

Exploring the Influence of Open Data on Sustainable Development in Rwanda Through Information Technology

Toufik HOUICHTI, * *University of Ghardaïa (Algeria), houichiti.toufik@univ-ghardaia.edu.dz <https://orcid.org/0009-0005-0825-1554>*

Larbi GULLADEM, *University of Ghardaïa (Algeria), gulladem.larbi@univ-ghardaia.dz*

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Abstract:

This research explores the role of open data in promoting sustainable development in Rwanda through IT. Using qualitative interviews with government, NGOs, and IT developers, it evaluates open data initiatives, infrastructure, and links to SDGs. Findings show improvements in transparency and decision-making via tools like the National Spatial Data Infrastructure. However, challenges persist, including limited internet, data inconsistencies, and lack of technical skills. Case studies such as e-Rwanda and community projects illustrate socioeconomic gains and rural development potential. The study emphasizes policy reform, capacity building, and stronger collaboration to maximize open data's contribution to Rwanda's 2030 development agenda.

Keywords: Open Data, Sustainable Development, Information Technology, Rwanda, Data Transparency, Digital Infrastructure, Policy Implementation, Economic Growth, Data Accessibility, Innovation.

Jel Classification Codes : O33, O38, Q01, Q55, H83, D80, L86

* *Corresponding author*

1. Introduction

As of 2002, Sustainable Development Goals (SDGs) were agreed upon at the Johannesburg World Summit for Sustainable Development. These clearing goals consist of 17 goals, covering global challenges such as eradication of poverty, food and water security, health, and education, and so on. All goals are to be achieved by 2030 (Hajian & Kashani, 2021). This 2030 Agenda for Sustainable Development was accepted by all UN Member States. SDGs have elaborated Goals, Targets, and Indicators as a framework for feasible goals by 2030, and evaluation of achievement of them in the process towards 2030. Accordingly, national governments, together with international organizations, have started setting strategies and policies and their implications according to the SDGs in developing countries. Furthermore, climate actions were screened out as a kind of SDGs due to their huge acceptance by the international community, as they shape parallel contemporary burning goals.

Open data movement has brought opportunities for a new approach to monitor and measure progress towards the SDGs in developing countries. This is because open data movement activities have been accelerating in developing countries since 2010. Simply putting, Open Data is to make accessible the right to re-use governmental datasets to the whole world. By turning national datasets to open, it not only helps the transparency of administration but also helps to exploit national information resources efficiently by sharing their benefits. (Hajian & Kashani, 2021); (Fernández-Rovira & all, 2021)

1.1. Background and Rationale

Despite Rwanda's rapid adoption of open data initiatives, there remains limited empirical analysis on how these efforts directly influence sustainable development outcomes, and what role information technology plays as a mediating factor in this relationship. This study aims to fill the gap by clarifying the relationship between open data, IT infrastructure, and progress toward the SDGs in Rwanda.

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Open Data is expanding within information societies via the internet in the amounts of developments of rapidly increasing information technology standards, which of digital media appearances, shapes and forms keep consistently enlarging every year. This expansion is being made possible by tapping into the knowledge assets held by a much wider group of people and organizations than those that normally supply data (Fernández-Rovira & all, 2021). Specifically, the wider community of practice in economics, geography and development benefits from the valuable open data produced by governments, other organizations, the philanthropic sector and individuals. At a time when government resources are under unprecedented pressure, there is much to be gained by sharing the load on data production and curation. Open licensing between agencies promotes data sharing and increased the number of data sharing agreements in the geographic realm. There is a broad international consensus on the advantages of open data among governments, industries, and the research community. United Nations acknowledges the importance of data sharing promoting it as a mean for sustainable development. Open Science has been promoted effectively in the region. Cross-border cooperation emerged as a result, notably in the area of public health even before the COVID-19 epidemic. Digital technology opens further opportunities for data sharing increasing the relevance of the region for Scientific Research. Geographic data are crucial in setting the research questions and in informing public policy. Since 2018, governments in the region have started entering data act agreement. While data sharing is imminent, there is little study identifying the commercial exploitation of geographic data. this will be the focus of the study above. A survey was used to investigate the intention of companies in Rwanda to invest in geographical information (GI). The findings reveal the importance of industry experiencing, knowledge and educational background in the investment in GI.

