WJARR

World Journal of
**Advanced
Research and
Reviews**

World Journal Series
INDIA

(REVIEW ARTICLE)

Check for updates

Theoretical frameworks for ICT for development: Impact assessment of telecommunication infrastructure projects in Africa and the U.S

Boma Sonimiteim Jacks [1], Olakunle Abayomi Ajala [2], Oluwaseun Augustine Lottu [3, *] and Enyinaya Stefano Okafor [4]

[1] Independent Researcher, Nigeria.
[2] Indiana Wesleyan University, USA.
[3] Independent Researcher, UK.
[4] Independent Researcher, Phoenix, Arizona, USA.

Abstract

This review paper examines the theoretical frameworks for assessing the impact of Information and Communication Technology (ICT) on development, focusing on telecommunication infrastructure projects in Africa and the U.S. A comparative analysis highlights the socio-economic and technological disparities between these regions and their implications for telecommunication development. The paper discusses various theoretical frameworks, such as the Digital Divide Theory, Technology Acceptance Model, and Capability Approach, and their applicability to evaluating telecommunication projects. It emphasizes the importance of context-specific strategies, digital literacy, and cross-regional collaboration to enhance the developmental impact of telecommunication infrastructure. The paper concludes with recommendations for policymakers and suggests areas for further research, particularly in developing adaptable frameworks that address regional challenges and opportunities in telecommunication development.

Keywords: ICT for Development; Telecommunication Infrastructure; Digital Divide; Comparative Analysis; Theoretical Frameworks

1. Introduction

In the contemporary era, Information and Communication Technology (ICT) has emerged as a cornerstone of development, fundamentally transforming how societies operate, communicate, and grow. The integration of ICT into various sectors, such as education, healthcare, and finance, has catalyzed socio-economic advancements across the globe (Ashraf, Grunfeld, Hoque, & Alam, 2017; Cave et al., 2009). It has facilitated increased access to information, streamlined service delivery, and enhanced connectivity, thereby contributing significantly to the socio-economic growth of regions. Particularly in developing regions, ICT acts as an enabler of inclusive development, offering unprecedented opportunities for rural and underserved communities to participate in the global economy, access essential services, and improve their quality of life (Adeya, 2002; Akinsola, Herselman, & Jacobs, 2005).

The assessment of telecommunication infrastructure projects is pivotal, especially within Africa and the U.S., due to their distinct socio-economic landscapes and the varied stages of ICT adoption. In Africa, telecommunication infrastructure is critical for bridging the digital divide, enabling economic empowerment, and fostering sustainable development (Musingafi & Zebron, 2014; Yonazi, Kelly, Halewood, & Blackman, 2012). The continent's diverse challenges, including geographical vastness, varied linguistic and cultural landscapes, and economic disparities, underscore the need for targeted telecommunication projects that address specific developmental needs. Conversely,

* Corresponding author: Oluwaseun Augustine Lottu

in the U.S., the focus is on enhancing existing infrastructure to support cutting-edge technologies, reduce urban-rural disparities, and ensure equitable access to high-speed internet as a means to spur innovation and competitiveness (Ashraf et al., 2017; Ben et al., 2017).

The crucial role of telecommunication infrastructure in catalyzing development necessitates a thorough impact assessment to ensure that these projects effectively contribute to the intended socio-economic outcomes. This is particularly relevant in an era where technology evolves rapidly, and the digital divide between and within countries can widen if not addressed strategically.

The primary objective of this paper is to explore and compare theoretical frameworks for assessing the impact of ICT on development, with a specific focus on telecommunication infrastructure projects in Africa and the U.S. This entails a detailed examination of existing theoretical perspectives that guide the evaluation of how telecommunication infrastructure contributes to socio-economic development, including the identification of key indicators of success and areas of improvement. By comparing these frameworks, the paper aims to highlight similarities and differences in the applicability and effectiveness of these frameworks in diverse socio-economic contexts.

This research seeks to identify, compare, and critique the various theoretical approaches used to evaluate the developmental impact of telecommunication infrastructure. The paper will focus on the overarching principles, theories, and models that can be applied universally or adapted to the unique contexts of Africa and the U.S. This approach allows for a broad understanding of the theoretical underpinnings that guide the assessment of ICT for development, offering insights into how these frameworks can be optimized or modified to serve the developmental goals of different regions better.

