

Assessing the Impact of Transmission Lines on Rural Economic Development in Rwanda. A Case of Mamba Rwabusoro Transmission Line in Bugesera and Kicukiro District (2017-2023)

Diane Twizere¹, Marie Claire Mukeshimana¹, Eustache Uwimana^{2*}, Beata Uwamahoro³

¹Environmental and Development Sciences, Environnemental, Economics, and Natural Resource Management, University of Lay Adventists of Kigali (UNILAK), Kigali, Rwanda

²School of Electronics and Information Engineering, Hebei University of Technology, Tianjin, China

³Economics Science and Management, Project Management, University of Lay Adventists of Kigali (UNILAK), Kigali, Rwanda
Email: *eustason07@gmail.com

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Abstract

This study aimed to evaluate the validity of three key objectives: (1) assessing the activities involved in transmission line construction in rural areas, (2) evaluating the economic development in rural areas covered by the Mamba-Rwabusoro transmission line project, and (3) examining the impact of transmission line construction on the economic development of rural communities in the project area. The research methodology integrated survey, descriptive, correlative, qualitative, and quantitative approaches. Both primary and secondary data were collected through questionnaires, interviews, and documentation. Primary data were gathered using structured questionnaires distributed to a purposive sample of beneficiaries of the Mamba-Rwabusoro transmission line, supplemented by interviews with project managers. Data analysis was conducted using SPSS (Statistical Package for Social Scientists), with results presented in descriptive and inferential statistics. The findings revealed that transmission line construction activities significantly contribute to rural economic development, with the Mamba-Rwabusoro project demonstrating a clear and positive impact. A strong correlation was identified between the development of transmission lines and expropriation costs, which accounted for 23% of rural economic development in Rwanda. However, the study also highlighted challenges in the expropriation process, such as delays in payment and land use issues, recommending revisions to expropriation terms, including adjusted prices, faster payment procedures, and simplified requirements for affected landowners. This study holds significant value for project developers,

particularly in the energy and environmental sectors, as well as for future researchers. Its findings can guide project developers in addressing expropriation issues effectively and assist local authorities in ensuring that affected individuals receive timely compensation with the necessary documentation.

Keywords

Impact Assessment, Transmission Lines, Rural Economic Development, Mamba Rwabusoro TL, SPSS

1. Introduction

The European Network of Transmission System Operators (ENTSO-E) operates a comprehensive transmission system network across Europe. This network includes power plants, converters, substations, and high-voltage cables/lines [1]. The higher the voltage, the more power can be transferred. Only the biggest customers are linked to the transmission network. Transmission network voltages are usually higher than 100,000 volts [2]. The networks are made to be very strong, so they can still work even if some parts of the network stop working at the same time. If one part of the system fails, like a transformer or transmission line, it's called an 'N-1' event. The transmission system should be able to handle this kind of event. When many things break at the same time, it can be called 'N-2' or something like that. For example, if a transmission line breaks when another line is already disconnected for repairs. Transmission systems must be able to handle any possible combinations [3].

Transmission lines move electrical energy from one place to another in a power system. The electric energy can be described as electricity that moves back and forth or moves in a single direction or a combination of both and can be transported through either aboveground or belowground wires. Overhead AC transmission lines have one thing in common: they use 3-phase electricity. The voltages are different depending on the grid system they are part of. Transmission voltages range from 69 kV to 765kV [4]. The tower that carries DC voltage has two lines together instead of three lines for AC voltage. One line carries a positive electric current and the other carries a negative electric current [5]. Transmission mostly uses power lines above the ground. While underground lines are less visible and cause fewer environmental concerns, they cost more to build and can't transmit as much power. Transmission systems are run by either transmission system operators (TSOs) or independent system operators (ISOs). Another organization may be responsible for building or owning the physical network [6].

The sixth edition of the Global Electricity Transmission Report released in March 2022 analyses the growth and investment opportunities in the high-voltage electricity transmission sectors of 100 countries [7]. Further, it includes the key developments and trends, and offers growth projections up to 2031. The global transmission line market grew from \$12.3bn in 2008 to \$32.1bn in 2014 [8]. Mean-

while, China's market size of Ultra High Temperature (UHT) lines is estimated to soar from \$37.6bn in 2020 to \$78.1bn in 2025 [8].

In Africa, private companies have mainly been investing in making electricity (mostly by using independent power producer business models) and also in some cases, in delivering electricity (by working with the government in partnerships, or by getting permission to manage power distribution). However, there is not enough money for medium and high-voltage transmission lines [9]. Between 2010 and 2020, only a small amount of money, about 7.5%, was spent on electricity in sub-Saharan Africa. Most of the money, about 98.2%, was used for making electricity, and only a very small amount, less than 0.3%, was used for moving electricity from one place to another. This means that the electricity transmission sector in sub-Saharan Africa made up only a very small part of the total electricity infrastructure deals involving private companies in the last ten years, while less of the total investment was from private capital. Moreover, there aren't many transmission lines in the area. A recent study shows that 38 countries in sub-Saharan Africa only had 112,196 kilometers of big power lines, meaning a per capita rate of only 247 km per million people. From 2015 to 2040, Africa needs to spend between \$3.2 and \$43 billion every year on transmission projects. In the past ten years, the region has only spent 19% - 36% of the money needed for the power sector. This is much less than the \$10.6 - \$142 billion needed for distribution and the \$33.4 - \$63 billion needed for the whole power sector [10].

A strong and steady supply of electricity is really important for any country to grow and do well. A strong and reliable transmission network with enough capacity is needed to supply electricity to all parts of a country. A network of transmission lines needs to be expanded to meet the growing needs of connecting new power sources and strengthening the network [11]. Transmission lines pass in areas free from settlement and infrastructure development as they may cause dangers to the livings and infrastructures. This may constitute both a challenge and an opportunity for rural development where the clearance of the transmission line buffer destroys community activities but also brings money to them as expropriation costs [12]. The clearance of transmission line buffers presents both challenges and opportunities for rural development. While it disrupts community activities, it also provides financial benefits through expropriation costs, creating a dual impact on local economies.

Common challenges include limited space and concerns about the visual impact of high-capacity power lines, especially those transmitting electricity over long distances. According to Nguyen (2019), the International Energy Agency (IEA) reported that energy demand in Southeast Asia has surged by over 80% since 2000, positioning the region as one of the world's fastest-growing energy consumers. The IEA predicts this trend will persist due to rising incomes, industrial growth, and urbanization. By 2040, the region is expected to require 60% more energy, with its economy doubling in size and its urban population increasing by 120 million people [13]. With such significant growth indicators, Asian

leaders are intensifying efforts to enhance the region's electricity transmission capabilities. Utilities in Southeast Asia are increasingly integrating renewable energy sources and battery storage into their grids. Additionally, they are exploring innovative technologies for transmission infrastructure. One promising solution under consideration is the Breakthrough Overhead Line Design (BOLD). In the United States, American Electric Power (AEP) has adopted a compact and low-profile power line design to address similar challenges faced by Southeast Asia and other utilities worldwide [14].

Significant changes are currently taking place in the electricity transmission market, driven by efforts to enhance efficiency and accommodate renewable energy integration. Many countries are upgrading their power lines to higher voltages to reduce energy losses during transmission. Globally, the total length of transmission lines has consistently increased annually between 2007 and 2017, and this growth is projected to continue at a similar rate from 2018 to 2025 [15]. Advanced technologies are being implemented to ensure power grids can manage the variability of renewable energy sources. Furthermore, the integration of solar-powered homes and the growing adoption of electric vehicles are prompting utilities to redesign their power systems to support two-way electricity flow. As renewable energy usage increases, countries are interconnecting their power systems to balance electricity generation and consumption. This has resulted in the development of larger transmission lines to facilitate cross-border electricity sharing [16].

