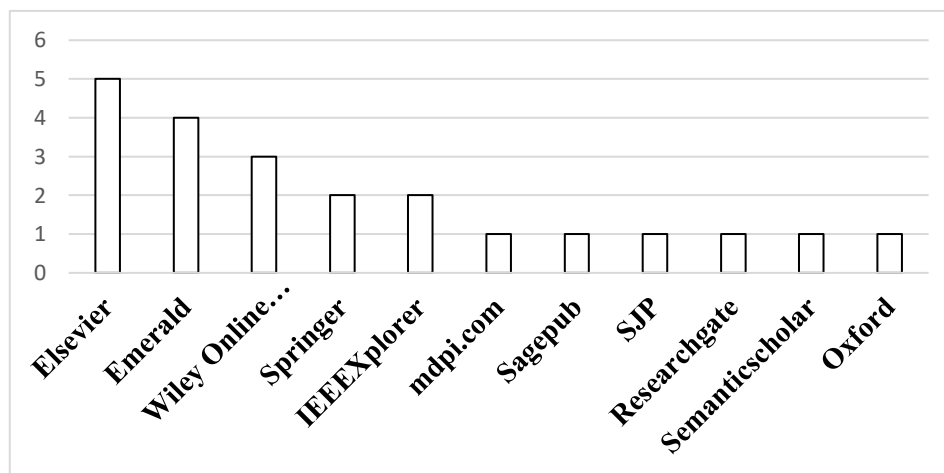
Search strategy navigates searching the relevant papers from the desired databases. Google scholar is used as potential search engine. Though google scholar does not compile the publishers' list or journals' list, it offers citation opportunities. Furthermore, it collects all the well-known databases required for this study. Search string is defined by the population listed in PICOC framework. Thus, the key words for searching the databases are 'smart services', 'smart service value chain', 'digital inclusion', 'inclusive connectivity', 'digital connectivity ecosystem' and '5G'.

Individual Google search with the key words ‘smart services’, ‘smart service value chain’, ‘digital inclusion’, ‘inclusive connectivity’ and ‘digital connectivity ecosystem’ produced enormous search results. To have a manageable but resourceful data, keywords are merged in search strings (for instance, ‘smart services’ + ‘value creation’, ‘digital connectivity’ + ‘smart services’ or ‘5G + smart services’). It filters the irrelevant or less important articles. The articles published by pre-defined databases (Emerald Insight, IEEE Xplore, Elsevier, Wiley Online Library) are selected following inclusion criteria. Furthermore, timeline of publications is selected from 2020 that reduced the hit to more controllable number of quality literatures. Search strategy thus excludes more literatures extraneous to this study.

### Appraisal

Inclusion criteria accumulated publications after initial screening. The literatures are then evaluated again with abstract, keyword, titles, and followed by full-text review. The articles with duplications, grey literatures, not having distinct findings, and that are not downloaded for some systematic causes are excluded. To extract the concepts grounded in publications, quality assessment and relevance is followed precisely. However, to exclude researchers bias, literatures of heterogenous categories are combined. Nevertheless, exception is applied to select older publications that contain established theory and concepts appropriate to this study.

Elsevier provides highest number of literatures for this study while Emeralds comes in the next position as shown in Figure 1. IEEE Xplorer offers the scientific journals on contemporary technology. It is noteworthy that IEEE comes as third source of literatures alongside Springer, as the study elucidates on the social element: digital inclusion. Notably, the studied journals from other databases also cited IEE to a larger extent.

