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POLICY AND INFRASTRUCTURE REQUIREMENTS FOR FOSTERING AN ENABLING ECOSYSTEM FOR RURAL DIGITAL COMMERCE IN KARNATAKA

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Keywords	***Abstract***
Karnataka, Rural Digital Commerce, Policy, Infrastructure, Ecosystem	Karnataka, a state renowned for its technological advancements, still faces a significant disparity in digital access and adoption between its urban and rural areas. While digital technologies offer immense potential to uplift rural communities through commerce, transforming "Land to Cloud" pathways, the realization of this potential in Karnataka's diverse rural landscape is heavily dependent on the availability of crucial infrastructure and supportive policies. This research investigates the specific policy and infrastructure requirements needed to foster a robust and inclusive ecosystem for rural digital commerce within Karnataka. The study will employ a mixed-methods approach, likely involving a detailed analysis of state-level digital development policies, assessment of existing digital infrastructure penetration in various rural districts of Karnataka (including internet connectivity, device affordability, and reliable power supply), and qualitative data collection through interviews and surveys with rural entrepreneurs, artisans, farmers, and consumers across different regions of the state. Furthermore, the research will examine successful grassroots digital commerce initiatives within Karnataka to identify the local-specific factors, policies, and infrastructure that have contributed to their effectiveness. Key challenges such as last-mile logistics in the state's varied terrain, digital literacy levels among different demographic groups, and the

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	accessibility of state-backed digital financial services will be explored. The ultimate goal is to provide targeted, actionable recommendations for Karnataka's policymakers and development agencies to strategically invest in infrastructure and design policies that effectively bridge the digital divide, stimulate rural digital entrepreneurship, and ensure that digital commerce serves as a sustainable engine for economic empowerment across rural Karnataka.

1. INTRODUCTION

Karnataka, often hailed as the Silicon Valley of India, stands at the forefront of the nation's digital revolution. While its urban centres boast thriving tech ecosystems and high digital penetration, a significant digital divide persists when looking towards its diverse rural landscapes. These rural areas, rich in agriculture, traditional crafts, and untapped entrepreneurial spirit, hold immense potential for economic growth and sustainable empowerment. The advent of digital technologies offers a transformative avenue, creating "Land to Cloud" pathways that can connect rural producers directly to broader markets and enable rural communities to access a wider array of goods and services through digital commerce.

However, translating this potential into reality for the millions residing in rural Karnataka requires more than just access to technology; it necessitates a carefully constructed enabling ecosystem. This ecosystem is fundamentally built upon two pillars: supportive policy frameworks and robust digital and physical infrastructure. Despite being a leader in India's digital economy, targeted interventions are crucial to ensure that the benefits of digital commerce reach the last mile in Karnataka's villages. This research delves into the specific policy and infrastructure requirements essential for fostering such an ecosystem, aiming to understand what is needed on the ground to unlock the full potential of rural digital commerce for sustainable empowerment across Karnataka.

2. OBJECTIVES OF THE STUDY

The objectives of this research are to:

1. Assess the current status of digital infrastructure (including internet connectivity, device accessibility, and power reliability) across various rural districts of Karnataka and its implications for digital commerce adoption.
2. Analyze existing state-level policies and initiatives by the Government of Karnataka aimed at promoting rural digital transformation and supporting e-commerce, evaluating their reach and effectiveness.
3. Identify and investigate the specific infrastructure and policy-related challenges faced by rural entrepreneurs and consumers in Karnataka that hinder their participation in and benefit from digital commerce.
4. Examine successful cases of rural digital commerce initiatives within Karnataka to understand the critical infrastructure, policy support, and local factors that have contributed to their viability and impact.

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5. Formulate actionable recommendations for the Government of Karnataka and relevant stakeholders to enhance digital infrastructure, refine policies, and develop targeted programs to foster a more inclusive and sustainable rural digital commerce ecosystem in the state.

