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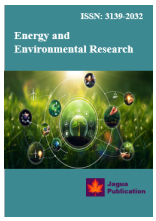

Research Article

Assessing the Environmental and Socio-economic Impacts of Rural Road Infrastructure Development in Jur River County, Western Bar El Ghazal, South Sudan

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Abstract

This study aimed to assess the environmental and socio-economic impacts of rural road infrastructure development in Jur River County, Western Bahr El Ghazal State in South Sudan. The specific objective is to explore the local community perception of the rural road infrastructure development, examine the environmental impacts associated with it, elaborates on the roles of local government in handling the sustainability of rural roads infrastructure and find out the operationalization of Environmental and Socio-economic Assessment (ESIA) in South Sudan. This research used quantitative and qualitative methods to collect the required data. A sample size of 260 participants was engaged for this study. The data were collected from community members, local government officials (civil servants), traditional authorities who have legal engagement with the government and those who were working with the Department of Physical Infrastructures in Jur River County. The study found that rural road infrastructure development was being majorly influenced by the development (34%), gentrification (24%) and time overrun cost compared to the labour (13%), efficiency of authorities (5%), political interference (3%) and by wastage and underutilization of human resources (1%) among others. About 3.5% of the people in the communities of Jur River have a negative perception of rural road infrastructure development. The finding also indicated that the sustainability of constructed rural roads reduced carbon emissions, conserving natural resources, promoting eco-friendly materials and mitigating adverse effects on ecosystems and communities by 23%. Therefore, it was concluded that the local community had a negative perception of rural road infrastructure development and that there are environmental and socio-economic impacts of rural roads construction in Jur River County due to the lack of ESIA used before rural road infrastructure development in Jur River County. The study recommended that stakeholder should make sure that all the necessary resources are provided to address the challenges of environmental and socio-economic impacts of rural road infrastructure development, conduct awareness on the negative perception and the importance of rural road network development, establish regulatory authority at all levels to guide the key players in planning and decision-making, adopt the use of ESIA and strengthening the institutional capacity to ensure excellence and professionalism at all levels of Government.

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1. Introduction

Rural roads infrastructures are most vital in enhancing livelihoods, improved access to markets, health, productivity, education, and other essential services and reducing poverty. Despite its importance, it also brings about various challenges that include environmental degradation, displacement of communities, deforestation and changes in social dynamics. Access to necessary services such as transportation, water supply, and sanitation are strongly correlated to the well-being of the general population [1].

Many authors argue that rural roads infrastructures should be improved in locations where poverty is most severe, as improvement in access to markets provides opportunities for subsistence farmers to integrate into the market economy. Others argue that rural road access should be primarily improved in locations where economic opportunities are already better and thus accelerate a dynamic process for commercial farming and manufacturing [2].

Rural roads infrastructures are crucial in agricultural economies as they accelerate the efficient movement of agricultural products, supporting productivity and the sustainability of rural development [3]. However, many rural areas still face limited access to efficient transport infrastructure, hindering rural development.

In Norway, for instance, using the modern state system, the construction of roads in the rural communities is for investment in roads (Railways, ports, air transport) [4].

The studies done among the communities of Kisumu, Kenya and Accra, Ghana, show clearly how road construction contributes to transforming the socio- spatial and landscapes and economic development and how it affects the social groups [5].

New major road infrastructure projects are planned or underway across sub-Saharan Africa (SSA) and are expected to have complex, and often deleterious, impacts on natural ecosystems across the region [6].

At the local level, South Sudan, as a newly independent country, faces many challenges in making its own development infrastructures, especially in road connections. Despites of many billions earned from oil revenue since the 2005 Comprehensive Peace Agreement (CPA), South Sudan still suffers from poor roads. About (three Quarters) $\frac{3}{4}$ over the country remains without roads network.

Problem Statement

While rural roads infrastructure development acts as catalyst of Environmental Health, Economic growth and improved living standards in rural communities, it often comes with unintended negative consequences (environmental damage, loss of agricultural land, deforestation, displacement). Therefore, research was needed to understand these impacts holistically and develop strategies that maximize benefits while mitigating the adverse impacts of Environmental and Socio-economic impacts of Rural Roads infrastructure development. Furthermore, this research was intended to investigate the Environmental and Socio-economic impacts of Rural Roads infrastructure development in Jur River County (JRC). It was worth mentioning that the above studies focused on the road effects on investments but did not consider the aspect of sustainability. Therefore, this study was designed to examine the environmental impacts associated with Rural Road infrastructure development in and to identify the causes of deterioration status of Rural Roads Infrastructure development annually in Jur River County.

