

# Assessing the Role of Broadband Connectivity via Biomedical Devices in the Provision of Macro-Scale Health Care in the Provinces of Rwanda

Nicola Ritsch, Chiedza Hwata, Therese Bme Uwiragiye, Omar Gatera, Daniel Armanios, Gerard Rushingabigwi, Celestin Twizere

## Problem Statement and Research Objective

Broadband internet is widely known to enhance digital connectivity, which has not just important economic implications (Calderón and Servén 2014; Czernich et al. 2011; Dedrick et al. 2003; Ding et al. 2008; Martin 1998; Sharon E. Gillett et al. 2006), but also health impacts (Tomer et al. 2020). At the same time, broadband access also presents capacity challenges as only those with the skills to incorporate such enhanced information access in their work (Autor et al. 2003), let alone who have access to information to connect to the Internet (Hargittai 2002), have been found to see those benefits. As such while broadband internet has the potential to serve as a catalyst for economic development in low-income areas (Tomer et al. 2020), these are precisely the areas with acute capacity constraints that are less likely to be able to translate this into value. In other words, broadband penetration throughout a region has the potential to compound existing financial and social inequities if the necessary tools and skillsets are not paired with its growth.

This connectivity-capacity challenge is especially acute in the field of healthcare. The role of broadband internet is growing increasingly important to the provision of healthcare services (Holland Board of Public Works 2021; Jha et al. 2009). This was highlighted during the COVID-19 pandemic when being able to access healthcare was reliant on the use of broadband systems more than ever before. Beyond the abilities of a hospital to provide healthcare remotely via telehealth, broadband internet expands the capacities of how data can be collected using biomedical devices, how online records for patients are managed and how doctors are able to communicate with each other within their own hospitals (inter-hospital communication) and at other hospitals (intra-hospital communication). This all ultimately influences the resources and skill sets doctors have to interpret and use collected information to make accurate diagnosis, develop proper treatments and create a course of action. Therefore, our research aims to explore *if and how access to broadband internet, via the use of biomedical devices, impacts the provision of healthcare, especially for low-income areas where capacity constraints are most acute?*

Rwanda is an ideal context for such a study. Rwanda has been pioneering in their use of the Internet of Things (IoT) in the healthcare sector (Twinoburyo et al. 2022), and even in more upstream inputs into the sector such as bus-boarding rates (Niyigena 2021), remote monitoring of crop development and health (Mujawamariya 2021), and for water management in order to increase rice production efficiency (Bamurigire et al. 2020). As such, the Internet of Medical Things (IoMT) plays a key role in improving the quality, reliability, and affordability health care services in the country. The Government of Rwanda has established strong priorities around improving every Rwandan's baseline healthcare. This can be demonstrated through the large amounts of money being invested into the public hospitals and the universal healthcare coverage all Rwandans receive. This can further be observed through government initiatives such as replacing all thatch roofs with corrugated steel roofs which serves to stop rain from entering dwellings which reduces the prevalence of water-borne diseases and viruses.

IoMT is seen as a strategic technological investment to power these performance outcomes (UNICEF 2021). The country is at the forefront of ensuring access to broadband internet for all of its citizens (ITU News 2018) and is currently ranked as being the fourth innovative country in Africa (ITU News 2022). The country has also set a strong priority improving access to medical health services, with recent

efforts reducing the average travel time to the closest clinic from 95 minutes to 47 minutes in 2020, with the goal of achieving an average travel time of 25 minutes in 2024 (WHO 2022). When the COVID-19 pandemic placed additional stresses on both the healthcare system and the broadband network, this “presented a rare window of opportunity for Africa’s health sector” to improve some of the gaps in provision of care through improving the broadband penetration throughout the entire country, and to use the momentum from addressing the pandemic to implement long-term IoMT-based solutions (Tredger 2021).

In light of this context, this study aims to ask two specific aims which are as follows:

*Aim 1: To what degree are wireless biomedical devices (specifically EKGs) available and used in the public hospital system in Rwanda?*

*Aim 2: What impact does broadband access have on the kinds of services which are offered?*