3. RESEARCH METHODOLOGY

This mixed-methods study assesses digital infrastructure and e-commerce adoption in rural Karnataka. **Primary data** will be collected using quantitative. Quantitative data comes from structured **surveys** administered to 340 participants via a **multi-stage stratified random sampling** design across selected districts and villages. These surveys measure infrastructure access, device ownership, digital literacy, and e-commerce usage. Qualitative data is gathered through **key informant interviews** with stakeholders and **focus group discussions** with rural consumers and entrepreneurs to explore challenges, policies, and successful initiatives in depth.

4. LITERATURE OF REVIEW

Zheng, Sultana, and Williams (2022) analyze how e-commerce integrates with rural life in China, exploring its transformative impacts on economic opportunities, social dynamics, and daily routines. They highlight both the benefits gained and the challenges rural residents experience with this integration. Kabango and Asa (2015) identify critical factors shaping e-commerce growth in developing nations. Their work highlights the interplay of technological infrastructure, economic conditions, policy environment, and socio-cultural elements as key determinants. The article provides insights into the unique challenges and considerations for fostering digital commerce adoption in these regions.

Mulla and Suresha K P (2023) examine how digital literacy is fundamental to promoting rural entrepreneurship and stimulating growth across rural India. Their work highlights that equipping individuals with digital skills empowers rural entrepreneurs to access wider opportunities, overcome traditional barriers, and significantly contribute to economic development in rural areas. Shiva Kumar B. & Pasha (2024), the study examines the impact of e-commerce growth on local retail markets in Chitradurga, Karnataka. It highlights significant challenges faced by traditional merchants due to online competition and suggests that adopting hybrid business models (combining offline and online strategies) is crucial for local retailers' survival and growth.

Kumari and Vineeth (2018) researched factors influencing agritech adoption by farmers in rural Bangalore. Their study identifies key determinants like awareness, perceived benefits, cost, and support. This highlights the need for targeted policies and infrastructure to address these factors for successful digital technology integration in rural agriculture and commerce. Gupta and Singh (2020) employ ISM and MICMAC analysis to map the interrelationships among barriers hindering digital transactions in rural areas. Their findings reveal the structural hierarchy of these barriers, identifying key drivers and dependencies. The study

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offers valuable insights for designing targeted strategies to overcome complex challenges in rural digital financial adoption.

Meyyappan R., Nivash T N, and Ariharan (2019) investigates the significant challenges in rural Indian e-commerce last-mile delivery. It explores both customer perceptions making traditional courier methods difficult and the obstacles companies face, ultimately suggesting alternative solutions based on secondary data analysis to tap into the rural market's potential. Liu and Li (2024) analyze how digital infrastructure drives rural revitalization. Their empirical study identifies mechanisms including reducing information asymmetry, enabling e-commerce platforms for products, and digitalizing rural services. This highlights the transformative power of digital access in bridging the urban-rural divide and fostering development.

Katterbauer, Cleenewerck de Kiev, and Yap (2023) explore the critical role of innovation in driving rural development to achieve the United Nations' Sustainable Development Goals (SDGs). The authors argue that rural areas face unique challenges but can leverage specific types of innovation, such as frugal, inclusive, and social innovation, to overcome these hurdles and create new growth engines. They propose a three-dimensional model to enable these innovations, focusing on pro-social technological innovation policy, effective rural innovation governance, and the creation of dynamic networks that bridge the gap between rural and urban innovation systems. The article suggests fostering closer interactions between rural and urban innovation ecosystems is necessary for rural areas to benefit from urban technologies, networks, and resources.

Sindakis and Showkat (2024) investigated factors influencing digital technology adoption in rural India, focusing on the Digital India Program. Analyzing data from rural Odisha, they found high adoption rates among young, educated populations, particularly challenging the perception of gender disparities by showing higher adoption among women. The study also highlights a trend towards mobile-based service use, emphasizing the critical need for improved rural mobile connectivity to bridge the digital gap and promote inclusion effectively. Stojanova, Cvar, Verhovnik, Božić, Trilar, Kos, and Stojmenova Duh (2022) explores Rural Digital Innovation Hubs (DIHs) as a model for sustainable rural development in Europe. Analyzing their concept, business models, and impact through a case study, the authors conclude that rural DIHs positively influence the sustainability of local businesses and should be integrated into rural development policies for smart transformation.