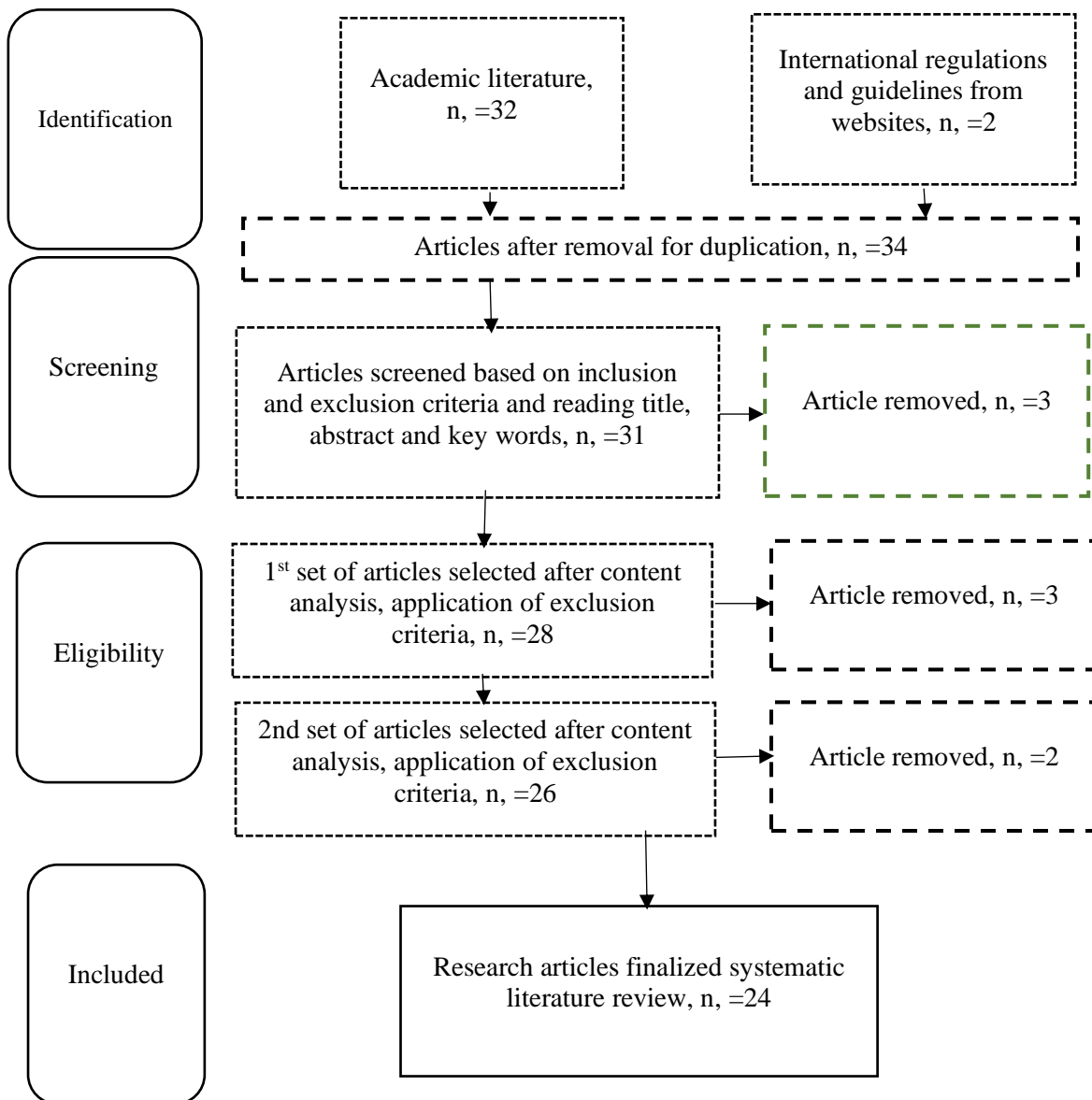


**Figure 1.** Chart of Sources of Academic Literatures (Number of Sources Used as Listed in the Reference List of The Study)

Preliminary screening is performed by manual review. The studies with indistinguishable conclusions, methodology, discussions are excluded. Notably, this qualitative study is more focused on quality articles rather than quantity of literatures. The insights grounded in literatures are extracted from selected literatures. Inclusion and exclusion criteria screen the literatures to compile the descriptive information. Finally, 24 literatures are selected for final evaluation where two literatures are included from websites (ITU and A4AI). This study will extract the intrinsic factors grounded in study population (smart service and connectivity ecosystem). Hence, the quality and relevance of the literatures are more significant than the quantity. In qualitative research, adequacy depends on conceptual depth rather than sample size. The 24 selected studies were sufficient to achieve thematic saturation, as no new concepts emerged. Articles were purposefully selected for high relevance to smart services, digital connectivity,

and PEST conditions in developing-country contexts. Purposive selection ensured high relevance and rigor, enabling robust conceptualization of the connectivity–smart service value chain.