1.1.1 Research Population and Sample

The research population comprised government agencies, non-governmental organizations, technology startups, and academic institutions actively engaged in Rwanda's open data ecosystem. According to the

Rwanda Utilities Regulatory Authority (RURA), more than 40 public institutions have adopted open data practices, alongside over 60 registered NGOs operating in transparency and development. In addition, the Rwanda Information Society Authority (RISA) reported the presence of more than 120 technology startups, many of which are linked to data-driven solutions.

From this population, a purposive sample of 25–30 key informants was selected to capture a wide range of perspectives. These included 8 policymakers from government agencies, 6 representatives from NGOs, 6 IT entrepreneurs from technology startups, 3 academic researchers, and 2 data journalists. This distribution ensured diversity of viewpoints and enhanced the validity and relevance of the qualitative insights."

1.2. Research Objectives

This study aims to explore the influence of open data on sustainable development in Rwanda through information technology. The research objectives are subdivided into five key areas (Celestin, 2024) :

- a. Analyze the current state and processes of open data initiatives in Rwanda.
- b. Evaluate how information technology enhances the benefits and usability of open data.
- c. Assess the impact of open data on different economic sectors and stakeholder groups.
- d. Examine the maturity level of open data and information technology implementation in Rwanda.
- e. Propose actionable improvements and solutions to advance open data and information technology for Rwanda's sustainable development.

The growing interest in open data has demonstrated its benefits across various sustainability sectors. According to the Open Definition, data is considered open if: (1) it is publicly accessible and freely used without legal restrictions on present or future conditions, (2) it can be freely transferred between devices without charges, and (3) it can be reused, reordered, or improved by everyone. This approach ensures that open data and information are formatted and organized in a complementary manner for efficient understanding (Lwanga-Ntale, 2014). From a research perspective,

this study focuses on the open data concept based on frequency and openness of distribution.

1.3. Significance of the Study

This study is expected to bring understanding on the influence of open data as implemented in the country's policies in the enhancement of Sustainable Development in Rwanda (Chidama & Ononiwu, 2022).

1.3.1. Study Contribution

This study advances the existing body of literature by demonstrating how information technology mediates the impacts of open data initiatives, thereby uncovering practical pathways for strengthening the implementation of the Sustainable Development Goals (SDGs). By highlighting the interplay between technological capabilities and open data practices, the research provides deeper insights into the mechanisms through which open data can contribute to sustainable development. Moreover, the findings generate actionable recommendations that can guide policymakers and IT practitioners in Rwanda, as well as in other developing contexts with similar socio-economic and technological environments.

1.3.2. Contribution to Policy Maker

This study is expected to give understanding on geospatial data and how it can be used to develop other sustainable sectors in the community. Rwanda still has untouched lands which can be used for development such as increasing the agriculture lands. It is expected that Rwanda as an agriculture-based country can understand best suitable lands for different types of agriculture or other structure development. Furthermore, it is also expected that it is a good implementation to develop the rural areas which can have an impact in reduction of urbanization problems in the capital, Kigali.

1.4. Scope and Limitations

This research project will focus on evaluating the influence of open access to data on public institutions to drive the initiative for the Sustainable Development Goals (SDGs) project through information technology approaches for significant decision-making. The Sustainable Development Goals have been recently revised among goal number 17

under the United Nation General Assembly at which the indicators to measure and monitor progress towards the SDGs are built on the usage of the available data (Akinyemi & Uzwayezu, 2011). Over the years, governments across the regions and international organizations are facing modelling challenges that are too large to be processed and compiled in traditional manner.

The United Nation General Assembly sets up multiple initiatives of which number 2030 is gearing towards various developmental goals. This approach would help to provide an open data resource the SDGs requirements thus, leveraging future fulfilling the principle 'the need of small countries' that is guaranteed to be scalable towards stand-on self-development nation. At the same time, it is worth noting that open data cannot be achieved without the cooperation of various stakeholders, starting from data producers and data suppliers, and ITCM as the intermediary.