## **Methodology and Approach**

Before we discuss our research design, we must first discuss scope as the Internet of Medical Things (IoMT) consists of a wide array of technologies with varying specifications and purposes. For this study, we have chosen to focus specifically on how broadband internet influences the effectiveness of IoMT-enabled biomedical devices within the Rwanda healthcare system. We have chosen to focus on biomedical devices specifically because out of the various pieces of the IoMT healthcare system, biomedical devices provide the most controlled setting which is the least influenced by external, unobservable factors (work force capacity, economic feasibility, etc.) than other aspects of the healthcare system. Furthermore, the combination of biomedical devices with adequate broadband internet has the potential of influencing fundamental aspects of how healthcare is provided in the country. Not only does the integration of broadband throughout the public hospital system increase the frequency with which e-health services can be used, but it also expected to increase the levels of inter and intra-hospital communication which can occur. This could consist of doctors and nurses being able to communicate with each other more quickly throughout the hospital when an emergency arises, collecting longer and more reliable data from a patient while they are undergoing a procedure through the use of a remote monitor which in turn allows for more accurate follow-up on their case, or having back-up copies of scans run on all the patients safely stored in the cloud. From the intra-hospital perspective, this could allow increased communication between hospitals in the country so that when a patient is transferred between hospitals, they receive the best level of care possible. It could also allow for the introduction of external skill sets to help supplement those existing in Rwanda, where applicable.

To precisely limit the biomedical application scope, we have elected to focus specifically on two biomedical devices: ECG/EKGs and autoclaves. We selected these two devices because they are very common medical devices (Mayo Clinic n.d.) which we believe will be present in most district and provincial public hospitals. By focusing on these devices in particular, we will be able to explore specific avenues through which broadband internet access impacts healthcare provision in a way that is highly targeted and ubiquitous, allowing for more apples-to-apples comparisons. In other words, we need to ensure the same device specification and requirements to more precisely connect broadband access to an equally comparable, ubiquitous, and standardized set of biomedical device-enabled healthcare practices.

We assess our research question by using a mixed methods research approach which integrates qualitative survey data collection (collected by our team) with quantitative data which is publicly available. To assess Aims 1 and 2, a qualitative survey was conducted with hospital technicians and nurses at each of the 42 participating hospitals throughout the country. The survey lasted an average of 30 minutes and the research team visited all public hospitals and clinics that accepted our request to interview. Given the interest in understanding how differences in broadband penetration impact the provision of healthcare services in different regions around the country, the study includes a wide array of public hospitals from the provinces of Rwanda. These interviews will allow us to more granularly understand the mechanisms that could explain the locational differences in broadband usage and its impacts on macrolevel healthcare provision. This data will identify the mechanisms and constructs that will inform subsequent quantitative regression analysis and t-tests to understand if varying levels of broadband access are associated with different economic indicators. Moreover, we are also collecting numerical information in these questionnaires to serve as a separate, descriptive checks on such subsequent quantitative analyses.

### **Key Findings, and Implications**

Initial findings from interviews suggest that while broadband is available at most of the hospitals in the provinces of Rwanda, the use of wirelessly enabled biomedical devices has not been widely adopted as a practice for sharing information within or between hospitals. Technicians suggest this is due to a lack of training on how to use broadband internet to enable this feature, and the cost of data. Results from the econometric analysis are forthcoming.

We hope that this work will achieve several important objectives. First, we hope to collect a comprehensive dataset exploring the impact of broadband access on healthcare provision and the role that biomedical devices play in facilitating or hindering inter and intra hospital communication. Secondly we hope to be able to contribute to the Government of Rwanda's Broadband Connectivity Initiative which aims to "connect rural and remote communities to a bright digital future" (ITU News, 2018). The findings from the work will be synthesized in a policy note and shared with governmental officials and institutions that contributed data to the effort. The capstone of the work will be a presentation to the Rwanda Information Society Authority (RISA) and the Ministry of ICT on our findings and the associated policy implications. Thirdly, we hope that by exploring this topic and highlighting where additional resources could be useful, we can bring in financial resources to continue understanding where further investment projects and collaborations would be most effective.

We believe that this work will add not only to an academic advancement in this space by collecting the first such dataset of its kind and by analyzing the data in a new and innovative manner, but we believe that the work will also help to contribute to address a range of national, regional, and global challenges. At a national level, we hope the work will help provide insight on what the role of broadband is in the healthcare field. We hope that the survey analysis will shed light on how reliable broadband internet penetration could impact inter- and intra-hospital communication, facilitate the use of e-health services, and shed light on what provinces in Rwanda might most directly benefit from improved internet access from a healthcare perspective. It may also help foster discussions around how addressing the connectivity-capacity of different regions may hinder groups if they are not adequately supported with skills training. In terms of addressing regional and global challenges, we hope that this work will contribute to a growing body of knowledge on this topic and will help share insight for the east-African context specifically because existing literature tends to overlook this region of the world. We also hope the work may facilitate discussions around how broadband internet connectivity could encourage

engaging health experts from other regions of the world and provide insight on how increased information sharing could improve the quality of healthcare provided globally.

Ultimately, we hope that this research will help us to better understand where broadband provision would be most beneficial, from a healthcare perspective, in Rwanda by providing insight on the role that broadband internet plays for biomedical devices in public hospitals throughout the country.

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