1.1. Theoretical Frameworks for ICT for Development

ICT for Development (ICT4D) refers to the practice of utilizing Information and Communication Technologies (ICTs) as tools to achieve economic, social, and political development, particularly in low-income countries (Heeks, 2017; Unwin, 2009). The essence of ICT4D lies in its ability to provide innovative solutions to development challenges, enhance access to information, improve service delivery, and foster empowerment and participation among marginalized communities. Theoretical frameworks in ICT4D are critical as they offer structured approaches to understanding, designing, implementing, and assessing the impact of ICT initiatives on development outcomes (Mthoko & Khene, 2018; Van Reijswoud, 2009). These frameworks provide a lens through which the complexities of development can be analyzed, ensuring that projects are technologically sound, socially relevant, and economically viable.

Several theoretical frameworks have been employed to assess the impact of telecommunication infrastructure on development. These include:

Digital Divide Theory: This theory explores the gap between individuals with access to, use of, and knowledge of ICT and those without. It emphasizes the need for telecommunication infrastructure to be inclusive and equitable to bridge this divide, focusing on access, skills, and usage disparities among different demographic groups (Bonfadelli, 2002; Dewan & Riggins, 2005; Gómez, 2018).

Technology Acceptance Model (TAM): TAM is used to understand how users accept and use a technology. It suggests that perceived usefulness and ease of use are fundamental in influencing an individual's decision to use a technology. In the context of telecommunication infrastructure, TAM can help assess how new technologies are adopted by communities and the factors influencing their acceptance (Davis, 1987, 1989; Legris, Ingham, & Collerette, 2003).

Capability Approach: Developed by Amartya Sen and further elaborated by Martha Nussbaum, the capability approach focuses on enhancing individuals' freedoms and opportunities to achieve their desired outcomes. In ICT4D, this framework emphasizes the role of telecommunication in expanding the capabilities of individuals and communities, allowing them to lead lives they value (Frediani, 2010; Robeyns, 2005).

These frameworks can be applied to telecommunication infrastructure projects to evaluate their development outcomes in various ways. Digital Divide Theory can guide the strategic placement of telecommunication services to ensure they reach underserved areas, highlighting the importance of physical access and the relevance and affordability of services. It prompts project designers to consider infrastructure deployment strategies that minimize disparities in access and usage.

The Technology Acceptance Model (TAM) offers insights into the adoption rates of telecommunication services. By assessing perceived usefulness and ease of use among potential users, project implementers can design user-centric services more likely to be embraced by the community. This could involve user education, customization of services to local needs, and simplification of technologies. Capability Approach provides a broader perspective on the impact of telecommunication projects beyond economic benefits (Eriksson, Niitamo, & Kulkki, 2005). It encourages assessing how such infrastructure enhances individuals' abilities to make choices and achieve outcomes they value, such as improved access to education, healthcare, and participation in civic life. This approach suggests that the success of telecommunication projects should be measured not just by economic indicators but by their impact on human development and empowerment (Kamal, Shafiq, & Kakria, 2020).

By applying these theoretical frameworks, stakeholders can ensure that telecommunication infrastructure projects are technologically sound and aligned with broader development goals. These frameworks help identify key focus areas, such as ensuring equitable access, understanding user needs and acceptance, and enhancing individual capabilities, which are crucial for the successful implementation and sustainability of telecommunication projects in the development context.

1.2. Impact of Telecommunication Infrastructure on Development

1.2.1. Economic Impact

Telecommunication infrastructure plays a pivotal role in the economic development of nations by serving as the backbone of modern economies. Its contributions can be seen in various aspects (Champlin, 1997; Röller & Waverman, 2001; D. H. Shin, 2008; Zahra, Azim, & Mahmood, 2008):

Improved Market Access: Telecommunication infrastructure facilitates market access for businesses by enabling efficient communication channels, online marketing, and e-commerce platforms. This access is particularly crucial for small and medium-sized enterprises (SMEs) and entrepreneurs in remote areas, who can now reach global markets, enhancing their growth potential and contributing to economic diversification.

Employment: The development of telecommunication infrastructure generates employment opportunities directly by creating jobs in the telecom sector and indirectly by enabling the growth of the digital economy. This includes many job opportunities in IT services, online businesses, and the gig economy, reducing unemployment and poverty.

