

## ICT & SUSTAINABLE DEVELOPMENT

Abhimanyu Malik\*

Assistant Professor, Department of CS, CRA College, Sonapat, Haryana, India

**Email ID:** erabhimanyumalik@gmail.com

**Accepted:** 08.10.2022

**Published:** 01.11.2022

**Keywords:** ICT, Sustainable Development.

### Abstract

ICTs may be used in several contexts related to sustainable development. Information and communication technologies first and primarily facilitate global networking and communication, allowing experts to help and collaborate with people from all over the globe without their physically travelling to their locations. People who otherwise would not have access to education and knowledge might potentially benefit significantly from just having this reality brought to their attention. The field of education is another area that makes use of ICTs. Students from all over the world are able to learn together via the use of several technologies, such as web conferencing, without the need of having the financial means to take an expensive journey. Because persons with disabilities are able to employ ICTs to communicate and acquire an inclusive education that may not be available in their community, this has also had a great deal of success in improving inclusive education. ICTs help to sustainable development in a number of different ways, including the fact that they make it possible for businesses all over the globe to engage with customers whenever and wherever they want. There is a possibility that this will have a considerable influence on both employment and economic development. Consider the fact that countries that already have major ICT use and

development are beginning to considerably outpace those nations that are in the process of constructing their ICT infrastructure and enterprises. This is something that should be taken into consideration. As a consequence of this, the gap that currently exists between nations that make extensive use of ICTs and those that are still in the process of developing them may become enormously wider, resulting in the formation of a "digital divide" that would span a sizeable portion of the earth. Even if information and communication technologies have huge potential applications in the field of sustainable development, more focus has to be placed on bridging the digital divide throughout the world; otherwise, sustainable development would suffer. Catching up with other countries that have less developed information and communication technology infrastructures should get a higher priority if these nations are to avoid slipping so far behind other countries. This will also have a substantial positive impact on sustainable development as a consequence of the different opportunities that ICTs present in this field.

### Paper Identification



\*Corresponding Author

## [1] Introduction

It is not always obvious whether or not ICT helps to the construction of a given development trajectory, even in the era of omnipresent digital life and ubiquitous ICTs, processes, and tools. Even if ICTs are considered a component of the greater problem of global development, their role in achieving SD is still poorly understood, both in terms of how to influence policy and how to take effective action. Sustainable development, as it is used here, is promoting economic and social development without compromising environmental integrity or the stability of future generations' access to natural resources. Two factors that contribute to simplicity are the effective use of energy resources and the decrease in carbon footprints and emissions of carbon dioxide. The practise of reducing the carbon footprint and the amount of trash produced by ICT while simultaneously increasing energy productivity is what is meant by the term "green ICT." The health of the environment is improved as a result of this.

In the context of SD, ICTs have had an inconsistent role in the past. In order to better understand eco-friendly ICTs, they summarize the results of previous empirical research reviews. For example, questionnaires addressed to different individuals involved in the school system have been used as the major source of data in a number of researches. Lack of finance and administrative support, lack of interest and engagement by stakeholders, lack of understanding of green ICT among decision makers, lack of concern about ICT's influence on sustainability, and a lack of regulation are all significant obstacles in the realm of policy.

The link between development of ICTs and the evolution of humans has garnered a lot of interest from academics. There is a substantial amount of consensus in the academic literature to the effect that developments in technology alone are not the only thing that may lead to an improvement in the quality of

life for humans, since there are other aspects which drive socio economic growth. It is important to take into consideration the degree to which these technologies may be used to bring about changes in the general well-being of society. An evidence-based story might show that ICT developments have the ability to improve human life if the right objectives are set and the right rules are put in place. Still, it's important to consider the situational context while weighing the nuances of the trade-offs, resource requirements, and other potential downsides.