5. DATA ANALYSIS AND INTERPRETATION

The rural sample in Karnataka shows a gender imbalance (201 male, 139 female), highlighting a need for gender-inclusive digital policies. Education is high (330 with 10+), suggesting potential for digital literacy initiatives. Key occupations are farming (109), students (93), and homemakers (56). This indicates that fostering rural digital commerce requires tailored infrastructure and policies addressing farmers' market access, students'

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digital engagement, and enabling e-commerce for women, leveraging the relatively educated profile while bridging the gender divide.

(i) Digital Infrastructure - Connectivity & Devices

The digital infrastructure in the surveyed rural areas of Karnataka appears relatively strong. Internet access at home is overwhelmingly via **Mobile Data (322).** A large majority perceive their internet speed as **Fast (311).** Crucially, **100% (340)** personally own a smartphone, the primary device for e-commerce, while computer (123) and tablet (22) ownership is much lower.

This indicates a robust mobile-first digital environment. The perceived positive quality of internet speed and near-universal smartphone access are significant enablers. Policies and infrastructure development should capitalize on this by ensuring reliable mobile connectivity, optimizing services for smartphones, and focusing on digital literacy for mobile-based transactions to foster rural digital commerce effectively. (Note: A discrepancy exists in the provided reliability count total).

(ii) Digital Infrastructure - Power Reliability

The power reliability aspect of digital infrastructure in rural Karnataka presents a notable challenge for fostering digital commerce. While **access to electricity is universally reported (100%)** and the **average daily availability is a respectable 21 hours**, the **reliability of the supply is questionable** for the majority.

A significant **267 respondents describe their electricity supply as "Moderately reliable"** (sometimes power cuts), and **12 find it "Unreliable"** (frequent power cuts). Only a small proportion (61) consider it reliable or very reliable. This indicates that despite having power available for most of the day, its inconsistent nature due to frequent cuts can significantly disrupt the use of digital devices necessary for online shopping or business operations.

For an enabling ecosystem for rural digital commerce, reliable power is non-negotiable. Interruptions affect device charging, the ability to stay online for Browse or transactions, and for rural entrepreneurs, maintaining continuous service. Thus, policy and infrastructure requirements must prioritize not just extending electricity access, but crucially, improving the **stability and reliability of the rural power grid** as a fundamental pillar for digital commerce to thrive.

(iii) Digital Literacy and Skills

A significant majority can perform **basic smartphone tasks (319 Yes)** and are **comfortable using mobile applications (304 Yes).** This foundational digital comfort and high smartphone ownership (from previous data) are positive indicators for adopting mobile-based digital commerce in rural Karnataka.

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However, a striking finding is that a large majority **have NOT used the internet to search for information (293 No)**, despite high comfort with apps. This suggests a gap between basic device/app usage and leveraging the internet for broader information access crucial for e-commerce (product search, comparison).

The high number who **received formal training (331 Yes)** is notable. This implies digital literacy initiatives have wide reach in this sample. Yet, the low internet search usage suggests existing training may need to focus more on practical online activities like effective internet Browse for information and e-commerce specific skills (e.g., safe online shopping, identifying reliable sellers).

While the base is strong in terms of device access and app comfort, policy and infrastructure requirements must prioritize enhancing practical internet skills beyond basic usage, ensuring training effectively covers online information retrieval and safe e-commerce practices to fully enable rural digital commerce adoption.

(iv) Digital Commerce Adoption (as a Consumer)

Firstly, awareness of online shopping is universally high (100%) in this sample. This is a significant finding, indicating that basic informational campaigns are less critical than addressing barriers to actual adoption and usage.