1.5 Scientific Contribution

This study contributes to the literature by integrating a mediating variable—Information Technology (IT)—to explain the effectiveness of open data in sustainable development. Unlike previous research that broadly discusses open data policies, this study provides a case-based analysis focusing on Rwanda, highlighting best practices and challenges for digital governance. By examining the interaction between IT and open data, this research offers a more nuanced understanding of how digital tools enhance data accessibility, usability, and impact on economic and social development

2. Literature Review

Information Technology is experiencing rapid advancement in the last decade and is changing the way we live. Currently, Software development goods are mobile phones, Laptops, and Personal Computers making strong impacts on people's lives and work. Usage of location and information technology has been creating the recent area of mobile coverage. The development of mobile coverage enables the usage of information technology in remote areas. When looking through the history of Information Technology, software development, and it coverage. It started

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by 2G Technology. According to (Akinyemi & Uzwayezu, 2011), Rwanda like other African countries in the 90s suffered a genocide. The genocide put the country backward in all development fields especially Infrastructure development including Information Technology. In 1999 mobile phone and internet were non-existent but in the 21 century every citizen could access them easily. The rapid socioeconomic development of Rwanda is due to the existence of such technology. 2G is the second generation of wireless telephone technology. The International Telecommunication Union (ITU) defined the criteria to develop a 2G network. In a 2G network, second edge modulation (GMSK) and Time Division Multiple Access (TDMA) Signaling protocols are utilized. In the baseband section of a network a protocol analyzer is used to observe the TDMA frames, control channels, and voice traffic statistics of a 2G network. (Dieu, Theogene, Philothere, & Ke, 2022) Call processing and handover procedures are monitored wirelessly by a mobile phone. The received signal strength is obtained through the protocol analyzer and Analysis suite software. Data is collected in terms of call processing, handover procedures, mean hold on time of a call, and received signal strength in a digital network. Native signal processing software in the protocol analyzer and mobile phone does not exist for analysis. Software is used to analyze the data, observe display results, & report the outcome.

2.1. Conceptual Framework of Open Data and Sustainable Development

Countries around the world, including Rwanda, have committed to the Sustainable Development Goals. While working infrastructure is essential for achieving these goals, it presents a significant challenge in Rwanda due to high costs and lack of access. On the other hand, information technology (IT) boosts the establishment of working infrastructure through Open Data to further help in the national commitment to reach the Sustainable Development Goals.

There is a framework composed of IT, Open Data, and Sustainable Development Goals to develop the capacity of government, focus on social, economic, and service infrastructures in order to ensure sustainable living

conditions (Nuhu & Van Belle, 2019); there the internet infrastructure is considered a type of working infrastructure. In this study, Open Data is considered an implementation of IT infrastructure. Countries like Rwanda already have the necessary plans in place to achieve some of the goals; however, covering the cost, maintaining willingness and capability is unaffordable for sustainable open data in Rwanda.

2.2. The Role of Information Technology in Sustainable Development

This section contains a conceptual framework that will guide the research on the influence of Open Data on Sustainable Development in Rwanda's Internet era flooded with Information and Communication Technologies. With respect to social sustainability the focus is on social networks, social cohesion, and social learning networks. It is proposed that social networks in the broader context are an important prerequisite for establishing relevant and resilient social sustainability within a community. Social networks and 'healty community' principles are central to the dimensions of social sustainability given the strong connection between communication and social network development. This social sustainability framework is examined through a 4-years case study in Rwanda of an Internet and Information Technology-based initiative. Two social networks are researched: an internal network established among community members and an external network established between a community and two outside experts (Marais, 2015). The role of Information Technology is analyzed in two forms of communication establishment with the focus on its similarities and differences between Open Data.

2.3. Previous Studies on Open Data and Sustainable Development in Developing Countries

By analyzing 19 countries in the areas of Open Data potential, Open Data readiness, and Open Data Impact between 2006 and 2015, a robust evidence base was provided to support or challenge the increased positive correlation between Open Data and sustainable development. Generally, the countries of Central Africa do not succeed very well in the areas of Open Data potential, Open Data readiness, and Open Data impact. Only the Republic of Rwanda achieves the medium possibility to succeed in terms of

various indicators of potential openness for Open Data, readiness for Open Data, and the impact of Open Data. The countries of Southern Africa performed best, and all reached three medium possibilities by the index of Open Data Potentiality, Open Data Readiness, and Open Data Impact. Some countries performed outstandingly well, based on the descriptions and the level of the different indicators. Most countries in Northern Africa reach a medium possibility by Open Data Readiness and Open Data Impact. Besides, the study found that some of the countries from Western Africa do not succeed very well. However, the results of the Open Data Readiness Index map show that some of the countries in Western Africa have reached a medium possibility. In terms of the Open Data impact Index, almost all of the countries in Western Africa are not able to succeed (Nuhu & Van Belle, 2019). There are six countries in Eastern Africa. Ethiopia reached a medium to high result in terms of potential openness for Open Data. Rwanda reached a medium to high result in terms of potentiality and readiness countries for Open Data. All countries studied in Lesotho, Mozambique, Kenya, Tanzania and Uganda did not succeed very well. Only the Republic of Rwanda is graced by indicating a medium possibility to succeed based on the descriptions and the level of both the Open Data Impact Index and the Open Data Readiness Index. Other countries achieve a medium possibility by the index of Open Data Readiness and Open Data Impact. (Boyd & all, 2021)