Although positivist academics tend to believe that ICT helps genuine economic progress, particularly in industrialised nations, several studies have put doubt on this notion by analysing the influence of ICT on economic growth. Additionally, keep in mind that an increase in human development does not always follow from a rise in economic growth. Even if the economy is functioning well, certain social problems, such rising inequality or poverty, may worsen. This is an important factor to make. But it is well known that human improvement predates ICT and technological progress. Data from the Eurostat database is used to examine how advances in ICT have affected socioeconomic progress across 27 European countries. It is important to study human development indices like the UNDP's HDI which measures things like per capita income, level of education, and life expectancy, and the Education Index which measures things like average grade point average in a certain country (EI). Family ICT use, business ICT use, and civic society ICT use are all examples of ICT contexts. In brief, the study considers a total of fifteen variables, nine of which have to do with the system's architecture and six with its governing rules. Human and economic growth in different EU member states have coincided with varying degrees of ICT development, suggesting that widespread adoption of ICT is vital for majority of growing economies.

## [2] Literature Review

Asongu, et al. (2018) focused on promote environmental sustainability in sub-Saharan Africa, we must improve ICTs. This research looks at how boosting ICT access in SSA can help achieve environmental sustainability by cutting down on CO2 emissions. Using the Generalized Method of Moments and data from 44 nations from 2000-2012, this article presents the empirical findings. At the same time as metrics like internet and mobile phone penetration are used to measure ICT, indicators like per capita CO2 emissions and CO2 emissions from liquid fuel usage are used to measure environmental damage. The results allowed us to draw the following conclusions: first, based on the non-interactive regressions, we may conclude that the use of ICTs has no appreciable impact on global CO2 emissions. Furthermore, we utilise interaction regressions to show that although a rise in mobile phone penetration has a net negative impact on CO2 emissions from liquid fuel usage, a rise in ICT has a positive effect on CO2 emissions per capita. At what point in a policy's implementation may ICT undermine any gains made, and how, was calculated and analysed. For ICT to have a negative impact on CO2 emissions, certain policy conditions must be met. The philosophical and policy ramifications were examined. [1]

Richmond, et al. (2018) provided digital technologies and the distribution of wealth in different countries. To investigate global empirical link between ICT & income inequality, the authors utilise panel data from 109 countries between 2001 & 2014. Our findings suggest that impact of ICT on economic inequality may be mitigated, at least in part, by the degree to which inequality was measured and by the nature of the technology used. The impact of ICT on income disparity is similar to that of older forms of economic infrastructure, which is already a major contributor to the problem. They conclude that the link

between ICT and income inequality was weakened by other economic and political factors.[2]

Niebel, et al. (2018) compared ICT's influence on the economies of developing, emerging, and developed countries. Growth in GDP in developing, middle-income, and developed countries are analysed to determine the role that information and ICT play in each category. The primary concern was whether or not developing, emerging, and industrialised nations get different benefits from ICT investments. A total of 59 nations from the years 1995 to 2010 were included in the study, making it a representative representation of the global landscape. The favourable correlation between ICT capital & GDP growth has been confirmed by many panel data regressions. Overall, estimated elasticity of ICT output was larger than the elasticity of compensation for ICT factors in 59 countries, suggesting above-average returns on ICT capital. When we looked at the production elasticity of ICT using regressions using samples from developing, emerging, and established nations, we didn't find any differences that were statistically significant. This study challenges the idea that emerging and underdeveloped nations are "leapfrogging" via ICT since they are not reaping the same benefits from ICT investments as more developed & established nations. [3]

Yan, et al. (2018) looked a view from energy efficiency on the future of ict and sustainable energy use. This research takes an innovative approach by exploring the correlation between ICT progress and energy consumption using the concept of energy productivity. Patent-based ICT knowledge stock suggests a huge discrepancy in ICT development between high-income nations and the rest of the world, whereas the Malmquist energy productivity index shows uneven growth in global energy production using a data panel of 50 countries from 1995-2013. In addition, the findings of the regression show that progress in ICT was highly linked to enhanced energy

productivity. Since achieving sustainable energy consumption was a worldwide priority, this study concludes by advocating for a quickening of ICT development in developing nations. [4]