Innovation: Telecommunication infrastructure is a key enabler of innovation, providing the necessary platform for developing and deploying new technologies and services. It supports the digital transformation of traditional industries, fostering a culture of innovation that creates new products, services, and business models. The availability of high-speed internet and mobile connectivity spurs innovation in fintech, agritech, and health tech, driving economic growth and competitiveness.

1.2.2. Social Impact

The social implications of telecommunication infrastructure are profound, touching on various aspects of daily life and community well-being (Haleem, Javaid, Singh, & Suman, 2021; He et al., 2020; Hu & Kapucu, 2016; Martin & Rice, 2012):

Access to Education: Telecommunication infrastructure enables access to digital learning resources, online courses, and virtual classrooms, breaking down geographical and socio-economic barriers to education. This is particularly important in remote or underserved areas, where traditional educational resources may be limited. It enhances the quality of education and facilitates lifelong learning opportunities for all segments of the population.

Healthcare: Telehealth and e-health services, enabled by telecommunication infrastructure, have transformed healthcare delivery, making it more accessible and efficient. Patients in remote areas can receive consultations, diagnostics, and treatment advice via mobile or internet-based platforms, reducing the need for physical travel. This infrastructure also supports the management of healthcare systems through electronic medical records, appointment scheduling, and remote monitoring of patients.

Emergency Services: Telecommunication is critical in emergency response and disaster management by facilitating timely communication and coordination among emergency service providers, authorities, and the public. It ensures the swift dissemination of warnings, coordination of relief efforts, and support for affected populations during natural disasters or crises.

1.2.3. Digital Divide and Inclusion

The role of telecommunication infrastructure in bridging or exacerbating the digital divide is a critical area of concern, especially when comparing regions like Africa and the U.S (Musa, 2006; Sabi, Uzoka, Langmia, & Njeh, 2016).:

Access: While significant progress has been made in expanding telecommunication infrastructure, disparities in access to high-speed internet and mobile connectivity persist between urban and rural areas and between developed and developing regions. In Africa, challenges include the lack of infrastructure, affordability, and power supply, whereas in the U.S., rural areas may still face connectivity issues despite the overall high level of infrastructure development.

Usage: Access alone does not bridge the digital divide; the usage of digital technologies is also influenced by factors such as digital literacy, language, and content relevance. Projects aimed at telecommunication development must therefore include components that address these aspects to ensure that all individuals can benefit from the opportunities offered by digital technologies.

Skills: Developing digital skills is essential for individuals to effectively use ICT for personal and professional development. Educational initiatives and training programs are needed to equip people with the necessary skills to navigate the digital world, ensuring that the benefits of telecommunication infrastructure are fully realized.

Telecommunication infrastructure has the potential to significantly impact economic and social development, as well as bridge the digital divide. However, addressing the challenges of access, usage, and skills through comprehensive policies, targeted investments, and collaborative efforts between governments, the private sector, and civil society is essential to maximize these benefits (Abbott, 2012; Marine & Blanchard, 2004; Wade, 2002).

1.3. Comparative Analysis: Africa vs. the U.S.

Africa and the U.S.'s socio-economic and technological landscapes present distinct challenges and opportunities for telecommunication projects. With its diverse and expansive geography, Africa faces challenges such as limited infrastructure, varying degrees of urbanization, and economic constraints that impact the widespread deployment of telecommunication services. Additionally, the continent's higher poverty rates and lower levels of digital literacy can hinder ICT adoption and effective use. In contrast, the U.S. boasts a more developed telecommunication infrastructure and higher average income levels, facilitating greater ICT access and usage. However, the U.S. still confronts issues such as the urban-rural digital divide, where remote areas may lack adequate access to high-speed internet, and socio-economic disparities affecting technology adoption rates (Jamil, 2021; Mishi & Anakpo, 2022; Warf, 2017).

1.3.1. Framework Adaptation and Challenges

Theoretical frameworks for ICT4D impact assessment must be adapted to address the unique contexts of Africa and the U.S. In Africa, frameworks need to consider the fundamental challenges of infrastructure development, affordability, and digital literacy. This might involve emphasizing community-based approaches, local content, and inclusive policies prioritizing access for underserved populations. For the U.S., frameworks might focus more on enhancing connectivity in rural areas, addressing socio-economic disparities in technology access and use, and fostering innovation ecosystems that can drive further economic growth and competitiveness (Champlin, 1997; Heeks, 2017; Uys & Pather, 2020).