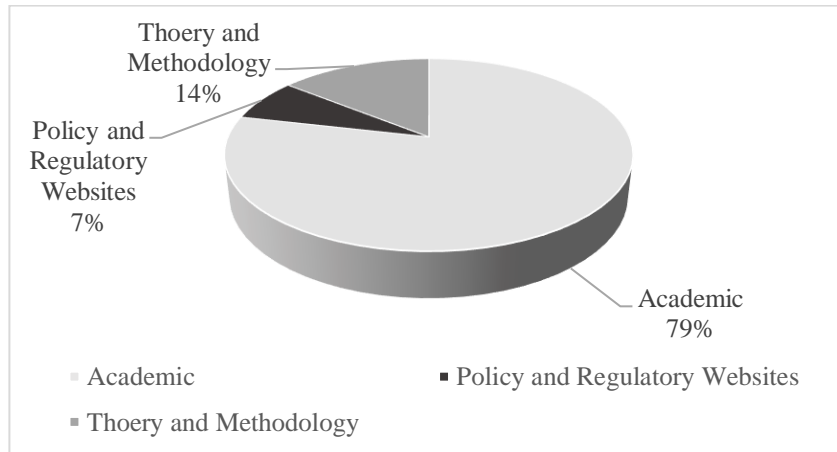
While the review synthesizes insights from 24 final papers, these were selected through stringent inclusion criteria ensuring conceptual richness and methodological rigor. Prior research indicates that carefully curated, smaller samples can provide sufficient saturation to draw reliable conclusions in emerging digital service contexts (e.g., Lichtenthaler, 2020; Andriuškevičius et al., 2022). Thus, the findings represent a focused, high-quality synthesis capable of supporting meaningful inferences about PEST influences on digital connectivity and smart services. Triangulation with ITU and A4AI policy frameworks further strengthened analytical rigor and confirmability of the findings.



**Figure 2.** Schematic Diagram of Information Flow of the Study (Source: Reproduced from Andriuškevičius, Štreimikienė and Alebaitė, 2022)

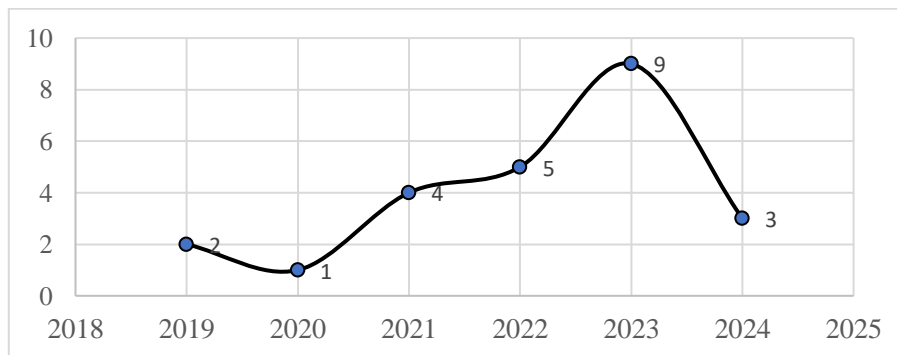
Validity is ensured through generalization from multiple categories of literatures. International policy regulations and theories are combined with academic research to minimize researcher’s bias. The

literatures studied are of three main folds: 79% are academic literatures, 7% regulatory websites, and 14% theory and methodology as shown in the following figure. The heterogenous collection of studies ensures reliability, validity, and guides the content analysis with minimum researcher’s bias.



**Figure 3.** Category of Literatures as Listed in the Reference List of the Study

Although some literatures are purposively selected for their relevance and connotations beyond the timeline, it is observed that they are insignificant in number. The timeline of the literatures is plotted for quality test to ensure inclusion of the contemporary data. It is found that the manual selection does not impact the timeline substantially, and researcher’s bias is not noticeable. Most of the literatures belong to desired timeframe window, and the highest number of literatures are drawn from the year 2023.



**Figure 4.** Timeline of Literatures as Listed in the Reference List of The Study

## RESULTS AND DISCUSSION

The screened literature was synthesized using content analysis and pattern recognition to identify key features of smart services and digital connectivity. Digital inclusion emerged as the common evaluative basis for both phenomena.