In Rwanda, the national transmission network distributes electricity from power plants across the country. The system operates at three voltage levels: 70 kV, 110 kV, and 220 kV. The 220 kV network supports large power plants and regional power trading, while the 110 kV network delivers electricity to consumers. To meet rising electricity demand, the Rwanda Energy Group (REG) has implemented a strategy to expand and modernize its infrastructure, ensuring reliability and functionality. As of June 2022, the high-voltage (HV) transmission network spans 994.2 km, supported by 354 substations [17]. For instance, the Birambo-Musha to Kabarondo substation line was upgraded from 70 kV to 110 kV in 2013 to enhance power supply stability and reliability, addressing the country's growing energy needs. Additionally, the 110 kV GAHANGA-RILIMA and 220 kV MAMBA-RWABUSORO-RILIMA transmission lines, along with their associated substations, were constructed by STEG International Services between 2017 and 2019. These lines traverse rural areas, highlighting their potential impact on local development.

This study focuses on evaluating the economic impact of the MAMBA-RWABUSORO transmission line project in Southern Province from 2017 to 2022, particularly its contribution to rural economic development in the areas it crosses. According to [18], such infrastructure projects play a critical role in fostering rural growth by improving access to electricity and enabling economic activities. [19] further emphasizes that transmission line projects can stimulate local economies

by creating jobs and enhancing connectivity in regards of electrical load demand for universal connectivity. The International Energy Agency (IEA, 2020) underscores the importance of reliable energy infrastructure for sustainable development, while the World Bank (2019) highlights the transformative potential of energy projects in rural areas.

1.1. Statement of the Problem

Under Rwandan expropriation law (Law N° 32/2015 of 11/06/2015 Relating to Expropriation in the Public Interest) [20], individuals' assets can be expropriated for public use, provided that compensation is paid in advance before the assets are utilized. This implies that, for transmission line construction, no work should commence until all expropriation payments are settled. However, in the case of the Mamba-Rwabusoro transmission line, some individuals have yet to receive compensation for their properties. As of now, the outstanding expropriation costs represent 5% of the total calculated amount [21].

This study seeks to evaluate the extent to which the construction of transmission lines has impacted the properties of rural residents. It aims to determine whether the compensation provided is commensurate with the value of the expropriated properties or not. Additionally, the study will assess other economic benefits brought by the transmission line project, such as improved access to electricity and roads, job creation, enhanced area recognition, infrastructure development, and other factors as reported by respondents.

The research focuses on investigating the effects of the Mamba-Rwabusoro transmission line on rural economic development in Rwanda. Specifically, it will examine how the construction and operation of this infrastructure have influenced economic indicators such as market prices, land values, household consumption, and production in the project area over a specified period. The findings are expected to provide valuable insights into the project's overall impact on the local economy and inform future policy decisions regarding transmission line development and rural economic growth in Rwanda.

1.2. Objectives of the Study

The main aim of this study is to assess the impact of transmission lines on rural economic development in Rwanda. The study focuses on the case of Mamba Rwabusoro transmission line, which is located in the southern province, and covers the period between 2017-2023. And specifically, this study intends:

- 1) To assess the activities made for transmission line construction in rural areas of Mamba-Rwabusoro Transmission Line in Bugesera and Kicukiro District.
- 2) To evaluate the economic development in rural areas covered by the Mamba-Rwabusoro transmission line project in Bugesera and Kicukiro District.
- 3) To assess the impact of transmission line construction on the economic development of rural people in the covered area.

2. Literature Review

According to a study referenced as [22], China's shift in development strategies has significantly influenced rural electrification efforts. The research highlights that rural electrification is crucial for reducing income disparities between urban and rural populations as the economy grows. China's transition from small-scale local power generation to large-scale projects and grid expansion is expected to have two major consequences. First, the high costs associated with extending the power grid to rural areas may delay electrification efforts. Second, increased central government control over electricity distribution could limit the economic benefits rural areas receive from electrification. These factors may widen the income gap between urban and rural residents. Given that China's revolution originated in rural areas, these changes could spark debates over the most effective development strategies.

Research by [23] examines land expropriation for economic development in the United States and explores better approaches to addressing land grabs globally. While land expropriation is often associated with poor countries due to weak legal and property systems, highlights that it also occurs in the U.S., a country typically regarded as having strong property laws and a fair legal system. The study argues that expropriation in the U.S. is neither strictly conditional nor exceptional. Although "takings" laws are intended to limit the state's power, their effectiveness depends on how terms like "public use," "purpose," "necessity," or "interest" are defined. In the U.S. and many other countries, these terms are broadly and vaguely interpreted, often including private, for-profit projects.

The study further emphasizes that the content, interpretation, and application of expropriation laws are influenced by social and political dynamics, a factor frequently overlooked in rule-of-law solutions to land grabbing. Consequently, initiatives like land titling, registration programs, and policies aimed at strengthening the rule of law may transform the nature of dispossession rather than eliminate it, particularly in the global South. [24] has studied to answer the question "does Land Expropriation Experience Increase Farmers' Farmland Value Expectations? Empirical Evidence from the People's Republic of China". Understanding the formation mechanism of farmers' farmland value expectations not only helps to evaluate farmers' land resource allocation behaviors but also enables the government to create better policies that can effectively guide and manage farmers' land value expectations. Based on cross-sectional data from the 2015 China Household Finance Survey (CHFS) of rural residents, research used quantitative analysis models to identify the effect of farmers' land expropriation experiences on their farmland value expectations, and the mechanisms of this effect. Research found that after experiencing land expropriation, farmers' farmland value expectations significantly increased; the effect was most pronounced in groups of farmers with low prior expectations. Land expropriation experience raises farmers' farmland value expectations due to land scarcity. The use of monetized compensation in the process of land expropriation will significantly increase farmers' farmland value

expectations. The results suggest that land expropriation activities can directly change the land resource endowment of farmers, thereby stimulating farmers' awareness of the need to protect their land rights and economic rights [25].

3. Conceptual Framework of the Study

In this study, the independent variable is “transmission lines” which involves land acquisition, preparation of the right way, payment of expropriation costs, and development of electrical infrastructures. The dependent variable is “Rural economic development in Rwanda” which involves access to income and increase of purchasing power, access to electricity infrastructure and road access, development of small income generating activities, awareness of project and economic development (capacity building and assistance), Rural environmental protection **Figure 1** bellows shows the details of the conceptual framework of this study.

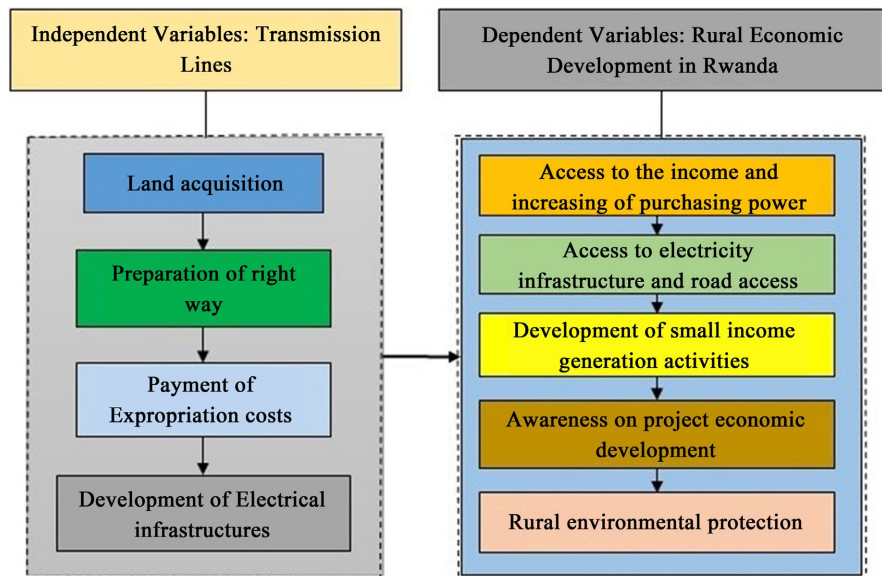


Figure 1. Conceptual framework of the study.