Ziamba, et al. (2019) presented sustainable adoption of ICT means for the future of the information society. This research employs a quantitative technique to analyse what drives business ICT adoption and how this trend could assist develop a more long-lasting & resilient digital society. Survey data from 396 enterprises' ICT adoption & sustainability in SIS were studied. The results imply that a SIS's potential to survive over time is intimately connected to the competence with which its administrators handle ICTs & determination to establishing an open, sharing culture focused on those technologies. By creating a model to illustrate the factors that influence the various forms of sustainability in the SIS, this work contributes to the field of information society research and practice. [5]

Asongu, et al. (2019) reviewed ICT to raise standards in sub-Saharan Africa's classrooms. The empirical findings were grounded on data gathered by 2SLS and IQR. Inferred from the 2SLS: Increasing internet prevalence has a larger negative net impact on education quality than increasing mobile phone penetration does. There is a non-monotonic relationship between ICT & bad education quality, as shown by IQR, with exception of highest quantile for mobile phone penetration & top quintiles for internet penetration. In internet-related regressions, only the median and highest quartile shows any negative net impacts. [6]

Majeed, et al. (2019) introduced ICTs help improve health examined the data empirically. The goal of this research was to ascertain how ICT influence public health. A panel data collection covering the years 1990-2014 was used to examine the state of population health in 184 different nations. To account for the endogenous character of ICT, the research used fixed

effects analysis utilising the Hausman test, as well as two-stage least squares and system GMM in cross-sectional and panel data analyses, respectively. Population health is often measured by looking at birth outcomes like infant mortality & life expectancy at birth. Here, they examine three surrogate measures of ICT infrastructure: internet use, mobile phone subscriptions, and landline use. Studies have indicated that the use of ICT has a beneficial effect on public health. The results suggest that health care programmers should priorities the implementation of rules that would open up access to digital health services to a wider population. [7]

G. Ramasubramanian, et al. (2021) looked quantify the long-term effects of information and communication technologies on economic growth. If you think about the problems with sustainable development and the solutions that can be found through the application of digital technology, you can see why they advocate for a narrative based on data describing how the progress of ICT affects the long-term prosperity of nations. Data from 39 developed and developing countries' panel records served as the foundation for this research. Because of its reliability, adaptability & practicality, the standard CRISP-DM protocol was used for the study. The results show that countries with high and low income have different sustainable development outcomes. As a result, it's unclear whether or not underdeveloped nations will be able to use ICT to achieve SDG set by the United Nations by the 2030 deadline. [8]

T. N. Nchofoung, et al. (2022) reviewed global proof of globalisation tipping points in the context of ICT for sustainable development. This research aims to understand how ICT affect sustainable development and what factors might moderate that impact. The time span covered is 2000-2019, and the sample of nations is 140. And in this case, I Individual differences are handled by a Fixed Effects estimator, cross-sectional dependencies between panels are handled by a Driscoll

and Kraay estimator, group averages across panels are handled by a Mean Group estimator, unobserved heterogeneity and simultaneity bias are handled by a system generalized method of moments estimator, and instrumental variables are handled by a random effects estimator. Costs that were constant over time results prove that ICT plays a crucial role in ensuring sustainability throughout time. While positive, the findings vary widely across different ICT usage indices, geographic contexts, and socioeconomic categories. Researchers concluded that policymakers should include ICT and its benefits when formulating strategies for the sustainable development agenda. [9]