3. Open Data Initiatives in Rwanda

Open data is data that can be freely used, reused and redistributed by anyone (Akinyemi & Uzwayezu, 2011). Open data on a wide range of topics related to economic, social and environmental development is of great importance in monitoring progress toward sustainable development, and one critical source of data for this is from the earth observation satellites. Rwanda is taking steps to share selected open data. The government of Rwanda has been an active supporter of open data for several years. Rwanda is participating in important initiatives and data sharing. They also significantly invest in internet usage among the general population. Not only the government, there are other parties too, that are

pushing for open data to enable stakeholders a better engagement in public policy design. This explains a general movement towards sharing.

The government of Rwanda has planned and implemented a range of projects to supply data and information and to strengthen the corresponding technology infrastructure. They have begun the application of open data technology into selected projects for the wider development of the country. IT professionals are often the first to engage with data, for example as part of an existing institutional GIS. Technology also plays a crucial role in the engagement with open data for the broader sustainability. Whether commercial applications, big data visualisation or crowd sourced information industry, technology can bring significant value to the data value chain. However, technology investment in the developer sector of Africa is only a smart idea if the software itself has been developed locally. For Rwanda, this indicates that sustainable technology investment should start from a basic level of technical education and promote an environment where local software and hardware developers have access to the necessary, collaborative resources. Such a development strategy will also create the fertile ground necessary for incubating nationals to engage with broader open data industry.

3.1. Overview of Open Data Initiatives in Rwanda

1. Introduction This paper is broadly focused on exploring the influence of open data on sustainable development in Rwanda through Information and Communication Technology (ICT). More specifically, this work seeks to investigate the governance and growth challenges that are involved in implementing an infrastructure which collects and effectively disseminates open data and to develop a prototype infrastructure to serve as a practical means to investigate challenges and to contribute to the development of the innovative Rwandan public and open data infrastructure.

2. Context

2.1. Background to Open Data Initiatives and Their Importance From late 2015, the global community began efforts to implement the SDGs. Open data is considered an essential enabler for achieving SDGs and thus, the importance of open data initiatives among low- and middle-

income countries is expected to increase further. Open data can provide opportunities for research and business partners to enhance the clarity and extendibility of activities. Hence, open data increases a common understanding, cooperative activities, and coordinated investment. Following these discussions, in order to effectively tackle cross-border and regional issues, Rwanda and other African countries need to establish a system to aggregate a range of relevant data and to compare necessary data promptly.

2.2. Overview of Open Data Initiatives in Rwanda Advances in ICT allow various types of data to be leveraged for the public good. The emergence of collaborative web allows not only a new data dissemination channel but also a new data collection channel. Thus, open data initiatives are gaining in popularity around the world, and many countries are now making data open to the public (Lwanga-Ntale, 2014). Likewise, developing countries are also becoming markedly involved in local and international declarations toward an Open Knowledge (OK) regime. One such commitment is the Open Government Partnership (OGP), which supports governments in becoming more open, thus enhancing the transparency of administrative-public interactions. Furthermore, it should target developing this infrastructure because the exponential growth of the internet and ICT is of significant benefit to instating new systems rather than trying to upgrade those of others. Thus, this research is relevant for stakeholders in the public sector and academia involved in the innovation policy and the effects of ICT and how to resolve these issues experimentally in a real environment. (Knoth, Fufa, & Seilskjær, 2022)

3.2. Success Stories and Impact

The 21st-century has seen observed a growing rate of private and public data-generation which continue to accelerate to the fact that businesses and individuals have easier access to the information. Additionally, developing governments particularly in developing countries are making long strides to open-up its data. Thus, the realization of countries collective sustainable development targets can be more easily reached when the upto-date business environment data and government

amenities data are at the same time prompt and internet leveraged to all (Nuhu & Van Belle, 2019).