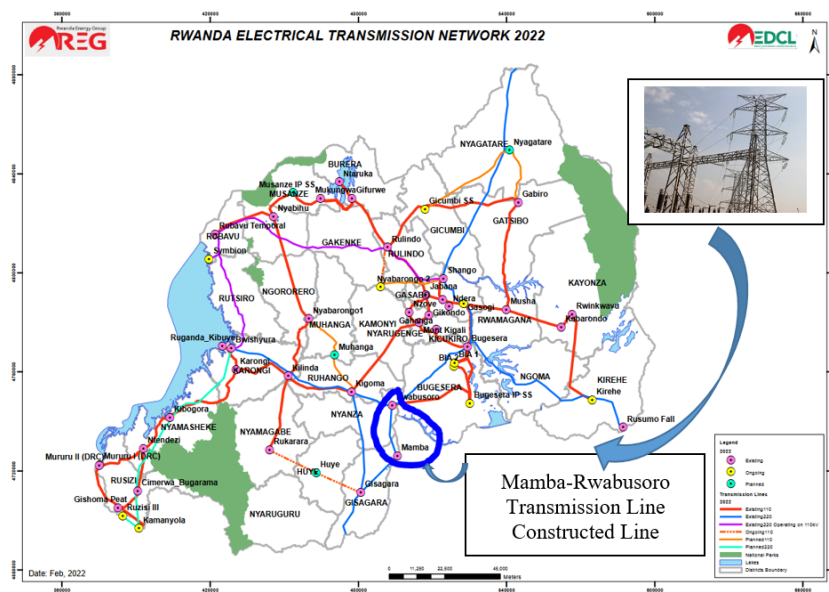
4. Methodology of the Study

4.1. Research Design

This study is descriptive and correlational design. This research study adopts a descriptive approach on describing activities brought by Mamba-Rwabusoro transmission line project and the economic development of project beneficiaries. The descriptive design is deemed appropriate because the main interest was analyzing the characteristics related to transmission line and rural economic development characteristics. Descriptive research design also enables the counting of the frequency at which a certain assessed item was observed and gives summary as the mean and standard deviation are easy to interpret. This study is also correlational because it clearly establishes the impact between transmission lines and rural economic development.

4.2. Study Area

220/110 kV Mamba-Rwabusoro-(110 kV) Bugesera-Gahanga project consists of building a 84.5 km long transmission line evacuating power from Hakan Peat to Power plant in Gisagara District up to Gahanga in through Rwabusoro and Bugesera substations. The project was developed and implemented with the Government of Rwanda's finance with the support of the World Bank. **Figure 2** shows the map of the electrical transmission network in Rwanda and the study area and highlights the MAMBA-Rwabusoro transmission line in a blue circle.



Energy Development Corporation Limited (EDCL): Annual Report and Audited Financial Statements for the year ended 30 June 2021.

https://www.reg.rw/fileadmin/EDCL_Financials_adjusted.pdf

Figure 2. Mamba Rwabusoro Transmission Line inside Rwanda electrical Transmission Line. (EUCL, 2021)

4.3. Study Population and Sample Size

The study population refers to a clearly defined group of individuals or objects that share similar characteristics relevant to the research. It represents the total number of people or items that the study focuses on or is concerned with. According to the expropriation unit of the Energy Development Corporation Ltd (EDCL), this study focuses on a target population of 10,638 expropriation files, representing 8,490 households (EDCL, 2022). This study also included interviews with project managers from the Energy Development Corporation Ltd (EDCL), during which four staff members were evaluated using a structured interview guide. Due to the large size of the target population, sampling techniques were applied to select a representative subset for the study. The sample size represents the portion of the population that was included in the research. For this study, the appropriate sample size was determined using Yamane's formula (1967), as referenced in [26].

$$n = \frac{N}{1 + N * e^2} = \frac{8490}{1 + 8490 * 0.088781835^2} = 125$$

From the above formula, “N” is total population, “n” is sample size, “e” is margin of error and here 8.9% was utilized. **Table 1** shows the distribution of all the population and the sample for our study.

Table 1. Distribution of population and sample.

Category	Population	Sample size
Beneficiaries of Mamba Rwabusoro Transmission Line for expropriation.	8,490	125
Staff of EDCL in charge of expropriation issues and Transmission line Construction.	26	4
Total	8,516	129

Source: (REG, 2023)

Instead of assessing all 8,490 beneficiaries of Mamba-Rwabusoro Transmission line project with expropriation benefits only 125 beneficiaries were consulted, and the survey results were generalized to the whole beneficiaries in the analysis.

The study used purposive sampling as the main sampling technique to reach 125 beneficiaries of Mamba-Rwabusoro transmission line project. The main purpose was to assess beneficiaries who made best practices in use of expropriation costs toward economic development. This means, these households used funds of materials expropriated in compensation toward living conditions improvements for their household’s members.

4.4. Instrument of Data Collection

A questionnaire consists of a list of questions designed by the researcher under study objectives, which allows the measurement of the indicators under the study. The questionnaire in our study was designed to include both open and closed ended questions, scaling questions and dichotomous questions as well as single location meeting. It was then addressed to 125 Mamba-Rwabusoro transmission line project expropriation beneficiaries at their meeting place. The questionnaire has scaling questions due to its format where respondents could choose the number 1, 2, 3, 4 or 5 (depending on whether they Strongly Disagree, Disagree, Not Sure, Agree and Strongly Agree, respectively).

To get extended background on the subject matter and to collect secondary data, the study used documents from published and unpublished sources. This study accessed EDCL annual reports mainly for assessing its performance over the years in providing expropriation costs to the project beneficiaries (2017-2023).

The interview was conducted to collect the open views of respondents. Interview was conducted to 4 project managers in Charge of monitoring Mamba-Rwabusoro Transmission Line activities, technical, construction, contractor supervision and expropriation.

5. Data Analysis, Results, and Findings

To achieve the objectives of the study, testing the validity of study questions and find solutions to study questions, the study needs to ensure statistical analysis: Both Descriptive statistics and inferential statistics (Bivariate Correlation analysis) were used to analyze the information collected. Here the study tends to analyze the frequency, percentages, mean, and standard deviation of the collected data. The analysis was done using Statistical Package for Social Scientists (SPSS) while maps of the study area were generated with the help of Geographical Information System (ArcGIS) tool.

Bivariate Correlation analysis was also used for testing the validity of research questions, this ensures test of one dependent variable to one independent variable. It is one of the simplest forms of statistical analysis, used to find out if there is a relationship between two sets of values. It usually involves the variables X and Y. Bivariate analysis is the analysis of exactly two variables. This generates Pearson Correlation (r) which ranges between -1 and 1 , this may be positive or negative strong or weak based on the test results, and which range it fit from $[-1; +1]$ and it also takes under consideration Sig. (2-Tailed) which test the statistical effect of tested variables. This should be less or equal to 0.05 for being statistically significant. **Table 2** shows different levels and categories of statistical analysis.

Table 2. Level of statistical analysis and categories.