A large majority, 249 out of 340 (~73%), have purchased online, demonstrating substantial existing engagement with digital commerce in these rural areas. Furthermore, a significant portion of these users are relatively frequent buyers (129 weekly, 82 monthly), suggesting that once adopted, digital commerce becomes a regular activity for many. The types of products purchased span both physical goods (Clothing, Electronics, Household, Groceries) and digital **services** (Recharge, Bills, Travel), highlighting a diverse consumer demand addressable by e-commerce. This pattern necessitates robust digital payment systems and efficient last-mile delivery infrastructure.

However, the 91 respondents (~27%) who are aware but have not purchased online reveal crucial barriers. Analysis of their reasons indicates that the primary hindrances are not typically basic internet or electricity access (which appears strong in this sample), but rather issues related to trust and security concerns, challenges with digital payment methods, the preference to see products physically, delivery problems, and language barriers on platforms. Cost and product availability are also factors.

For fostering an enabling ecosystem, policies and infrastructure requirements should thus focus beyond fundamental connectivity (which is a base requirement but appears relatively met in this sample). The emphasis should shift to:

- **Policy:** Building consumer trust through regulatory measures, cybersecurity awareness, and accessible grievance redressal. Promoting digital literacy specifically focused on safe online transactions and digital payments. Incentivizing e-commerce platforms to enhance rural delivery networks, simplify returns, and offer local language support.

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- **Infrastructure:** Ensuring consistent quality of internet service, even if access is widespread. Developing logistical infrastructure that supports reliable and affordable delivery to rural doorsteps.

(v) Impact of Infrastructure on Digital Commerce

The impact of infrastructure on the willingness and ability to use online shopping among 249 rural households (excluding the 91 who do not use online shopping), critical insights emerge for fostering rural digital commerce in Karnataka.Regarding internet connectivity, a significant majority (about 83%) feel that the quality or reliability of their internet connection *hinders* their willingness to use online shopping, either significantly or moderately. This indicates that despite potential availability, issues like slow speed, frequent disconnections, or unpredictable service are major deterrents to engaging in digital commerce.

Access to a suitable device also presents a substantial barrier. 213 respondents (121 significantly hinders, 92 moderately hinders, representing about 86%) reported that a lack of access to a suitable device (smartphone/computer) would hinder their ability to shop online. While smartphone ownership might be high, this suggests challenges related to the *type or quality* of the device, or potentially consistent personal access to a device within a household, still impact the ability to effectively participate in digital commerce. Most critically, the reliability of electricity is perceived as a significant impediment. A combined 215 respondents (186 significantly hinders, 29 moderately hinders, approximately 86%) stated that unreliable electricity supply hinders their ability to use online shopping or even charge their devices. This highlights a fundamental infrastructure gap that directly restricts the practical use of digital tools necessary for e-commerce.

The data strongly indicates that for the majority of rural residents interested in or already using digital commerce, the perceived quality and reliability of digital infrastructure are critical barriers, often more so than mere availability.

- **Policy Requirements:** Policies aimed at boosting rural digital commerce must shift focus beyond simply increasing internet coverage to ensuring high-quality, reliable connectivity. Subsidies or incentives for improving the robustness of mobile networks and potentially expanding reliable wired broadband options in viable rural clusters are essential. Furthermore, addressing the fundamental issue of electricity reliability through targeted power infrastructure upgrades in rural areas is paramount, as power cuts directly impact device usability.
- **Infrastructure Requirements:** The data underscores the urgent need for investment in upgrading both telecommunications and power infrastructure in rural Karnataka. For digital commerce to thrive, residents require not just internet access, but a connection stable enough for transactions. Similarly, consistent electricity is non-negotiable for charging and operating devices. Infrastructure planning must consider the last-mile quality and reliability, not just the presence of towers or lines. Initiatives promoting

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access to affordable, suitable devices and potentially community charging solutions in areas with persistent power issues could also play a supportive role.

6. IMPLICATIONS: POLICY AND INFRASTRUCTURE REQUIREMENTS

While formal education is high, policies should leverage this by investing in **refined digital literacy programs** that focus on practical e-commerce skills, such as secure online transactions, effective product searching, and using digital payment methods, tailored for different groups like farmers, students, and homemakers. Given the high awareness but significant non-adoption due to trust, payment issues, and delivery concerns, policies must prioritize **building consumer trust** through regulatory measures, cyber security awareness campaigns, and accessible grievance redressal mechanisms. Incentivizing e-commerce platforms to enhance rural delivery networks, simplify returns, and provide local language support is also crucial.