### Smart service attributes

Smart services are widely characterized by value co-creation, enabled through data-driven technologies, user participation, and collaborative ecosystems. Prior studies highlight that smart service value depends on user capacity, data richness, predictive capability, and cross-functional integration supported by digital platforms (Dreyer et al., 2019; Koldewey et al., 2020; Bulut & Anderl, 2022; Sabatini et al., 2023). Innovation in service design and business models is critical for delivering responsive and participatory smart services (Heinz, 2023). Predicting the digital future, Khalid (2023)

argued that ‘Internet of Thinking’ will control every sphere of our future life ranging from education, economy, politics, life, and social culture. It implies, smart technology possesses the socio-economic elements that must be examined. Most of the researchers characterized smart services as product-service system where digital transformation enables service functionality in products. The attributes of smart services are summarized in Table 3.

**Table 3.** Smart Services Attributes

Smart Services Attributes	Researcher
Value-creation	1. Heinz, 2023 2. Kashef, Visvizi and Troisi, 2021 3. Sabatini, Pascucci and Gregori, 2023 4. Bulut and Anderl, 2022 5. Koldewey et al., 2020 6. Dreyer et al., 2019
Collaborative	1. Koldewey et al., 2020 2. Bulut and Anderl, 2022
Predictive	Koldewey et al., 2020
Cross-functional	Bulut and Anderl, 2022
Participatory	1. Kashef, Visvizi and Troisi, 2021 2. Kaiser, Z. A., 2024
Responsive	Svítek and Kozhevnikov, 2023
Innovative to develop business model and service design	1. Sabatini, Pascucci and Gregori, 2023 2. Heinz, 2023 3. Bulut and Anderl, 2022

After critical analysis of the existing studies, the attributes of smart services are segregated to distinct features that are mapped in Table 4.

**Table 4.** Value Creation and Innovative Business Model Derived from Smart Services Attributes and Features

Researcher	Smart Services Attributes	Smart Service Features				Outcome
		User capacity	Smart technology	Data richness	Data-driven decision making	
1. Koldewey et al., 2020 2. Bulut and Anderl, 2022	Collaborative	√			√	√
Koldewey et al., 2020	Predictive		√	√	√	√
Bulut and Anderl, 2022	Cross-functional	√	√		√	√
1. Kashef, Visvizi and Troisi, 2021 2. Kaiser, Z. A. (2024)	Citizen Participation	√	√			√
Svítek and Kozhevnikov, 2023	Responsive		√	√	√	√
Outcome	Value co-creation	√	√	√	√	Smart services with innovative business model and value co-creation

### PEST Interpretation of Smart Services

Content analysis shows that while product-service system contributes to value co-creation, the underlying features collectively enable innovative business models (Table 4). These features can be broadly grouped into technological (smart technology, data, platforms) and non-technological (user capacity, affordability, policy support) dimensions. Further analysis reveals that smart service features are strongly influenced by PEST factors. User capacity is shaped by social and economic conditions such as digital literacy and affordability, while smart technologies rely on political support, investment, and high-speed networks. Data richness and data-driven decision-making require both technological readiness and social capabilities, indicating that smart services operate within a broader macro-environmental context. The smart service features are translated into PEST factors in the lens of digital inclusion in Table 5.

**Table 5.** PEST Analysis of Smart Services

Smart service Features	Associated PEST Factors	PEST property
User capacity (Sabatini, Pascucci and Gregori, 2023; Dreyer et al., 2019; A4AI, 2020)	<ul style="list-style-type: none"> <li>• Digital literacy</li> <li>• Affordability</li> <li>• Access to appropriate devices</li> </ul>	<ul style="list-style-type: none"> <li>• Social</li> <li>• Economic</li> <li>• Technological</li> </ul>
Smart Technology (Dreyer et al., 2019; Shan et al., 2021, Koldewey et al., 2020; Raihan et. Al., 2024)	<ul style="list-style-type: none"> <li>• IoT, AI and Big data,</li> <li>• Hi-speed (4G/5G) network</li> <li>• Investment</li> <li>• Policy</li> </ul>	<ul style="list-style-type: none"> <li>• Technological</li> <li>• Technological</li> <li>• Economic</li> <li>• Political</li> </ul>
Data richness (Sabatini, Pascucci and Gregori, 2023)	<ul style="list-style-type: none"> <li>• Broadband internet</li> <li>• Safe cyberspace</li> <li>• Access to appropriate devices</li> <li>• Digital Skills</li> </ul>	<ul style="list-style-type: none"> <li>• Technological</li> <li>• Technological/Social</li> <li>• Technological</li> <li>• Social</li> </ul>
Data driven decision making (Koldewey et al., 2020)	<ul style="list-style-type: none"> <li>• Meaningful use</li> <li>• Safe cyberspace</li> <li>• Smart Technology</li> <li>• Access to appropriate devices</li> <li>• Digital Skills</li> </ul>	<ul style="list-style-type: none"> <li>• Technological/social</li> <li>• Technological/Social</li> <li>• Technological</li> <li>• Technological</li> <li>• Social</li> </ul>