Mean	Evaluation
1.00 - 2.00	Weak
2.01 - 3.00	Neutral
3.01 - 4.00	Moderate
4.01 - 5.00	Strong
Standard deviation	Level spreading
Stdv. <0.5	Homogeneity
Stdv. >0.5	Heterogeneity
Coefficient/positive or negative	Label/positive or negative
$r = 1$	100% of dependency for tested variables
$0.7 < r < 1$	High dependency
$0.5 < r < 0.7$	Moderate dependency
$0 < r < 0.5$	Weak Dependency
$R = 0$	No Dependency
Statistical Significance: Sig.(2-tailed)	Evaluation
Less or equal 0.05 or 5%	Existence of statistical significance
Greater than 0.05 or 5%	Non-Existence of statistical significance

Source: (Dr. John C. Maxwell, 2021)

The study also used linear regression model for assessing the validity of research questions of the study. Here below is the linear model function:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

where:

Y : Rural economic development.

- X_1 : Land acquisition.
 X_2 : Preparation of right of way.
 X_3 : Payments of expropriation costs.
 X_4 : Development of electrical infrastructure.
 β_1, β_4 : Slope or coefficient of estimates.
 β_0 : Constant and ϵ_0 : Error term.

5.1. Findings

Findings presentation in form of descriptive statistics was made using parameters like frequency, percentage, mean, standard deviation and comment (this combines the category of the mean and category of standard deviation). The mean was analyzed and classified with reference to the codes assumed to the perception level (see chapter three and questionnaire). This means that reading mean gives an insight on how respondents considered same statement or the meaning under the statement. Standard deviation explains the spread of respondent's perception from the general perception or mean. A higher standard deviation (greater than 0.5) means that some respondents chose perception far from the general mean. For example, if the mean is between 4 to 5 (agree to strongly agree) and standard deviation is greater than 0.5 means that not all agreed, some disagreed or strongly disagreed on a specific statement or item assessed.

5.2. Economic Activities Created from Construction of Mamba-Rwabusoro Transmission line

The study has evaluated a total 12 items categorized under 4 indicators (Land acquisition, Preparation of right of way, Payment of expropriation costs and Development of electrical infrastructures) under independent variable (Transmission lines). Per each indicator three items were assessed and for each item, Views of respondents were captured using scaling measurement (strongly agree, agree, not sure, disagree and strongly disagree coded 5 to 1 respectively). The analysis was focused on the frequency and percentage per each scaling level, mean, standard deviation and comment. Comment is combining the category of the mean and the standard deviation (defined in methodology). **Table 3** below shows the details of respondents' perceptions on the economic development inputs created by the construction of Mamba-Rwabusoro transmission line. Here below are details:

Table 3. Views of respondents on the economic development inputs created by the construction of Mamba-Rwabusoro Transmission Line. (N = 125)

Items Assessed	SA		A		NS		D		SD		Mean	Stdv.	Comment
	Fi	%	Fi	%	Fi	%	Fi	%	Fi	%			
<i>Land acquisition</i>													
Mamba-Rwabusoro transmission line project has taken land of people in the area.	24	19.2	101	80.8	0	0.0	0	0.0	0	0.0	4.19	0.395	Strong Homogeneity

Continued

Mamba-Rwabusoro transmission line project has followed the law of land acquisition.	4	3.2	23	18.4	14	11.2	47	37.6	37	29.6	2.28	1.168	Neutral Heterogeneity
Mamba-Rwabusoro transmission line project has fully considered the land use value.	0	0.0	22	17.6	0	0.0	88	70.4	15	12.0	2.23	0.881	Neutral Heterogeneity
<i>Preparation of right of way</i>													
Mamba-Rwabusoro transmission line project right of way is clean and on regular basis the trees are cut.	24	19.2	101	80.8	0	0.0	0	0.0	0	0.0	4.19	0.395	Strong Homogeneity
Mamba-Rwabusoro transmission line project has valued and paid the right of ways assets once.	63	50.4	62	49.6	0	0.0	0	0.0	0	0.0	4.50	0.502	Strong Heterogeneity
Mamba-Rwabusoro transmission line project management has conducted an awareness on the extent to which the right of way were managed in the future after project completion.	0	0.0	125	100.0	0	0.0	0	0.0	0	0.0	4.00	0.000	Moderate Homogeneity
<i>Payment of expropriation costs</i>													
Mamba-Rwabusoro transmission line project has paid all expropriation costs and none pending.	13	10.4	50	40.0	5	4.0	57	45.6	0	0.0	3.15	1.122	Moderate Heterogeneity
Mamba-Rwabusoro transmission line project has respected the law of expropriation payment of full amount before the use of individual properties.	5	4.0	25	20.0	19	15.2	71	56.8	5	4.0	2.63	0.980	Neutral Heterogeneity
Mamba-Rwabusoro transmission line project has counted costs accordance to the guidelines and all people were fully agreed the amount calculated.	0	0.0	33	26.4	15	12.0	72	57.6	5	4.0	2.61	0.924	Neutral Heterogeneity
<i>Development of electrical infrastructures</i>													
Mamba-Rwabusoro transmission line project expropriation beneficiaries have access to electricity (grid electricity).	0	0.0	82	65.6	0	0.0	29	23.2	14	11.2	3.20	1.143	Moderate Heterogeneity
Mamba-Rwabusoro transmission line project expropriation beneficiaries has got job in protection of the line and its construction.	10	8.0	49	39.2	8	6.4	58	46.4	0	0.0	3.09	1.085	Moderate Heterogeneity

Continued

Mamba-Rwabusoro transmission line project expropriation beneficiaries were informed about the role and negative risks which may be caused by the approach of transmission lines.	62	49.6	63	50.4	0	0.0	0	0.0	0	0.0	4.50	0.502	strong Heterogeneity
Valid N (listwise)	17	13.7	61	49.1	5	4.07	35	28	6	5.1	3.38	0.758	Moderate Heterogeneity

Keys: Fi: Frequency; Strongly agree (SA) was coded 5, Agree (A) coded 4, Not Sure (NS) coded 3, Disagree (D) coded 2, and Strongly Disagree (SD) coded 1. The mean classification was into 3 categories such as weak (1.00 - 2.00), neutral (2.01 - 3.00), moderate (3.01 - 4.00) and strong (4.01 - 5.00) and standard deviation was into two categories such as homogeneity (Stdv. < 0.5) and heterogeneity (Stdv. > 0.5). Mean: Average of perception from all 125 perceptions as coded in numbers and Stdv: Standard deviation which signify gap between individual perception from the general perception or mean. The comment column combines the category of mean and that of the standard deviation based on the findings.

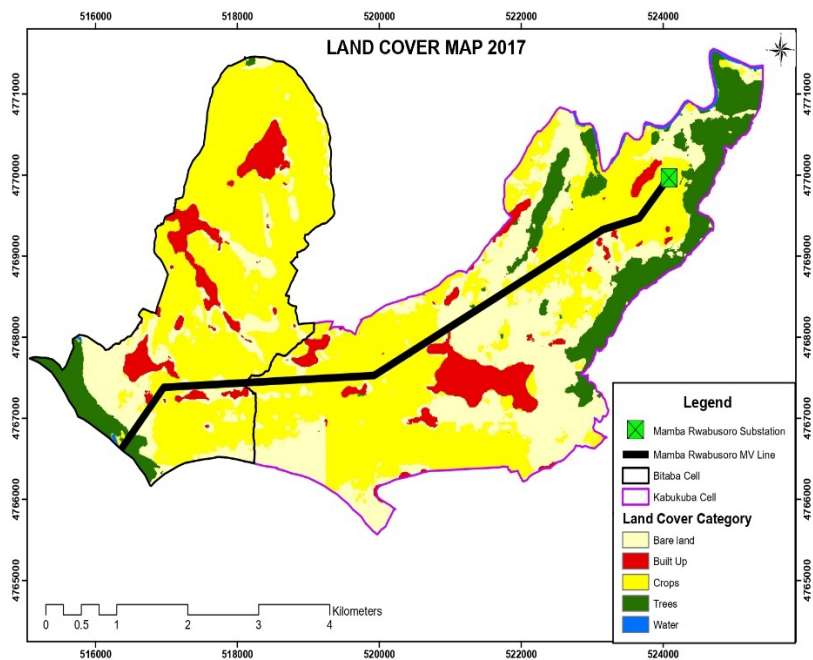
As seen in **Table 3**, among the 125 assessed respondents or beneficiaries of the Mamba Rwabusoro Transmission Line expropriation costs, there is a confirmation that Mamba-Rwabusoro transmission line project has taken land of people in the area (19.2% SA, 80.8% A, 0% NS, 0% D, 0% SD, 4.19 Mean, 0.395 Standard Deviation and Strong Homogeneity), Mamba-Rwabusoro transmission line project has followed the law of land acquisition (3.2% SA, 18.4% A, 11.2% NS, 37.6% D, 29.6% SD, 2.28 Mean, 0.168 Standard Deviation and Neutral Heterogeneity) and Mamba-Rwabusoro transmission line project has fully considered the land use value (0% SA, 17.6% A, 0% NS, 70.4% D, 12% SD, 2.23 Mean, 0.881 Standard Deviation and Neutral Heterogeneity).