Challenges in applying these frameworks arise from their often generic nature, which may not account for local socio-cultural nuances, regulatory environments, and economic conditions. In Africa, the diversity across countries regarding languages, cultures, and regulatory frameworks can complicate the implementation of region-wide telecommunication strategies. In the U.S., the challenge may lie in balancing the drive for technological innovation with ensuring equitable access to the benefits of such advancements (Pahl-Wostl et al., 2008; Scott, Levitt, & Orr, 2011).

1.3.2. Opportunities for Cross-Learning

Despite these differences, there are significant opportunities for mutual learning and collaboration between Africa and the U.S. in telecommunication development. Both regions can exchange best practices in policy-making that promote equitable access to telecommunication services. Africa can learn from the U.S.'s experiences in regulatory frameworks that foster competition, innovation, and investment in telecommunication (Maon, Lindgreen, & Vanhamme, 2009). At the same time, the U.S. can glean insights from Africa's mobile-first approaches and innovations in mobile payments and digital services that have flourished in less saturated markets (Council, 2012; D.-H. Shin, 2014).

There is potential for technology transfer from the U.S. to Africa, particularly in areas like broadband technologies, satellite communications, and digital services innovation. Conversely, the U.S. can benefit from Africa's experience

deploying mobile technologies in low-resource settings and developing innovative applications for health, education, and financial services accessible on basic mobile devices. Joint ventures in research, development, and implementation of ICT projects can foster innovation and shared learning. Initiatives could include collaborative research on low-cost telecommunication technologies, joint development programs aimed at digital skill-building, and exchange programs for professionals and students in the ICT sector (Youtie & Shapira, 2008).

These opportunities highlight the potential for enhanced cooperation and exchange between Africa and the U.S., leveraging their respective strengths and experiences to address the challenges of telecommunication development. Such collaboration can drive progress in each region and contribute to the global agenda of leveraging ICT for sustainable development.

2. Conclusion and Future Directions

The comparative analysis between Africa and the U.S. reveals significant socio-economic and technological disparities that influence the implementation and outcomes of telecommunication projects. While Africa faces infrastructure, affordability, and digital literacy challenges, the U.S. grapples with the urban-rural digital divide and socio-economic disparities in technology access. The review of theoretical frameworks for ICT for Development (ICT4D) impact assessment—such as the Digital Divide Theory, Technology Acceptance Model (TAM), and Capability Approach—underscores the need for adaptable, context-specific strategies to evaluate and enhance the impact of telecommunication infrastructure on development.

Key insights include the importance of understanding local contexts, the necessity of fostering digital literacy and skills, and the potential for technology and policy innovation to address specific challenges faced by different regions. Furthermore, opportunities for cross-learning and collaboration between Africa and the U.S. highlight the mutual benefits of sharing knowledge, experiences, and best practices in telecommunication development.

For policymakers, practitioners, and researchers, several recommendations emerge from this analysis:

Develop and implement telecommunication policies tailored to each region's unique socio-economic and cultural contexts. This may involve prioritizing infrastructure development in underserved areas, subsidizing access to ensure affordability, and promoting content and services that meet local needs.

Invest in initiatives that enhance digital literacy and skills among all population segments, particularly in underserved and rural areas. This is crucial for ensuring that the benefits of telecommunication infrastructure are equitably distributed and that individuals can fully participate in the digital economy.

Encourage innovation in telecommunication technologies and services through partnerships between governments, the private sector, academia, and civil society. Collaborative projects between regions, such as Africa and the U.S., can leverage diverse experiences and strengths to address common challenges.

Utilize and adapt theoretical frameworks to continuously monitor and evaluate the impact of telecommunication projects. This should include assessing economic, social, and digital inclusion outcomes to inform future initiatives and policies.

Future research should focus on several key areas to enhance the understanding and effectiveness of telecommunication infrastructure in promoting development. There is a need for research into the development of theoretical frameworks that are specifically tailored to the unique challenges and opportunities in different regions. This includes exploring how existing frameworks can be adapted to better suit local contexts. Further research is needed on methodologies for assessing the multifaceted impact of telecommunication infrastructure, incorporating both quantitative and qualitative measures to capture the full range of economic, social, and cultural effects.