Asongu, et al. (2019) introduced a monetary perspective, they examine the relationship between ICTs, environmental deterioration, & human development in Sub-Saharan Africa. This research looks at 44 different nations in Sub-Saharan Africa to see whether ICTs may help mitigate environmental deterioration & promote human progress. Indicators of ICT include Internet and mobile phone penetration rates, whereas emissions of carbon monoxide per person & CO<sub>2</sub> intensity were indicators of environmental damage. The empirical proof we provide comes from Fixed Effects & Tobit regressions applied to data from 2000-2012. In order to make the findings more applicable to policy, the dataset is broken down into areas such as income, legal origin, religious dominance, sea access, resource riches, and political stability. According to the results of the baseline study, lowering the negative impact of CO<sub>2</sub> emissions on inclusive human development might be achieved by enhancing the two ICT indicators. After controlling for these factors, we find that the group of nations with middle income, English Common law, & abundant oil had a greater moderating effect on CO<sub>2</sub> emissions than the group of countries with French Civil law, low income, and scarce oil. They examine theoretical and practical implications for policymaking. [10]

Dutta, et al. (2019) focused on panel data analysis using data from 30 Asian nations to determine the effect of information and communication technology on health outcomes. To analyse the connection between ICT features and health outcomes, they have created a weighted index called the "ICT Index" using principal component analysis. To do this, they used Pedroni's cointegration method to analyse the historical relationship between the two variables. As a consequence of the findings, they provide policy recommendations, mostly for poor nations, on a number of pressing challenges relating to information and communication technologies. [11]

Alshubiri, et al. (2019) presented aspects of ICTs on GDP Development in the Gulf Cooperation Council Countries. The purpose of this research was to examine evolution of ICT adoption in six GCC nations between 2000 and 2016 using the Financial Development Index as a proxy for economic prosperity. Internet users and fixed broadband penetration were used to measure ICT development, while private sector loans and wide money supply were used to measure financial development. Using FEs estimations, we find that increased fixed broadband penetration is correlated with both indices of economic expansion. When using the domestic credit as a surrogate for GDP, the advantages of ICT (broadband) outweigh those from Internet users. While an increase of 0.09 percent in Internet users was associated with a 0.09 percent gain in economic development, an increase of 1 percent in fixed broadband was associated with a 2 percent boost in economic growth. When information and communication technology rose by 1%, the other proxy for the money supply rose by 0.40 percent. When the percentage of people who have access to the Internet rises by one percentage point, the money supply rises by 0.11 percent. The research employed a generalized technique of moment's estimator to deal with the endogeneity issue, and its findings corroborate those of the FE. [12]

Table 1: Literature Survey

Sno.	Author / Year	Title	Methodology	Limitation	Productivity via ICT	le Energy Consumption	cy
[1]	Asongu / 2018	Improving ICTs to Promote Ecological Sustainability in Sub-Saharan Africa	ICT, Environmental sustainability	Scope of work is limited	Innovation and Long-Term Energy Sustainability		
[2]	Richmond / 2018	A global look at the relationship between ICT and wage disparity.	ICT	This work is not long-lasting work	The Importance of ICT Adoption in Creating a Sustainable Information Society	ICT	Need to improve the performance and accuracy
[3]	Niebel / 2018	Comparing effects of ICT on economic development in developing, emerging, and established nations.	ICT	There is not performed in future	Better use of ICTs to raise academic standards in sub-Saharan Africa	ICT	There is lack of performance
[4]	Yan / 2018	Increasing Energy	ICT, Sustainable	Lack of efficient	Should we expect improved health because of the	ICT, healthcare	Research is limited to traffic flow
[5]	Ziemba / 2019						
[6]	Asongu / 2019						
[7]	Majeed / 2019						

		use of ICTs? Research Based Evidence							
[8]	G. Ramasubramanian / 2021	Investigating the Role of ICTs in Promoting Sustainable Development: A Narrative Analysis	ICT , Sustainable development	There is less technical work			with equality of opportunity in sub-Saharan Africa: a comparative economic analysis.		
					[11]	Dutta / 2019	New evidence from a panel data study on correlation between use of ICTs & health outcomes in 30 Asian countries	ICT, health outcome	Lack of technical work
[9]	T. N. Nchofoung / 2022	Using ICT for sustainable development: cross-national evidence of globalization's tipping points	ICT , Sustainable development	Lack of security and accuracy					
					[12]	Alshubiri / 2019	Effect of ICTs on economic growth: data from nations of Gulf Cooperation	ICT	Performance of this research is very low
[10]	Asongu / 2019	ICTs, environmental devastation, and human development	ICT	There is lack of performance					