On the side of right of way preparation for sustainability of Mamba-Rwabusoro Transmission line project, 125 respondents confirm that Mamba-Rwabusoro transmission line project right of way is clean and on regular basis the trees are cut (19.2% SA, 80.8% A, 0% NS, 0% D, 0% SD, 4.19 Mean, 0.395 Standard Deviation and Strong Homogeneity), Mamba-Rwabusoro transmission line project has valued and paid the right of ways assets once (50.4% SA, 49.6% A, 0% NS, 0% D, 0% SD, 4.50 Mean, 0.502 Standard Deviation and Strong Heterogeneity) and Mamba-Rwabusoro transmission line project management has conducted an awareness on the extent to which the right of way were managed in the future after project completion (0% SA, 100% A, 0% NS, 0% D, 0% SD, 4.00 Mean, 0.000 Standard Deviation and Moderate Homogeneity).

On the side of expropriation costs to the beneficiaries from properties taken or damaged by Mamba-Rwabusoro Transmission line, 125 assessed respondents confirm that, Mamba-Rwabusoro transmission line project has paid all expropriation costs and none pending (10.4% SA, 40% A, 4% NS, 45.6% D, 0% SD, 3.15 Mean, 1.122 Standard Deviation and Moderate Heterogeneity), Mamba-Rwabusoro transmission line project has respected the law of expropriation payment of full amount before the use of individual properties (4% SA, 20% A, 15.2% NS,

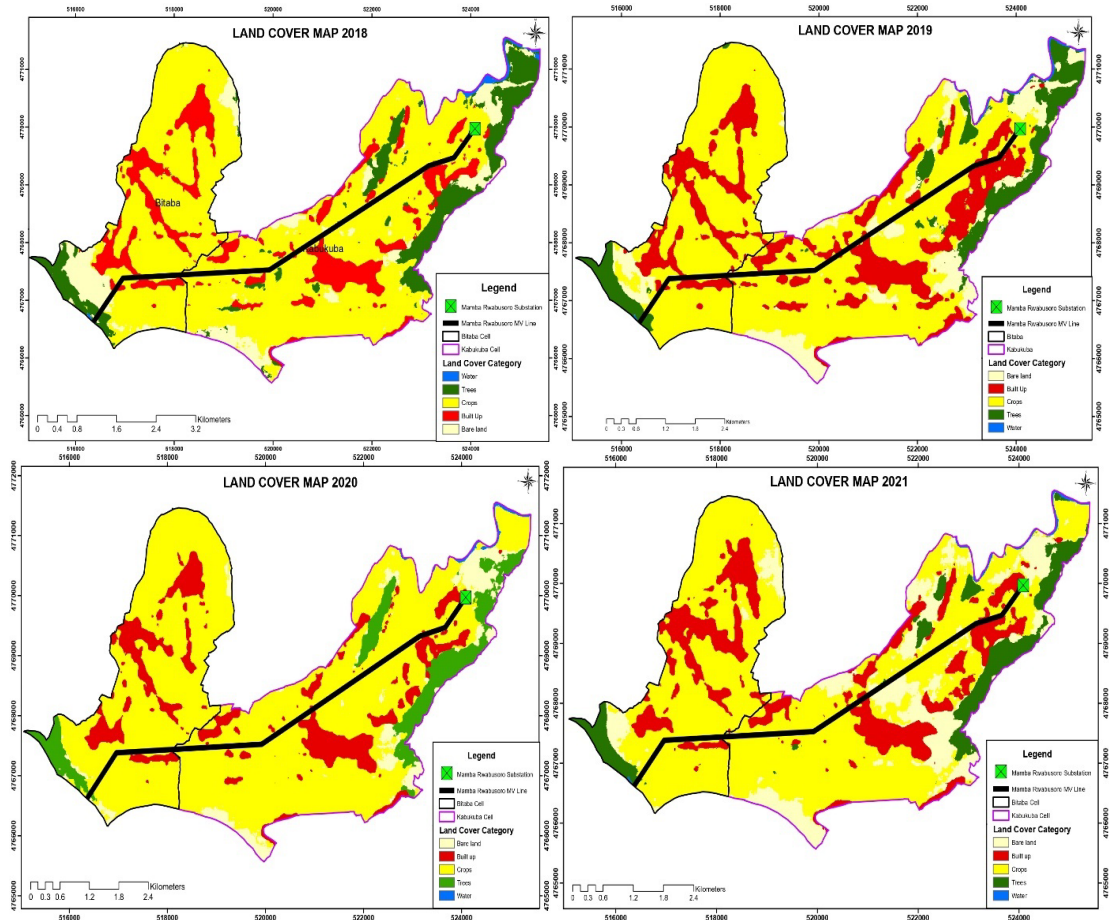
56.8% D, 4% SD, 2.63 Mean, 0.980 Standard Deviation and Neutral Heterogeneity) and Mamba-Rwabusoro transmission line project has counted costs accordance to the guidelines and all people were fully agreed the amount calculated (0% SA, 26.4% A, 12% NS, 57.6% D, 4% SD, 2.61 Mean, 0.924 Standard Deviation and Neutral Heterogeneity).

On the side of development of electrical infrastructure and its role in the rural communities, 125 respondents assessed have been confirmed that, Mamba-Rwabusoro transmission line project expropriation beneficiaries have access to electricity (grid electricity) (0% SA, 65.6% A, 0% NS, 23.2% D, 11.2% SD, 3.20 Mean, 1.143 Standard Deviation and Moderate Heterogeneity), Mamba-Rwabusoro transmission line project expropriation beneficiaries have got job in protection of the line and its construction (8% SA, 39.2% A, 6.4% NS, 46.4% D, 0% SD, 3.09 Mean, 1.085 Standard Deviation and Moderate Heterogeneity) and Mamba-Rwabusoro transmission line project expropriation beneficiaries were informed about the role and negative risks which may be caused by the approach of transmission lines (49.6% SA, 50.4% A, 0% NS, 0% D, 0% SD, 4.50 Mean, 0.502 Standard Deviation and Strong Heterogeneity).



Source: (ESRI Sentinel 2 Imagery at 10m resolution 2017).

The land coverage in the area of Mamba-Rwabusoro Transmission line before the construction of this line in 2017. The map shows a small part of the transmission line where it passes (Bitaba and Kabukuba), it shows that before the construction of this line the land was mostly covered by crops with 42.01%, Trees 20.11%, bare land 26.51%, built up area 11.06% (counting the buffer zone of the transmission line) and water 0.31%. This represents the expropriated activities which include houses, trees affected, land taken for poles and other economic activities.