They need to investigate the potential for new and emerging technologies to address specific telecommunication challenges different regions face. This includes exploring the use of satellite technology, low-cost broadband solutions, and mobile development applications. Finally, comparative studies on policy and regulatory frameworks that have successfully facilitated telecommunication development will be conducted, focusing on lessons learned and best practices that can be adapted and applied across different regions.

In conclusion, the development and implementation of telecommunication infrastructure projects hold immense potential for socio-economic development in both Africa and the U.S. By applying context-specific theoretical

frameworks, fostering collaboration, and focusing on digital inclusion, policymakers and practitioners can maximize the developmental impact of these initiatives. Future research in this field will play a critical role in advancing our understanding of how best to leverage telecommunication technologies for the benefit of all.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Abbott, K. W. (2012). Engaging the public and the private in global sustainability governance. *International Affairs, 88*(3), 543-564.

[2] Adeya, C. N. (2002). ICTs and poverty: A literature review. *Ottawa, IDRC*.

[3] Akinsola, O., Herselman, M., & Jacobs, S. (2005). ICT provision to disadvantaged urban communities: A study in South Africa and Nigeria. *International Journal of Education and Development using ICT, 1*(3), 19-41.

[4] Ashraf, M., Grunfeld, H., Hoque, M. R., & Alam, K. (2017). An extended conceptual framework to understand information and communication technology-enabled socio-economic development at community level in Bangladesh. *Information Technology & People, 30*(4), 736-752.

[5] Ben, S., Bosc, R., Jiao, J., Li, W., Simonelli, F., & Zhang, R. (2017). Digital Infrastructure Overcoming the digital divide in China and the European Union. *Centre for European Policy Studies*.

[6] Bonfadelli, H. (2002). The Internet and knowledge gaps: A theoretical and empirical investigation. *European Journal of communication, 17*(1), 65-84.

[7] Cave, J., Van Oranje, C., Schindler, R., Shehabi, A., Robinson, N., & Ph-B, B. (2009). Trends in connectivity technologies and their socio-economic impacts. *DG Information society and Media*.

[8] Champlin, A. E. (1997). *Telecommunications infrastructure and economic and social development.* American University,

[9] Council, N. R. (2012). Rising to the challenge: US innovation policy for the global economy.

[10] Davis, F. D. (1987). User acceptance of information systems: the technology acceptance model (TAM).

[11] Davis, F. D. (1989). Technology acceptance model: TAM. *Al-Suqri, MN, Al-Aufi, AS: Information Seeking Behavior and Technology Adoption*, 205-219.

[12] Dewan, S., & Riggins, F. J. (2005). The digital divide: Current and future research directions. *Journal of the Association for information systems, 6*(12), 298-337.

[13] Eriksson, M., Niitamo, V.-P., & Kulkki, S. (2005). State-of-the-art in utilizing Living Labs approach to user-centric ICT innovation-a European approach. *Lulea: Center for Distance-spanning Technology. Lulea University of Technology Sweden: Lulea*.

[14] Frediani, A. A. (2010). Sen's Capability Approach as a framework to the practice of development. *Development in practice, 20*(2), 173-187.

[15] Gómez, D. C. (2018). The three levels of the digital divide: barriers in access, use and utility of internet among young people in Spain.

[16] Haleem, A., Javaid, M., Singh, R. P., & Suman, R. (2021). Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Sensors international, 2*, 100117.

[17] He, D., Gu, Y., Shi, Y., Wang, M., Lou, Z., & Jin, C. (2020). COVID-19 in China: the role and activities of Internet-based healthcare platforms. *Global health & medicine, 2*(2), 89-95.

[18] Heeks, R. (2017). *Information and communication technology for development (ICT4D)*: Routledge.

[19] Hu, Q., & Kapucu, N. (2016). Information communication technology utilization for effective emergency management networks. *Public Management Review, 18*(3), 323-348.

[20] Jamil, S. (2021). From digital divide to digital inclusion: Challenges for wide-ranging digitalization in Pakistan. *Telecommunications Policy, 45*(8), 102206.