The analysis underscores that mere availability of infrastructure is insufficient; **quality and reliability** are paramount. Despite high mobile data usage and smartphone ownership, investment is needed to ensure **reliable mobile connectivity** with consistent speed to reduce hindrances to online willingness and ability. Most critically, the data on power reliability highlights a fundamental infrastructure gap. **Improving the stability and reliability of the rural power grid** is a non-negotiable requirement, as frequent power cuts significantly disrupt device usage and online activities. Furthermore, developing **robust last-mile logistics infrastructure** tailored for rural areas is essential to overcome delivery bottlenecks and build consumer confidence, directly impacting adoption and usage frequency. While smartphone ownership is high, ensuring access to suitable devices and supporting device charging infrastructure where power is unreliable are also important considerations.

Fostering rural digital commerce in Karnataka requires policies that champion inclusion, enhance practical digital skills, and build trust, coupled with infrastructure investments that prioritize the quality and reliability of internet and electricity, alongside the development of rural-specific logistics solutions.

The study reveals a rural population with a promising educational profile and high basic smartphone ownership, indicating a strong foundation for digital engagement. Awareness of online shopping is also high, and a significant portion of the surveyed households are already active digital commerce users, with frequent purchase behavior across various product categories. This demonstrates existing demand and potential for growth in rural digital commerce.

7. CONCLUSION

However, the analysis highlights critical barriers that hinder broader and more consistent adoption. Despite high reported internet speeds and universal access to electricity, the reliability of both internet connectivity and, particularly, electricity supply emerges as a significant impediment. Frequent power cuts and inconsistent internet quality directly impact

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the willingness and ability of rural residents to engage in online activities, including shopping and business operations.

Furthermore, while basic digital comfort is present, a gap exists in practical skills for leveraging the internet for more complex tasks like searching for information, which is crucial for informed online purchasing. The noted gender imbalance also suggests that specific efforts may be needed to ensure equitable access and participation for women in the digital commerce space. Challenges related to trust in online transactions, payment methods, the inability to physically inspect goods, and last-mile delivery issues also persist for a notable segment of the population.

Therefore, fostering a truly enabling ecosystem for rural digital commerce in Karnataka necessitates a comprehensive approach focused on:

1. **Prioritizing Infrastructure Reliability:** Policy and investment must shift focus from mere availability to ensuring the *quality* and *reliability* of both internet connectivity and electricity supply in rural areas.
2. **Enhancing Practical Digital Literacy:** Initiatives should go beyond basic skills to provide training specifically on safe online searching, secure digital payments, and effective use of e-commerce platforms, tailored to different demographic and occupational groups like farmers and homemakers.
3. **Building Trust and Addressing Non-Infrastructure Barriers:** Policies should promote consumer protection, cyber security awareness, and facilitate accessible grievance redressal mechanisms. Incentivizing e-commerce platforms to adapt to rural needs (local language support, improved delivery, easier returns) is also crucial.
4. **Promoting Inclusivity:** Targeted policies and programs are needed to bridge the gender divide in digital access and literacy, empowering women's participation in digital commerce.

In conclusion, while rural Karnataka possesses valuable human capital and a growing awareness of digital commerce, persistent infrastructure reliability gaps, coupled with specific digital skill deficits and trust issues, act as significant constraints. Addressing these through targeted policy interventions and robust infrastructure upgrades focused on reliability is paramount to unlocking the full potential of rural digital commerce in the state

8. AUTHOR(S) CONTRIBUTION

The writer affirms that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

9. CONFLICTS OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, And/or publication of this article.

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10. PLAGIARISM POLICY

The author declares that any kind of violation of plagiarism, copyright, and ethical matters will be taken care of by the author. Journal and editors are not liable for the aforesaid matters.

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