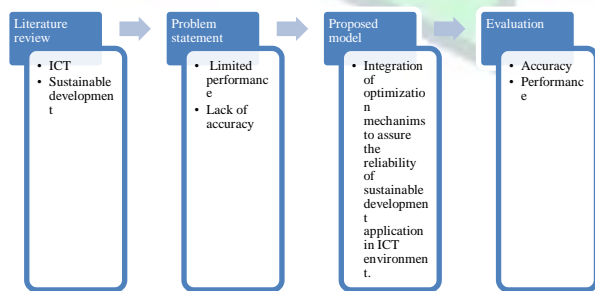
		Council.		
--	--	----------	--	--

**[3] Problem Statement**

Many researchers have been done on the role of ICTs in sustainable development, leading to significant progress in the subject. However, it has been noticed that the work of implementing an integrated system for ICT in sustainable development that should be supported by ICT is a tough undertaking. There is a pressing need to create a model that is accurate and efficient for use in ICT-based sustainable development systems.

**[4] Proposed Research Methodology**

Methods from the ICT have been used in a variety of recently conducted sustainable development related research projects. Research has often focused on the problem-solving aspects of the field. In spite of this, adopting an ICT strategy in sustainable development presents a number of obstacles, one of which is the need to include an accuracy mechanism in order to ensure the integrity of a sustainable development system while operating in an ICT environment. In addition to this, traditional techniques of research need to have a greater capacity for accuracy. There is an immediate need to provide a different approach for the sustainable development system to improve level of accuracy & handle issues with performance.



**Fig 1:** Research Methodologies

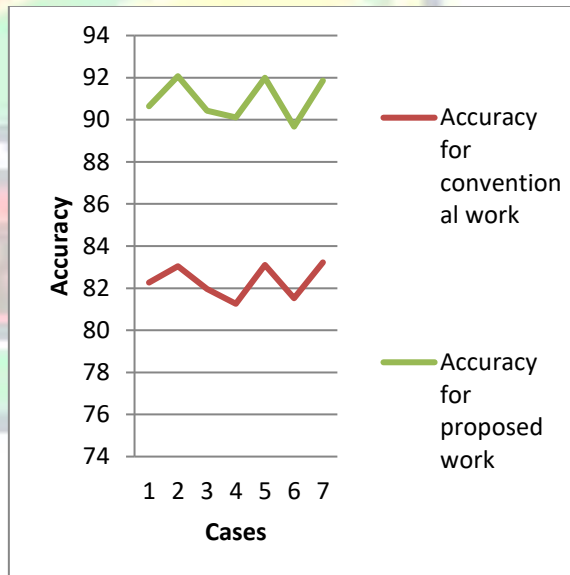
**[5] Result and Discussion**

**5.1 Comparison of Accuracy**

This section is presenting accuracy in case of conventional model and proposed work. Table 2 is presenting comparative analysis obtained of conventional model and proposed work after testing.