[21]   Kamal, S. A., Shafiq, M., & Kakria, P. (2020). Investigating acceptance of telemedicine services through an extended technology acceptance model (TAM). *Technology in Society, 60*, 101212.

[22]   Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management, 40*(3), 191-204.

[23]   Maon, F., Lindgreen, A., & Vanhamme, J. (2009). Developing supply chains in disaster relief operations through cross-sector socially oriented collaborations: A theoretical model. *Supply chain management: an international journal, 14*(2), 149-164.

[24]   Marine, S., & Blanchard, J.-M. (2004). Bridging the digital divide: An opportunity for growth for the 21^ s^ t century. *Alcatel telecommunications review*(3), 308-313.

[25]   Martin, N., & Rice, J. (2012). Emergency communications and warning systems: Determining critical capacities in the Australian context. *Disaster Prevention and Management: An International Journal, 21*(5), 529-540.

[26]   Mishi, S., & Anakpo, G. (2022). Digital Gap in Global and African Countries: Inequalities of Opportunities and COVID-19 Crisis Impact. *Digital Literacy, Inclusivity and Sustainable Development in Africa. Facet Publishing*.

[27]   Mthoko, H., & Khene, C. (2018). Building theory in ICT4D evaluation: a comprehensive approach to assessing outcome and impact. *Information Technology for Development, 24*(1), 138-164.

[28]   Musa, P. F. (2006). Making a case for modifying the technology acceptance model to account for limited accessibility in developing countries. *Information Technology for Development, 12*(3), 213-224.

[29]   Musingafi, M. C., & Zebron, S. (2014). The role of information and communication technology in rural socio-economic development in Africa. *Int. J. Publ. Pol. Admin. Res, 1*(2), 38-46.

[30]   Pahl-Wostl, C., Tàbara, D., Bouwen, R., Craps, M., Dewulf, A., Mostert, E., . . . Taillieu, T. (2008). The importance of social learning and culture for sustainable water management. *Ecological economics, 64*(3), 484-495.

[31]   Robeyns, I. (2005). The capability approach: a theoretical survey. *Journal of human development, 6*(1), 93-117.

[32]   Röller, L.-H., & Waverman, L. (2001). Telecommunications infrastructure and economic development: A simultaneous approach. *American economic review, 91*(4), 909-923.

[33]   Sabi, H. M., Uzoka, F.-M. E., Langmia, K., & Njeh, F. N. (2016). Conceptualizing a model for adoption of cloud computing in education. *International Journal of Information Management, 36*(2), 183-191.

[34]   Scott, W. R., Levitt, R. E., & Orr, R. J. (2011). *Global projects: Institutional and political challenges*: Cambridge University Press.

[35]   Shin, D.-H. (2014). A comparative analysis of net neutrality: Insights gained by juxtaposing the US and Korea. *Telecommunications Policy, 38*(11), 1117-1133.

[36]   Shin, D. H. (2008). The development of community telecommunication infrastructure: An evaluation of rural telecommunications project. *International Journal of Information Management, 28*(4), 322-335.

[37]   Unwin, P. (2009). *ICT4D: Information and communication technology for development*: Cambridge University Press.

[38]   Uys, C., & Pather, S. (2020). A benefits framework for public access ICT4D programmes. *The Electronic Journal of Information Systems in Developing Countries, 86*(2), e12119.

[39]   Van Reijswoud, V. (2009). Appropriate ICT as a tool to increase effectiveness in ICT4D: Theoretical considerations and illustrating cases. *The Electronic Journal of Information Systems in Developing Countries, 38*(1), 1-18.

[40]   Wade, R. H. (2002). Bridging the digital divide: new route to development or new form of dependency. *Global governance, 8*, 443.

[41]   Warf, B. (2017). Digital divides in the twenty-first century United States. *Geographies of Digital Culture*, 115-130.

[42]   Yonazi, E., Kelly, T., Halewood, N., & Blackman, C. (2012). *The transformational use of information and communication technologies in Africa*: World Bank.

[43]   Youtie, J., & Shapira, P. (2008). Building an innovation hub: A case study of the transformation of university roles in regional technological and economic development. *Research policy, 37*(8), 1188-1204.

[44]   Zahra, K., Azim, P., & Mahmood, A. (2008). Telecommunication infrastructure development and economic growth: A panel data approach. *The Pakistan Development Review*, 711-726.