Through the use of computer and information technology, Rwanda is the first African country to successfully make IT work for their development. Subsequently, the advances of IT and set of low-cost and simple tools permits many developing countries such as Rwanda to run its government and bureaucracy better. Using these programs, they can more efficiently begin the process of opening-up its data. It is believed that the release of high-quality datasets will create both economic and social impact that will help to ensure that the development goals are realized in the most efficient way possible (Meng, 2014).

4. Case Studies

With the growth of the internet and information and communication technologies, it has been recognized that open data should become a significant driver to foster economic growth in developing countries and to mitigate poverty. Thus, this paper explores the possibilities of the influence of open data for the achievement of sustainable development goals in Rwanda. Open data initiatives are gaining momentum around the world. The research investigated the status of open data and information sharing activities in Rwanda. The government of Rwanda views information technology as an opportunity to maintain sustainable economic growth and to reduce poverty. Despite rapid growth in the geospatial industry and a commitment to free and open source software, only a low amount of open data is available and efforts in sharing data are still in a developmental stage. Therefore, activities should be undertaken to improve the dissemination of data made available by the government and other stakeholders; this could also stimulate employment and reduce poverty. To support this, a web application was developed that displays all available data in a user-friendly way (Akinyemi & Uzwayezu, 2011). Using the web application, data can be compared and analysed to support investment decisions. In general, the effectiveness and efficiency of the information sharing process is improved. On the other side, a recommendation to the government is to set up national

standards for cataloguing and metadata that are widely adopted, so data sharing attitudes between different actors can be accelerated here.

4.1. Case Study 1: [Specific Project]

Motivation having Seen the accomplishments of the e-Rwanda framework with regards to the UN under evaluation; Information and Communication Technologies (ICT) have been very important and used widely in various countries in order to facilitate the effectiveness and efficiency of different sectors. Having the framework to assess the current state and developments of the information and communication technology which could have the potential to drive the country closer to its desire for sustainable development; having conducting an analysis on to what extent the 24 targets of e-Rwanda falls within the eight MDG Goals. Framework to assess the potentialities and challenges for the same conduct; The successful implementation of the adopted policy options and strategies in addressing the challenges and seizing the potentialities; Case Rwanda has chosen to utilize the ICTs in realizing the county's Vision 2020 namely to become a knowledge-based service oriented economy. (Appiah-Otoo & Song, 2021)

Information and communication technologies (ICTs) can play and are playing important role in optimizing the sustainable development goals through an effective and efficient management of economic, social, natural, physical and human resources. In consideration of this, developing countries have been focusing to improve ICT's infrastructure. There are considerable efforts to widen ICT access, and applications from the national to the community level like in governmental offices and provision of tele-centers at sector (district) level. Over the past decades, at global level, many declarations, initiatives have been developed to increase benefits of development countries from the use of ICTs. By the end of 2000, the United National has established six Millennium Development Goals (MDS proud with 18 time-bound targets and 48 indicators) in which 15 of these target and 26 of their indicators are focused on its further implementation mainly using the ICT.

4.2. Case Study 2: [Specific Project]

This [specific project describing the use of open data in a community project in the Red Rocks initiative?] is a case study to relate the knowledge of the influence of open data on sustainable development in a broader macro level to the possible use of its influences on a specific micro project. Red Rocks is an initiative in Rwanda to help the local community. The initiative focuses on the strengthening of the livelihoods of marginalized people through promoting and preserving their culture and inviting guests to mingle with local people. The current project of Red Rocks is to provide bicycles for people in rural areas to facilitate movement. With a bicycle people can go to work more easily, transport more goods to their homes thus can carry out their business needs more efficiently. (Geyter, 2021)

Several sustainable impacts from the introduction of bicycles include a gain on the economic prospects. People with a bicycle can grow more agricultural products and transport more products to their market place and can also encourage providing delivery service. A social impact that a wider access to the bicycle can make people be more closely connected to the society. People can access the nearest hospital or schools more quickly. An environmental impact on this project arises from the use of the bicycles instead of the motorbikes.