**Table 2:** Comparative Analysis of Accuracy for Conventional Model and Proposed Work

Cases	Accuracy for conventional work	Accuracy for proposed work
1	82.27231912	90.644429
2	83.04708865	92.06925522
3	81.96670428	90.42998334
4	81.25764493	90.10917375
5	83.09965456	91.99642727
6	81.51659191	89.67315158
7	83.22352814	91.85779448



**Fig 2:** Comparative Analysis of Accuracy

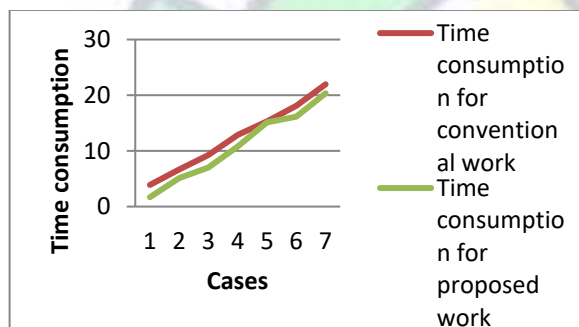
**5.2 Comparison of Performance**

This section is presenting performance in case of conventional model and proposed work. Table 2 is presenting comparative analysis obtained of conventional model and proposed work after testing.



**Table 3:** Comparative Analysis of Performance for Conventional Model and Proposed Work

Cases	Time consumption for conventional work (second)	Time consumption for proposed work (second)
1	3.35157388	2.560087079
2	6.402376861	4.650111413
3	9.409932663	7.888465033
4	12.78221278	11.25488606
5	15.24672968	13.9081148
6	18.1714552	15.34290082
7	21.11821096	18.62075863



**Fig 3:** Comparative Analysis of Time Consumption

### [5] Conclusion

Simulation results conclude that proposed work is providing better accuracy and performance. The simulation operation has been performed over Matlab environment. The performance of proposed work is above 15% while accuracy of proposed work is above 10% as compared to conventional approach. In this way more reliable and scalable solution has been provided.

### [6] Scope of Research

In the context of sustainable development, "mutually beneficial interaction" refers to the dynamic in which lawful interests of a company economy, government & politics, civil society & culture all work together to benefit one another. Nevertheless, these forms of social

contact are not a standalone phenomenon. In further research projects aimed in this direction, it will be important to take into account additional mediating mechanisms, such as institutional governance. Additionally, research on a country-by-country basis might be done to inform policy decisions more thoroughly. It is undeniable that ICT has had a beneficial effect on development in the areas of economic growth, environmental performance, & human progress. This indicates that ICT usage may speed the realisation of SDGs.

### References

- Asongu, S. A., Le Roux, S., & Biekpe, N. (2018). Enhancing ICT for environmental sustainability in sub-Saharan Africa. *Technological Forecasting and Social Change*, 127, 209-216.
- Richmond, K., & Triplett, R. E. (2018). ICT and income inequality: a cross-national perspective. *International Review of Applied Economics*, 32(2), 195-214.
- Niebel, T. (2018). ICT and economic growth—Comparing developing, emerging and developed countries. *World Development*, 104, 197-211.
- Yan, Z., Shi, R., and Yang, Z., "ICT Development and Sustainable Energy Consumption: A Perspective of Energy Productivity", *Sustainability*, 10 (7), 2018, 1–15. MDPI AG.
- Ziemba, E., "The Contribution of ICT Adoption to the Sustainable Information Society", *Journal of Computer information Systems*, 59 (2), 2019, 116–126, DOI: 10.1080/08874417.2017.1312635.
- Asongu, S. A., & Odhiambo, N. M. (2019b). Enhancing ICT for quality education in sub-Saharan Africa. *Education and Information Technologies*, 24(5), 2823-2839.