Source: (ESRI Sentinel 2 Imagery at 10m resolution 2018-2021).

During the construction of Mamba-Rwabusoro Transmission Line, the corridor was created to facilitate construction works and to avoid casualties that may arise due to accident before and after construction, corridor was made by removing trees, buildings and crops in the buffer zone of transmission line. Between 2017 up to 2021 built up area have increased from 11.06% to 21.08% mainly because of Mamba Rwabusoro Transmission line that is passing through in rural area, in 2020 built up area went down by 2.31% from 18.6% of 2019. The reason why the change affected greatly crops and trees as shown in **Table 4** below is because Transmission line usually passes through Agricultural land to cut down expropriation cost and for beneficiaries continues to use their land.

Table 4. Land cover change.

Land cover category	YEARS									
	2017		2018		2019		2020		2021	
	Area (m ²)	Percentage (%)	Area (m ²)	Percentage (%)	Area (m ²)	Percentage (%)	Area (m ²)	Percentage (%)	Area (m ²)	Percentage (%)
Built Up	51397	11.06	79930	17.91	116999	18.60	112091	16.29	173919	21.08
Trees	93425	20.11	69850	15.65	110122	17.51	107849	15.67	96070	11.64
Crops	195145	42.01	251462	56.36	308451	49.04	420411	61.10	400007	48.48

Continued

Bare land	123171	26.51	39284	8.80	90601	14.40	44620	6.48	151497	18.36
Water	1437	0.31	5682	1.27	2823	0.45	3147	0.46	3685	0.45

5.3. Views of Respondents on the Rural Economic Development Delivered from the Implementation of Mamba-Rwabusoro Transmission Line

In this section, the researcher has assessed the Views of respondents on the rural economic development delivered from the implementation of Mamba-Rwabusoro Transmission Line. A total 15 items were assessed under 5 indicators (Access to the income and increase of purchasing power, Access to electricity infrastructure and road access, Development of small income generating activities, Awareness on project and economic development (capacity building and assistance), Rural environment protection) and all were developed under the dependent variable (Rural economic development in Rwanda). **Table 5** below shows detailed findings on each item assessed (15 items in total) regarding the rural economic development in Rwanda:

Table 5. Views of respondents on the Rural economic development in Rwanda. (N = 125)

Items Assessed	SA		A		NS		D		SD		Mean	Stdv.	Comment
	Fi	%	Fi	%	Fi	%	Fi	%	Fi	%			
<i>Access to the income and increase of purchasing power</i>													
Mamba-Rwabusoro transmission line project given money or income to the expropriated beneficiaries which increased their purchasing power.	18	14.4	89	71.2	5	4.0	13	10.4	0	0.0	3.90	0.771	Moderate Heterogeneity
Due to the implementation of Mamba-Rwabusoro transmission line project the value of land in the area was increased.	22	17.6	85	68.0	0	0.0	18	14.4	0	0.0	3.89	0.863	Moderate Heterogeneity
Due to the implementation of Mamba-Rwabusoro transmission line project jobs were created and the passing place was opened to the rest of region and people earned income.	10	8.0	115	92.0	0	0.0	0	0.0	0	0.0	4.08	0.272	Strong Homogeneity
<i>Access to electricity infrastructure and road access</i>													
Mamba-Rwabusoro transmission line project has made the rural area to access on electricity (via the initiative of EDCL of connecting people around electricity infrastructure).	9	7.2	68	54.4	0	0.0	48	38.4	0	0.0	3.30	1.064	Moderate Heterogeneity
Due to the implementation of Mamba-Rwabusoro transmission line project access roads for materials transportation were created and remained useful to the local population.	9	7.2	60	48.0	0	0.0	56	44.8	0	0.0	3.18	1.093	Moderate Heterogeneity

Continued

Due to the implementation of Mamba-Rwabusoro transmission line project, electrical infrastructures are available in the area (electric poles) and people have capacity to use electricity.	14	11.2	98	78.4	0	0.0	13	10.4	0	0.0	3.90	0.723	Moderate Heterogeneity
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Development of small income generating activities

Mamba-Rwabusoro transmission line project beneficiaries were used money from assets expropriated to develop small income generating activities.	9	7.2	78	62.4	14	11.2	24	19.2	0	0.0	3.58	0.882	Moderate Heterogeneity
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During the implementation of Mamba-Rwabusoro transmission line project small restaurants and bars, etc., were opened for business with employees in the project and now the businesses are still open.	9	7.2	101	80.8	5	4.0	10	8.0	0	0.0	3.87	0.647	Moderate Heterogeneity
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People have used money from the project to develop renting houses and for developing small businesses and now they have regular and sustainable sources of income while land generate income rarely.	14	11.2	74	59.2	9	7.2	28	22.4	0	0.0	3.59	0.960	Moderate Heterogeneity
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Awareness on project and economic development (capacity building and assistance)

Mamba-Rwabusoro transmission line project beneficiaries got awareness on project and economic development (capacity building and assistance). And now they are skilled on the key activities which may support them for better economic development.	15	12.0	75	60.0	0	0.0	35	28.0	0	0.0	3.56	1.027	Moderate Heterogeneity
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Mamba-Rwabusoro transmission line project implementers have conducted training to beneficiaries before the beginning of the project mainly focusing on the use of Transmission Line opportunities.	10	8.0	59	47.2	8	6.4	48	38.4	0	0.0	3.25	1.060	Moderate Heterogeneity
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Mamba-Rwabusoro transmission line project beneficiaries were trained on the protection of assets and how they can improve their living conditions in sustainable manner.	10	8.0	69	55.2	10	8.0	32	25.6	4	3.2	3.39	1.054	Moderate Heterogeneity
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Rural environment protection

Mamba-Rwabusoro transmission line project was constructed with maximum respect of environmental measures and all environmental certifications was made.	0	0.0	58	46.4	57	45.6	10	8.0	0	0.0	3.38	0.632	Moderate Heterogeneity
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Continued

People in the area of Mamba-Rwabusoro transmission line project were trained on the role of the project and on the alternatives to plant trees in the other area not under the line buffer zone.	33	26.4	75	60.0	0	0.0	17	13.6	0	0.0	3.13	0.902	Moderate Heterogeneity
Mamba-Rwabusoro transmission line project implementers have complied with environmental regulations vis a vis all environmental aspects damaged and the project materials are friendly to the environment.	0	0.0	89	71.2	13	10.4	23	18.4	0	0.0	3.53	0.789	Moderate Heterogeneity
Valid N (listwise)	12	9.7	80	64	8	6.5	25	20	0	0	3.63	0.849	Moderate Heterogeneity

As seen from **Table 5**, from 125 assessed respondents, on the side whether the transmission lines contribute in rural economic development in Rwanda or not and the level at which this contribution can be measured results from 125 evaluated respondents confirm that, Mamba-Rwabusoro transmission line project given money or income to the expropriated beneficiaries which increased their purchasing power (14.4% SA, 71.2% A, 4% NS, 10.4% D, 0% SD, 3.90 Mean, 0.771 Standard Deviation and Moderate Heterogeneity), Due to the implementation of Mamba-Rwabusoro transmission line project the value of land in the area was increased (17.6% SA, 68% A, 0% NS, 14.4% D, 0% SD, 3.89 Mean, 0.863 Standard Deviation and Moderate Heterogeneity) and Due to the implementation of Mamba-Rwabusoro transmission line project jobs were created and the passing place was opened to the rest of region and people earned income (8% SA, 92% A, 0% NS, 0% D, 0% SD, 4.08 Mean, 0.272 Standard Deviation and Strong Homogeneity).