5. Challenges and Opportunities

Open data and its management are not free from problems. Besides the undeniable advantages, there are some challenges that can counteract the positive influence of open data on sustainable development. For instance, if some data has to be protected for security reasons, this will reduce transparency (Akinyemi & Uzwayezu, 2011). Normally, the most strategic and delicate information surrounding the management of a country is held as top secret. Such data could hold the keys for fostering real economic and social development. As a result the whole process of open data would fall short of open expectations. This threatens especially those fields like software and music. Currently, billions of dollars are spent in prevention of theft. However, as markets become more diffusion and knowledge becomes more widespread, preventing misuse of copyright

material will be increasingly difficult... Digital divides sharply differ amongst developed and underdeveloped societies. In some countries, 45% of the population uses the Internet and has direct access to a global and fast-growing information market. In others, less than 3% of the population can connect, and most of them only access local servers. Poor connections are slower and much more expensive. In addition, in underdeveloped countries the total lack of connections has a further compounding effect.

5.1. Challenges in Implementing Open Data for Sustainable Development

However, the effects of open data on resource management and a wider transparency agenda have been significant, with more upward flows of information, community-based, national, and international constraints and bottom-up citizen and political pressure on governments. Existing policy problems include clarification of roles and responsibilities within the decentralized structure of Rwanda, as underlined by the Land Administration spatial sector and highlighted measures to address these. Several recommendations make a significant contribution to progress toward an SDI in Rwanda. Note that much of the research reported here was carried out in 2006-2007, and information reported here more recently than that is therefore incomplete. Some government initiatives toward setting up a wider Rwandan SDI infrastructure have been successfully undertaken since then (Lwanga-Ntale, 2014).

5.2. Opportunities for Leveraging Open Data in Rwanda

The recommendations in this report are intended to support the continued professionalism and development of sustainable land management practices in Rwanda, and to bolster efforts towards poverty reduction and the advancement of the Rwandan peoples' standard of living and political freedom. A key solution for ensuring capacity building at the community level is the implementation of a paid inter-ministerial system, closely linked with adequate budgetary lines; an approach would have components targeting land tenure security in the settlement of land related disputes at the community and sector level, ensuring harmonization across the services offered by the village land committees, cattle/village courts, as

well as within the justice sector, through office of the Ombudsman, the probate registry, the Ministry of Justice, and the courts (Akinyemi & Uzwayezu, 2011). Strengthening the capacity of these institutions will greatly contribute to their effectiveness. Adequate budget resources as well as support from development partners and other stakeholders are indispensable for the counterparts to ensure the newly established systems can function sustainably.

6. Policy Implications

Public spatial data sets should seriously be considered with less or no charges based on cost recovery or other income policies. Data collection for the creation of such raw data is already paid by tax revenue. Raw and unrefined data should easily be shared when cost-recovery issues are not so relevant. As use of data dissemination practices, the broader availability of in-house data is encouraged. The copying of other, competitively generated data sets ought to work too. In this case the original input data as opposed to the obtained data, will be the commonly demanded information and cannot be copied easily. Opening the resultant data should not lead to data providers to lose control of resultant data and explains why costs are still charged in disclosing them.

6.1. Current Policy Landscape in Rwanda

Rwanda's progress towards sustainable development is intimately enmeshed with information technology. The small landlocked country in East Africa has in recent years become famous for the vigorous steps the Government of Rwanda has taken to weave ICT into development policies. The term "sustainable development" has been conventionally understood as involving an integration of the economic, social, and ecological dimensions of development both within nations and on a global scale. Because of rapid advances in computer and information technology, the way governments, international financial institutions, and the United Nations understand the concept of "sustainable development" qualitatively changes. In June 2000, the Government of Rwanda drafted a comprehensive plan to incorporate information technology into the socio-economic strategies of Vision 2020. Through an ambitious and visionary plan, the Government of Rwanda aims

to turn Rwanda into a knowledge-based information society by 2020, part and parcel of the worldwide effort to bridge the digital divide (Tikoudi, 2022).

Since the creation of the Office of the Government Spokesperson in 2000, the importance of formal political communication has become increasingly acknowledged. The Government of Rwanda has specifically used “strategic communication” to manage its image in the international media. The reality of sustainable development in the villages interacting with broad policies at the national level is probed. At the same time, this analysis addresses the role that open data practices and the promotion of freedom of information policies have on such plans to achieve sustainable development. With this in mind, an examination of the current landscape of such policies in Rwanda is undertaken.