7. Majeed, M. T., & Khan, F. N. (2019). Do information and communication technologies (ICTs) contribute to health outcomes? An empirical analysis. *Quality & quantity*, 53(1), 183-206.
8. G. Ramasubramanian, A. A. Shaikh, and R. Sharma, "Examining the impact of ICT on sustainable development: A data-driven narrative," *Proc. Annu. Hawaii Int. Conf. Syst. Sci.*, vol. 2020-January, no. January, pp. 4394-4403, 2021, doi: 10.24251/hicss.2021.534.
9. T. N. Nchofoung and S. A. Asongu, "ICT for sustainable development: Global comparative evidence of globalisation thresholds," *Telecomm. Policy*, vol. 46, no. 5, 2022, doi: 10.1016/j.telpol.2021.102296.
10. Asongu, S. A., Nwachukwu, J. C., & Pyke, C. (2019). The comparative economics of ICT, environmental degradation and inclusive human development in Sub-Saharan Africa. *Social Indicators Research*, 143(3), 1271-1297
11. Dutta, U. P., Gupta, H., & Sengupta, P. P. (2019). ICT and health outcome nexus in 30 selected Asian countries: Fresh evidence from panel data analysis. *Technology in Society*, 59, 101184.
12. Alshubiri, F., Jamil, S. A., & Elheddad, M. (2019). The impact of ICT on financial development: Empirical evidence from the Gulf Cooperation Council countries. *International Journal of engineering business management*, 11, 1847979019870670.
13. Amari, M., Mouakhar, K., & Jarboui, A. (2021). ICT development, governance quality and the environmental performance: avoidable thresholds from the lower and lower-middleincome countries. *Management of Environmental Quality: An International Journal*. DOI: 10.1108/MEQ-12-2020-0299.
14. Adams, S., & Akobeng, E. (2021). ICT, governance and inequality in Africa. *Telecommunications Policy*, 45(10), 102198.
15. Ahmed, Z., & Le, H. P. (2021). Linking Information Communication Technology, trade globalization index, and CO 2 emissions: evidence from advanced panel techniques. *Environmental Science and Pollution Research*, 28(7), 8770-8781.
16. Avom, D., Nkengfack, H., Fotio, H. K., & Totouom, A. (2020). ICT and environmental quality in Sub-Saharan Africa: Effects and transmission channels. *Technological Forecasting and Social Change*, 155, 120028.
17. Khan, F. N., Sana, A., & Arif, U. (2020). Information and communication technology (ICT) and environmental sustainability: a panel data analysis. *Environmental Science and Pollution Research*, 27(29), 36718-36731.
18. Kouton, J., Bétila, R. R., & Lawin, M. (2020). The Impact of ICT Development on Health Outcomes in Africa: Does Economic Freedom Matter?. *Journal of the Knowledge Economy*, 1-40.
19. Kurniawati, M. A. (2020). The role of ICT infrastructure, innovation and globalization on economic growth in OECD countries, 1996-2017. *Journal of Science and Technology Policy Management*.
20. Chien, M. S., Cheng, C. Y., & Kurniawati, M. A. (2020). The non-linear relationship between ICT diffusion and financial development. *Telecommunications Policy*, 44(9), 102023.
21. Azam, A., Rafiq, M., Shafique, M., & Yuan, J. (2021). An empirical analysis of the nonlinear effects of natural gas, nuclear energy, renewable energy and ICT-Trade in

- leading CO2 emitter countries: Policy towards CO2 mitigation and economic sustainability. *Journal of Environmental Management*, 286, 112232.
22. Liu, X., Latif, Z., Latif, S., & Mahmood, N. (2021). The corruption-emissions nexus: Do information and communication technologies make a difference?. *Utilities Policy*, 72, 101244
23. Jayaprakash, P., & Pillai, R. R. (2021). The Role of ICT for Sustainable Development: A Cross-Country Analysis. *The European Journal of Development Research*, 1-23.
24. Njangang, H., Beleck, A., Tadadjeu, S., & Kamguia, B. (2021). Do ICTs drive wealth inequality? Evidence from a dynamic panel analysis. *Telecommunications Policy*, 102246
25. Cheng, C. Y., Chien, M. S., & Lee, C. C. (2021). ICT diffusion, financial development, and economic growth: An international cross-country analysis. *Economic modelling*, 94, 662-671.
26. Usman, A., Ozturk, I., Ullah, S., & Hassan, A. (2021). Does ICT have symmetric or asymmetric effects on CO2 emissions? Evidence from selected Asian economies. *Technology in Society*, 67, 101692.