On the side of access to electricity infrastructure and road access as an outcome of implemented or constructed transmission line in the rural area, 125 assessed respondents confirm that Mamba-Rwabusoro transmission line project has made the rural area to access on electricity (via the initiative of EDCL of connecting people around electricity infrastructure) (7.2% SA, 54.4% A, 0% NS, 38.4% D, 0% SD, 3.30 Mean, 1.064 Standard Deviation and Moderate Heterogeneity), Due to the implementation of Mamba-Rwabusoro transmission line project access roads for materials transportation were created and remained useful to the local population (7.2% SA, 48% A, 0% NS, 44.8% D, 0% SD, 3.18 Mean, 1.093 Standard Deviation and Moderate Heterogeneity) and Due to the implementation of Mamba-Rwabusoro transmission line project, electrical infrastructures are available in the area (electric poles) and people have capacity to use electricity (11.2% SA, 78.4% A, 0% NS, 10.4% D, 0% SD, 3.90 Mean, 0.723 Standard Deviation and Moderate Heterogeneity).

On the extent to which expropriation costs received from the properties damaged or taken by transmission lines, 125 assessed respondents have been con-

firmed that Mamba-Rwabusoro transmission line project beneficiaries were used money from assets expropriated to develop small income generating activities (7.2% SA, 62.4% A, 11.2% NS, 19.2% D, 0% SD, 3.58 Mean, 0.882 Standard Deviation and Moderate Heterogeneity), During the implementation of Mamba-Rwabusoro transmission line project small restaurants and bars, etc, were opened for business with employees in the project and now the businesses are still open (7.2% SA, 80.8% A, 4% NS, 8% D, 0% SD, 3.87 Mean, 0.647 Standard Deviation and Moderate Heterogeneity) and People have used money from the project to develop renting houses and for developing small businesses and now they have regular and sustainable sources of income while land generate income rarely (11.2% SA, 59.2% A, 7.2% NS, 22.4% D, 0% SD, 3.59 Mean, 0.960 Standard Deviation and Moderate Heterogeneity).

On the extent to which transmission lines contribute to the development of awareness on project and economic development (capacity building and assistance), 125 assessed respondents confirm that, Mamba-Rwabusoro transmission line project beneficiaries got awareness on project and economic development (capacity building and assistance). And now they are skilled on the key activities which may support them for better economic development (12% SA, 60% A, 0% NS, 28% D, 0% SD, 3.56 Mean, 1.027 Standard Deviation and Moderate Heterogeneity), Mamba-Rwabusoro transmission line project implementers have conducted training to beneficiaries before the beginning of the project mainly focusing on the use of Transmission Line opportunities (8% SA, 47.2% A, 6.4% NS, 38.4% D, 0% SD, 3.25 Mean, 1.060 Standard Deviation and Moderate Heterogeneity) and Mamba-Rwabusoro transmission line project beneficiaries were trained on the protection of assets and how they can improving their living conditions in sustainable manner (8% SA, 55.2% A, 8% NS, 25.6% D, 3.2% SD, 3.39 Mean, 1.054 Standard Deviation and Moderate Heterogeneity).

On the extent to which transmission lines contributed or impact rural environment protection, 125 assessed respondents confirm that, Mamba-Rwabusoro transmission line project was constructed with maximum respect of environmental measures and all environmental certifications was made (0% SA, 46.4% A, 45.6% NS, 8% D, 0% SD, 3.38 Mean, 0.632 Standard Deviation and Moderate Heterogeneity), People in the area of Mamba-Rwabusoro transmission line project were trained on the role of the project and on the alternatives to plant trees in the other area not under the line buffer zone (26.4% SA, 60% A, 0% NS, 13.6% D, 0% SD, 3.99 Mean, 0.902 Standard Deviation and Moderate Heterogeneity) and Mamba-Rwabusoro transmission line project implementers have complied with environmental regulations vis a vis all environmental aspects damaged and the project materials are friendly to the environment (0% SA, 71.2% A, 10.4% NS, 18.4% D, 0% SD, 3.53 Mean, 0.789 Standard Deviation and Moderate Heterogeneity).

5.4. Impact of Transmission Line Construction on the Economic Development of Rural People in the Covered Area

As explained in methodology the inferential statistics was made via both bivariate

correlation analysis and linear regression model. Both models were made using codes attributed to respondents' perceptions and these codes were used to calculate mean which represent the indicator assessed and the mean of the mean to present the variable assessed (both dependent and independent variable).

Table 6. Overall Bivariate correlation analysis for main study variables.

Correlations			
Tested main variables (Independent and Dependent)		Transmission lines	Rural economic development in Rwanda
Transmission lines	Pearson Correlation	1	0.230**
	Sig (2-tailed)		0.000
	N	125	125
Rural economic development in Rwanda	Pearson Correlation	0.230**	1
	Sig (2-tailed)	0.000	
	N	125	125

** . Correlation is significant at the 0.01 level (2-tailed).

The bivariate correlation analysis results shown in **Table 6** indicate a Pearson correlation or “r” which is equal to 0.230 and Sig (2-tailed) equal to 0.000. This means that, there is a positive correlation between Development of Transmission Lines and Rural economic development in Rwanda and this correlation is strong. The correlation is also statistically significant as p-value of 0.000 is less than 1% level of significance. In other words, Development of Transmission Lines and expropriation costs payment contribute 23% in rural economic development in Rwanda.

Table 7. Model summary.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.521 ^a	0.271	0.247	0.1727720

a. Predictors: (Constant), Development of electrical infrastructures, Preparation of right of way, Land acquisition, Payment of expropriation costs

As seen from **Table 7**, the regression model summary had R² of 0.271, which implies that ensuring Development of Transmission Lines (Land acquisition (X1), Preparation of right of way (X2), Payment of expropriation costs (X3) and Development of electrical infrastructures (X4)), indicate that the model is perfectly feet. R-squared is a measure of how closely the data in a regression line fit the data in the sample. The closer the r-squared value is to 1, the better the fit. An r-squared value of 0 indicates that the regression line does not fit the data at all, while an r-squared value of 1 indicates a perfect fit. This imply that, for the above model, the model fit at 27.1% which is a positive level but not strong.

Table 8. Analysis of Variance. (ANOVA)

Model	Sum of Squares	ANOVA ^a			Sig.
		df	Mean Square	F	
1 Regression	1.334	4	0.333	11.172	0.000 ^b
Residual	3.582	120	0.030		
Total	4.916	124			

a. Dependent Variable: Rural economic development in Rwanda; b. Predictors: (Constant), Development of electrical infrastructures, Preparation of right of way, Land acquisition, Payment of expropriation costs

As seen from **Table 8**, the results show that the regression analysis of variance (ANOVA) model had an F ratio of 11.172 and the P value was $0.000 < 0.05$, signifying that the F ratio was statistically significant, therefore the overall regression model for all the variables tested were statistically significant and can be used for prediction at 5% significant level. This further indicates that the predictors variables (Land acquisition (X1), Preparation of right of way (X2), Payment of expropriation costs (X3) and Development of electrical infrastructures (X4)) used in this study are statistically significant to performance of Rural economic development in Rwanda (Y). Therefore, it is confirmed that there is a significant and positive impact of Development of Transmission Lines (Land acquisition (X1), Preparation of right of way (X2), Payment of expropriation costs (X3) and Development of electrical infrastructures (X4)) on performance of Rural economic development in Rwanda (Access to the income and increase of purchasing power (Y1), Access to electricity infrastructure and road access (Y2), Development of small income generating activities (Y3), Awareness on project and economic development (capacity building and assistance) (Y4), and Rural environment protection (Y5).

Table 9. Summary of coefficients.