### **Inclusive Digital Connectivity**

Digital inclusion theory conceptualizes connectivity in terms of access, affordability, quality, skills, and policy support (Sharp, 2022). International guidelines by ITU (2023) and A4AI (2020) further emphasize meaningful and affordable connectivity, including high-speed networks, appropriate devices, and regular use. It is interesting to note that digital inclusion theory deals with factors from diverse segments: political (policy), economic (affordability), social (digital skills) and technological (internet access and speed) context. Eventually, these PEST factors shape the connectivity ecosystem of a nation. Notably some of these PEST factors coincide with the factors of smart services as listed in Table 5.

Content analysis of digital inclusion theory (Sharp, 2022), ITU (2023) and A4AI (2020) infers that connectivity can be segregated into three major components: infrastructure, digital inclusion and meaningful use. In developing countries, infrastructure readiness—particularly the choice between 4G and 5G networks—is constrained by economic, technological, and policy factors (Halder et al., 2023; Karim, 2023). These constraints highlight the decisive role of PEST conditions in shaping national connectivity ecosystems. Multiple PEST factors for smart digital connectivity are summarized in Table 6.

**Table 6.** PEST Analysis of Inclusive Digital Connectivity

Connectivity Components	Connectivity Factors	PEST aspect
Infrastructure (4G or above network) (A4AI, 2020, Raihan et. Al., 2024 and Sharp, 2022)	<ul style="list-style-type: none"> <li>• Policy support</li> <li>• Investment</li> </ul>	<ul style="list-style-type: none"> <li>• Political</li> <li>• Economic</li> </ul>
Broadband Internet (A4AI, 2020 and Sharp, 2022)	<ul style="list-style-type: none"> <li>• Affordability</li> <li>• Smartphone ownership</li> <li>• Digital Literacy</li> <li>• Policy Support</li> </ul>	<ul style="list-style-type: none"> <li>• Economic</li> <li>• Economic</li> <li>• Social</li> </ul>
Meaningful Use (ITU 2022 and Raihan et. Al., 2024)	<ul style="list-style-type: none"> <li>• Cybersecurity</li> <li>• Smart Technology</li> <li>• Digital Literacy</li> </ul>	<ul style="list-style-type: none"> <li>• Technological/Social</li> <li>• Technological</li> <li>• Social</li> </ul>

SLR summarizes the factors intrinsic to smart services and inclusive connectivity in Table 5 and Table 6 that constitute the basis for data analysis.


### **Convergence of Smart Services and Digital Connectivity**

Comparative analysis shows substantial overlap between the PEST factors influencing smart services and those shaping inclusive digital connectivity. Common converged factors: infrastructure (hi-speed 4G/5G network), digital inclusion (broadband internet, digital literacy and affordability) and meaningful use (cybersecurity, smart technology, digital literacy) as shown in Table 7.

This convergence indicates that digital connectivity functions as a structural enabler of smart service value chains. Features such as participation, collaboration, responsiveness, and predictive capability are directly linked to connectivity parameters like digital skills, broadband quality, and meaningful use. Consequently, the effectiveness of smart services depends not only on technological sophistication but also on the broader socio-economic and political environment.