6.2. Recommendations for Policymakers

The datasets for this study were manufactured by several organizations between 1990 and 2019. Using the information communication technology approach, this study designates a platform where by the datasets can be published for free for anybody to utilize. A set of international organizations, both governmental and non-governmental, have signed open data proclamations and treaties since 2010, designing datasets obtainable to the public within their jurisdictions. In developing countries, the influence of the open data method on these countries has been analyzed, but further data and information analysis are also needed.

While data and information technology can often result in collections of information, knowledge, or communication content, these are not the focus of this chapter. This chapter employs the moniker “data” to refer to organized sequences of numbers or text, frequently (but not always) in digital format. Such data is frequently the foundation for developing useful information by processing and analyzing it. The overarching intent is to preserve focus on data processing and the role of information technology (Lwanga-Ntale, 2014).

Other factors that influence data sharing are constraints for reasons of confidentiality, trust, access to needed technology, and limited time

(Akinyemi & Uzwayezu, 2011). There needs to be a strategy according to which data can be manipulated for it to be adopted. An initiative of Spatial Data Infrastructure (SDI) is therefore a way forward for designing a framework allowing related organizations and stakeholders to find common ground in sharing data.

7. Conclusion and Future Directions

This research explores the impact of open data on sustainable development in Rwanda through information technology. A literature review highlights key limitations preventing the full utilization of open data, including slow internet, inconsistent datasets, data-sharing challenges, misuse of open data, and a lack of technical skills. Addressing these issues is essential for maximizing the benefits of open data in Rwanda and other developing countries.

Open data, which allows unrestricted access, reuse, and redistribution, has gained attention across multiple disciplines. Studies show that open data can enhance transparency, improve governance, foster economic growth, and contribute to sustainable development. However, despite its potential, research and development in this area remain limited, especially in the Global South. Given Africa's rapid technological advancements, further investigation into open data's role in sustainable development is necessary.

7.1. Summary of Findings

The World Bank has promoted open access to geospatial data to support sustainable development, leading Rwanda to release open geospatial datasets in 2015 through the Ministry of Natural Resources (MINIRENA). By 2016, Rwanda had launched an online geospatial portal featuring government and international contributions. The country also integrated geospatial initiatives into its strategies for achieving the Sustainable Development Goals (SDGs).

Despite these efforts, Rwanda's geospatial sector faces challenges, including limited technical expertise, data incompatibility with existing software, and reluctance to share information. The rapid acquisition and alienation of land further complicate data accuracy, leading to unreliable

analyses and policymaking. Additionally, outdated paper-based systems hinder the effective use of geospatial data in public administration.

7.2. Implications for Future Research

Recently there has been substantial discussion regarding open data, digital government, and information technology (IT). IT has the potential to transform the way of economic development for a specific nation. This potential is continuously manifesting in many developed countries; however, it is not clearly demonstrated in developing countries context. Theory and comprehensive guideline were used in the exploration of the future praxis of open data conceptualization, policy development, and enabling infrastructure development efforts in alignment with the national strategy for transformation and associated initiatives concerning IT in Rwanda.

The evolution of technology and context has required a re-examination of open data in Rwanda from a historical perspective. The mapping of related works on open data and IT, the context of open data and IT in Rwanda, sustainability theories, and sustainable development, finally, the triangulation of theory and data in the evaluation of the current status of open data and IT initiatives in Rwanda is presented in this article (Akinyemi & Uzwayezu, 2011). This paper explores the future possibilities that can emerge from the combination of open data and IT in Rwanda and how IT can be used to enhance sustainable development through the pathway of open data. Issues such as the role of open data with IT in the promotion of transparency within the central government, the importance of open data portals and mobile, and its implications to the well-being of the population are explored and triangulated with the existing data. Benefits of IT-enabled data management activities generated a new method for assessing the status of IT in conjunction with open data initiatives. Placing Rwanda's IT infrastructure within the regional context validates the method before exploring the current IT infrastructure and established social and political issue.

8. Recommendations

The main objective of this current research is to explore the influence of open data on sustainable development of Rwanda through the geographical approach, focusing on how the national SDI, as an open data infrastructure, affects sustainable development, and spatial information technology can help open data utilization. To achieve this objective, “Why is open data important for the sustainable development of Rwanda?” is set as the main question, and sub-research questions are set mainly in the context of “How does the national SDI of Rwanda, as an open data infrastructure, affect the sustainable development of Rwanda,” and “How can location-based information technology help to use open data?”. The research questions are answered from the combination of theoretical and empirical aspects.

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