Model	Coefficients				t	Sig.
	Unstandardized Coefficients		Standardized Coefficients			
	β	Std. Error	Beta			
(Constant)	1.1255	0.391		5.100	0.000	
Land acquisition (X1)	0.059	0.030	0.157	1.955	0.053	
Preparation of right of way (X2)	0.122	0.079	0.135	1.541	0.126	
1 Payment of expropriation costs (X3)	0.094	0.028	0.295	3.316	0.001	
Development of electrical infrastructures (X4)	0.162	0.029	0.457	5.676	0.000	

a. Dependent Variable: Rural economic development in Rwanda

As seen from **Table 9**, the beta (β) sign shows the positive correlation of the

independent variable's coefficients over the dependent variable. **Table 9** above shows that, beta values for all independent variable indicators are positive meaning positive impact or correlations on the predicted dependent variable. $\beta_1 = 0.059$, $t = 1.955$, $p = 0.053 > 0.05$; $\beta_2 = 0.122$, $t = 1.541$, $p = 0.126 > 0.05$; $\beta_3 = 0.094$, $t = 3.316$, $p = 0.001 < 0.05$ and $\beta_4 = 0.162$, $t = 5.676$, $p = 0.000 < 0.05$. That means, any increase in the independent variables lead to increase in the dependent variable and vice versa. The regression model become as follows:

Y or Rural economic development in Rwanda = $1.1255 + 0.059X_1 + 0.122X_2 + 0.094X_3 + 0.162X_4$. Thus, the study concluded that ensuring best practices in Land acquisition (X1), Preparation of right of way (X2), Payment of expropriation costs (X3), and Development of electrical infrastructures (X4) have positive impact or correlation on rural economic development in Rwanda. In other words, if these determinants are not available, rural economic development in Rwanda were equivalent to 1.995 units. Note that for land acquisition and preparation of right of way, the impact is not statistically significant toward rural economic development in Rwanda as these activities always took the natural resources of the community or rural people while expropriations costs were made once.

5.5. General Views of Respondents

This section summarizes open discussion collected views from Mamba Rwabusoro project managers (4 staff of EDCL including, manager of expropriation, Project manager, head of transmission and distribution unit and director of generation and transmission department). The section also comes up with a summary of findings in the comparison to the existing theories as defined in the literature review.

(1) Activities made for transmission line construction in rural areas: Not only reference to the reports of REG (2017-2023) on the activities made during the implementation of Mamba Rwabusoro Transmission line but also similar to the normal required activities for transmission line development. It was observed that, transmission lines projects are developed in land plots of people and require people to stop some agriculture activities or vegetation expansion like forests or vegetation. The transmission lines flow the clean area, that's why most of them are developed in rural area where there are no more activities which may increase expropriation costs. Here also the transmission line construction is one among the activities for infrastructure development and this also makes the area open to the rest of the world where people come in the area and the jobs created.

As communicated by the management, the activities of developing a transmission line, is very important to the country as this take electricity of high voltage from generating technology to the substation or big transformers which reduce the power to medium voltage which later distributed for use. The people who lose their lands, houses and other home income generating activities sometimes remain unhappy as the price for expropriation follow the standards which sometimes not valuing the real value of the property owners. Another issue is delay of

payment, for example the current Mamba-Rwabusoro Transmission line is still having unpaid files from 2017, so that, any time the payment will take place, there is no interests which were applied while the property of the people was taken and not exploited since last 6 years.

(2) Economic development in rural areas covered by the Mamba-Rwabusoro transmission line project: Reference to theories and existing studies (Jahan, 2016), (Keith, 2017), and (Plantinga, 2020) most people in Rwanda rural area really on land as main assets to support living conditions. More than 75% are living (NISR, 2020) with agriculture as main income generating activity. Due to that, taking people's land sometimes create conflicts. As reduce the land area for cultivation, and affect the production. The transmission lines take land and pays once while land pay the owner every season. However, people have managed to use expropriation costs for small income generation, and also people know that transmission line most of the time could not create interest in the area where its passing but huge impact to the national economy as whole and indirectly return to the rural community here we can say for example beneficiaries of VUP.

(3) Is there any significant impact of transmission line construction on the economic development of rural people in the covered area: Yes, but not big as impact for national economy? This explained by the authorities of the Mamba-Rwabusoro Transmission line project. In rural area people are not happy as their land was gone, as they were prevented to sue their land in clearance area as they want, and as they are not allowed to develop big infrastructures under transmission line, but they appreciate development of electrical infrastructures in the area. In other words, people are happy with expropriation costs however not paid on time, but some issues were caused also by themselves where they don't have all requirements to meet the payment of properties taken (example land titles issues). Here also the area was electrified by the local distribution network as presidential guidance, some people in the area was employed and businesses were developed and environmental alternative activities were created. All in all, transmission lines have a positive impact in rural economic development, but the impact remain low change creating.

5.6. Discussion of Results

The study findings confirm that Development of Transmission Lines and expropriation costs payment contribute 23% in Rural economic development in Rwanda, this is similar to the findings of the study made by Coleman (2019) as mentioned that transmission lines is a tool for economic development of the country, but the specificity of the current study is linked to the fact that the current study assess the role of transmission line in rural areas more specifically rural households living in the coverage area of Mamba-Rwabusoro Transmission line in Rwanda.

Zhongcheng (2021) has studied to answer the question "does Land Expropriation Experience Increase Farmers' Farmland Value Expectations? This is different

where from the current study people lose their land and vegetation coverage as the transmission line is passing and where the line is passing, non-vegetation should grow too much to protect the line. Here people use money from expropriation to develop alternative income-generating activities that succeed and changes their living conditions.

5.7. Conclusions

The study aimed to evaluate three specific objectives: (1) assessing the activities involved in transmission line construction in rural areas, (2) evaluating the economic development in rural areas covered by the Mamba-Rwabusoro transmission line project, and (3) examining the impact of transmission line construction on the economic development of rural communities in the project area.

The research adopted a mixed-methods approach, combining survey, descriptive, correlative, qualitative, and quantitative designs. Data were collected from 125 respondents using questionnaires and documentation and analyzed using SPSS. Results were presented using descriptive and inferential statistics.

For the first objective, findings indicated moderate evidence that transmission line construction activities significantly impact rural economic development. Respondents moderately agreed (mean score: 3.38) that these activities create opportunities contributing to economic growth, though challenges such as land loss, restricted land use, delayed compensation payments, and unequal access to electricity infrastructure were noted.

For the second objective, there was strong agreement among respondents (mean score: 3.63) that the Mamba-Rwabusoro transmission line has clear and significant benefits for rural economic development. However, only a few individuals used compensation funds to start small income-generating activities, while most used the money for consumption, maintaining their pre-project living conditions.

For the third objective, findings confirmed that transmission lines positively impact rural economic development, primarily at the national level, with indirect benefits trickling down to rural communities. Bivariate correlation analysis revealed a strong positive correlation (23%) between transmission line development and expropriation costs, highlighting their contribution to rural economic growth in Rwanda for three Key Insights:

- 1) Transmission line construction creates economic opportunities but is accompanied by challenges like land loss and delayed compensation.
- 2) While the project has clear benefits, its impact on improving living conditions varies, with limited long-term economic transformation observed.
- 3) Expropriation costs and national-level benefits indirectly support rural development, though direct impacts on local communities require further attention.

5.8. Recommendations

The study findings reveal that the compensation values for land were not satisfac-

tory to the affected individuals. Additionally, the payment timelines and conditions, as well as the restrictions on land use after construction, were poorly received. To address these issues, revising the expropriation terms and conditions is recommended. This includes adjusting compensation prices to reflect fair market values, expediting payment procedures to ensure timely disbursement, and simplifying requirements for landowners whose properties were utilized. These measures would help improve community satisfaction and ensure a more equitable process.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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