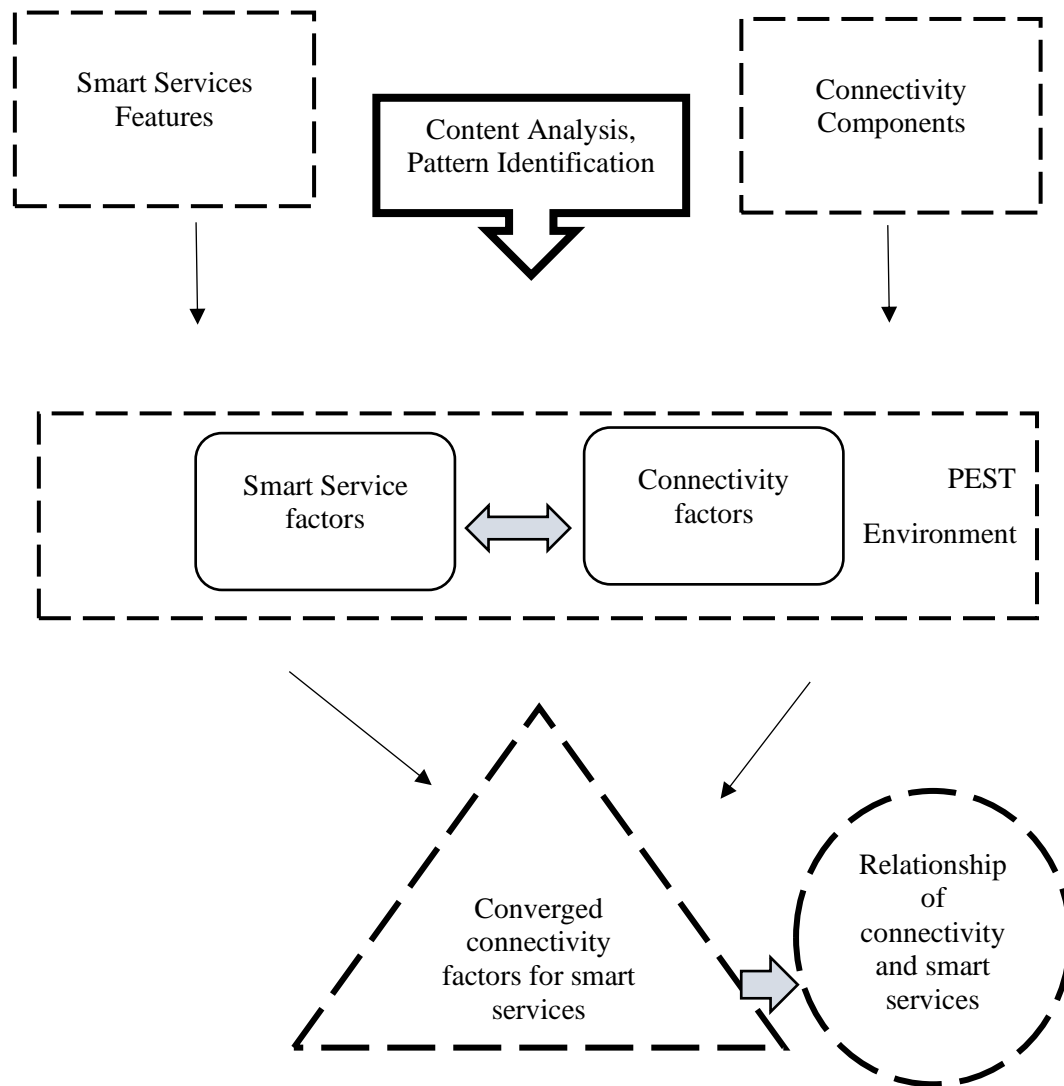
Thus, the factors of smart services and connectivity are assessed, compared and correlated to investigate their relationship. The common factors into which both phenomena are converged are considered as the basis for relationship. Hence, smart service characteristics are correlated with connectivity factors. It measures the role of connectivity on smart service value chain. For instance, the extent to which digital literacy impacts participation or collaboration, or hi-speed network produces cross-functional and responsive services will determine how the connectivity ecosystem shape smart services functionality of a nation.

**Table 7.** Comparison and Evaluation of Smart Services and Connectivity Factors



Connectivity Components	Connectivity Factors	Converged Factors	Smart Factors	Service Features
Infrastructure (4G or above network)	<ul style="list-style-type: none"> <li>• Policy support</li> <li>• Investment</li> </ul>	<ul style="list-style-type: none"> <li>• Policy Support</li> <li>• Investment</li> </ul>	<ul style="list-style-type: none"> <li>• Hi-speed (4G/5G) network</li> <li>• Investment</li> <li>• Policy</li> </ul>	<ul style="list-style-type: none"> <li>• Smart Technology (Dreyer et al., 2019, Shan et al., 2021, Koldewey et al., 2020)</li> </ul>
Broadband Internet (A4AI, 2020 and Sharp, 2022)	<ul style="list-style-type: none"> <li>• Affordability</li> <li>• Smartphone ownership</li> <li>• Digital Literacy</li> <li>• Policy Support</li> </ul>	<ul style="list-style-type: none"> <li>• Digital literacy</li> <li>• Affordability</li> <li>• Access to appropriate devices</li> </ul>	<ul style="list-style-type: none"> <li>• Broadband internet</li> <li>• Digital literacy</li> <li>• Affordability</li> <li>• Access to appropriate devices</li> </ul>	<ul style="list-style-type: none"> <li>• Data richness (Sabatini, Pascucci and Gregori, 2023)</li> <li>• User capacity (Sabatini, Pascucci and Gregori, 2023, Dreyer et al., 2019)</li> </ul>
Meaningful Use (ITU 2022 and Raihan et. Al., 2024)	<ul style="list-style-type: none"> <li>• Cybersecurity</li> <li>• Smart Technology</li> <li>• Digital Literacy</li> </ul>	<ul style="list-style-type: none"> <li>• Cybersecurity</li> <li>• Smart Technology</li> <li>• Digital literacy</li> </ul>	<ul style="list-style-type: none"> <li>• Meaningful use</li> <li>• Safe cyberspace</li> <li>• Access to appropriate devices</li> <li>• Digital literacy</li> </ul>	<ul style="list-style-type: none"> <li>• Data driven decision making (Koldewey et al., 2020)</li> </ul>

Convergence of connectivity and smart services are thus derived from pattern recognition of the factors. Notably, some factors of connectivity merge with smart services value chain, and they share the common PEST environment as shown in following Figure 5.



**Figure 5.** Convergences of Smart Services and Connectivity Derived from Pattern Recognition

### Discussion

Unlike prior SLR studies that examine smart services or digital connectivity in isolation, this study integrates both streams and demonstrates that PEST conditions as a mediating mechanism linking digital connectivity to smart service outcomes. Comparison with previous SLR with this study and the extension/difference it adds are listed in Table 8.

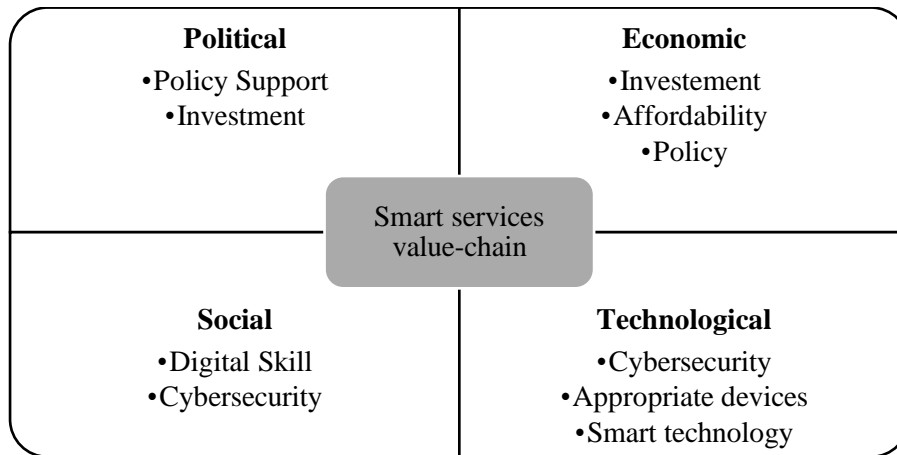
Comparing this study with ITU and A4AI also develops some significant outcome. The ITU (2023) defines meaningful connectivity as safe, affordable, and productive internet access. This study confirms ITU's dimensions but extends them by demonstrating that meaningful connectivity enables specific smart service functions (e.g., responsiveness, participation, data-driven decision making). Similarly, A4AI's (2020) four connectivity pillars—high-speed networks, appropriate devices, affordability, and regular use—are fully supported. However, this study advances the framework by showing that these pillars are embedded in PEST conditions and directly shape smart service performance, not just access.

**Table 8.** Comparison of Findings with Prior SLR Studies

Prior Study	SLR	Focus Area	Key Findings of Prior Study	Confirmation by This Study	Extension / Difference in This Study
Dreyer et al. (2019)		Smart services & value co-creation	Smart services depend on data-driven technologies and user participation	✓ Confirms role of data, participation, and technology	Extends by showing these attributes are subject to PEST factors and digital connectivity
Koldewey et al. (2020)		Smart service ecosystems	Collaboration and predictive services enable smart value creation	✓ Confirms collaboration and predictive capability	Adds connectivity (network, skills, affordability) as a prerequisite for collaboration
Bulut & Anderl (2022)		Digital platforms & smart services	Integrated digital platforms enable cross-functional services	✓ Confirms platform centrality	Extends by embedding platforms within macro-PEST environments
Sabatini et al. (2023)		Smart services & business models	Data richness and innovative business models drive smart services	✓ Confirms data richness & innovation	Shows data richness is dependent on broadband access and meaningful use
Kashef et al. (2021)		Participatory smart services	User participation is essential for smart service success	✓ Confirms participatory nature	Demonstrates participation depends on digital literacy and affordability
Sharp (2022)		Digital inclusion theory	Inclusion measured by access, quality, affordability, skills, policy	✓ Confirms inclusion dimensions	Integrates inclusion into smart service value chain, not just connectivity
Raihan et al. (2024)		Meaningful connectivity	Affordable broadband and skills are critical in developing countries	✓ Confirms meaningful connectivity	Connects meaningful connectivity directly to smart service performance

Thus, this study advances existing literature and policy frameworks by positioning digital connectivity as a functional component of the smart service value chain, rather than a background infrastructure only. Singh et al. (2025) proposed for concerted effort of diverse smart technology, e.g. AI, blockchain and cloud computing for data-driven predictive services. However, for the low and middle-income countries cultural shift, is critical for digital transformation (Manzoor et al.,2025). The findings demonstrate that PEST factors simultaneously shape connectivity ecosystems and smart service outcomes, providing an integrated macro-level explanation for smart service development in

developing countries. Macro-environmental factors thus mediate the relationship between digital connectivity and smart service outcomes, reinforcing its central role in value creation within developing-country contexts (Figure 6).



**Figure 6.** Connectivity Ecosystem to Foster Smart Service Value- Chain

### Limitations and Scope Of Future Research

This study extracts the attributes of value chain grounded in connectivity ecosystem. The qualitative approach is limited to recognize the PEST factors only; their degree of impact is not measured. The smart services features must be harmonized to PEST environment to bridge digital-divide. The future research can be performed to determine the magnitude of the connectivity to affect smart service value-creation. A quantitative or mixed method research can be adopted with regression analysis to calculate the impact of the connectivity factors on smart services value chain. Another qualitative approach is also applicable to develop a conceptual framework to show the causal pathway between the concepts-smart services and digital connectivity.

Furthermore, translating the insights regarding relationship between smart service and digital connectivity into actionable strategies for practitioners is a key next step. Future work could develop an operational framework linking each PEST dimension to targeted interventions, thereby providing concrete guidance for optimizing smart service implementation.

### CONCLUSION

This study identified that PEST factors steer both the connectivity and smart services, and also outline the extent of value-addition. Digital skill, affordability, policy support, investment, access to appropriate devices, smart technology and cybersecurity shape the connectivity ecosystem in which smart services propagate. Although it comprises political, social, economic and technological sphere, it is observed that the socio-economic factors outperform the technological progression, especially in growing economy. Such value-creation predominantly relies on societal capacity, economic growth, and political will. Collective effort of PEST factors is critical for smart service value chain. To maximize the outcome of smart services, the PEST factors should be optimized to the socio-economic context of a nation. It will help service design, policy reform, and future academic research. Actionable interventions for the potential stakeholders are listed in Table 9.

**Table 9.** Actionable recommendations for the stakeholders

Sl.	Stakeholder	Value Chain Stage	Digital Connectivity Lever	Actionable Recommendation	Expected Outcome
1	Policymakers & Regulators	Ecosystem governance	Policy, regulation, affordability	Shift from infrastructure-based targets to service-oriented connectivity benchmarks (QoS for smart health, e-government, digital finance).	Connectivity investments translate into functional smart services.
2	Service Designers and practitioners	Service design	Network quality, device access, innovation	Develop innovative design to include the grassroots	Inclusive services
		Value creation	Skills, affordability	Embed inclusion-by-design principles into participatory and predictive service features.	Broader user participation and equitable value creation.
		Co-creation	Network-service alignment	Co-design services with telecom providers and end-users at early stages.	Improved service reliability and responsiveness.

Table 9 implicates the significance of the study in a greater extent. The policymakers, practitioners and regulators will have the directives to translate the recommendation into actionable strategies and business design.

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