2. Data and Methods

2.1. Description of the Study Area

The study was conducted in Jur River County, Western Bhar El Ghazal State (WBGS), and South Sudan. Jur River County is a county in the Western Bahr el Ghazal State in the Bahr el Ghazal region of South Sudan, located between Latitude of E “8.39.0 and N 29.18.0”. This area is bordered by the east and northeast parts of the state, which cover an area of 10,032 km square. Jur River County is divided into five Payams of Kangi, Udoci, Marial Bai, Rocrocdong, and Kuajiena, with unknown population. The hot season lasts for 2.7 months, from January 25 to April 17, with an average daily high temperature above 100°F. The hottest month of the year in Wau is March, with an average high of 103°F and a low of 76°F. The cool season lasts for 3.7 months, from June 20 to October 12, with an average daily high temperature below 88°F. The coldest month of the year in Wau is August, with an average low of 70°F and a high of 85°F.

2.2. Population of the Study

Population refers to the entire group of individuals, objects, or events that share a common characteristic and are the focus of the study. It represents the complete set of elements that the researcher aims to study and draw conclusions about [7, 8]. Defining the population is a critical step in research design as it sets the boundaries and scope of the study’s findings. The study population targeted Community Members, Local government Officials (Civil Servants), Traditional Authorities who have legal engagement with the government and those who were working with the Department of Physical Infrastructures at Jur River County.

2.3. Sample Size

Sampling means taking any portion of a population as representative of that population. According to Mbaaga [9], the ideal research is getting data from the whole population because it would ensure wide coverage of all elements in the population under the study. A sample was chosen to represent the whole population. The research carried out by [10] comments that the study must consider a sample size that is within the cost constraint that should provide the ability to detect an independent variable effect on the sample size as being a phase of research, which is crucial because of its major impact on time and money that must go into data collection. The study used a simple random sampling technique because some people have characteristics that are needed for the study. Since the population of Jur River County is unknown, the Cochran formula was used to calculate the sample size below:

$$\mathrm{n} = \frac{\mathrm{Z2} \times \mathrm{p} \times (1 - \mathrm{p})}{\mathrm{E2}}$$

Where, Confidence level = 95%, e = margin of error is equal to 5%, n= population portion is 21.6% (260 people).

$$\frac{n = 1.962 \times 0.216 \times (1 - 0.216)}{0.052}$$

$$n = 260.22;$$

$$n = 260 \text{ Respondents}$$

2.4. Data Collection Methods and Procedure

The data for this study were collected using a structured questionnaire, and through face-to-face interviews and direct observations during the study period. The questionnaire was in English with verbal translation in Arabic and local languages for the case of those who do not understand English or Arabic. The information collected includes demographic information of the respondents, the socio-economic impact of road infrastructure development, the local community perception on the road construction, the environmental impacts associated with Rural Roads Construction, and the factors affecting the road's sustainability, among others, in Jur River County.

2.5. Data Analysis

Quantitative data from household surveys and structured questionnaires were analyzed using descriptive and inferential statistics using SPSS software (version 29.0.2), and the information was presented in tubular form. The integration of quantitative and qualitative findings through triangulation enhanced the validity and comprehensiveness of the research outcomes [11].

2.6. Ethical Consideration

Ethical standards were rigorously upheld throughout the research process. confidentiality Participants' anonymity and were safeguarded by excluding identifying information from all reports and publications. Approval was obtained from University of Juba and the relevant authority in Western Bar El Ghazal State before data collection commences. Participation was entirely voluntary, with respondents free to decline or withdraw without penalty at any stage of the study. All data were securely stored and managed in accordance with ethical guidelines to maintain integrity and protect participant information.

3. Results

3.1. Demographic Information of the Respondents

About the demographic data of the respondents, the researcher investigated gender, age, marital status, level of education and sources of livelihood with the details as shown below.

Table 1 showed the percentage distribution of the demographic information of the participants in Jur River County. It was seen that 131 (50.4.7%) interviewed in Jur River County were dominated by females than males, 129 (49.6%). Regarding age distribution, 123 (47.3%) participants were aged 40-49, while 79 (30.4%) were aged 31-39, (7.7%) were aged 50-55, 24 (9.2%) were aged 15-30, and 14 (5.4%) were aged $>$ 56. This means that most of the participants were in the middle-aged category. About the occupational status of participants, the majority were 144 (55.4%) farmers, followed by civil servants with 67 (25.8%), while students, peasants, and others were 5.8%, 8.5%, and 4.6%, respectively. However, the level of education showed that 167 (64.3%) were uneducated, while 60 (21.1%) attained secondary. However, the primary and tertiary levels were11.1% and 1.2%, respectively. Its oblique access to universal education was at the minimum levels in Jur River County. On religions, most of the people living in Jur River County practiced Christianity (90.0%), compared to traditionalists and Islamists, were represent 6.2% and 3.8% respectively. The level of income indicated that 156 (60%) get SSP 50,000-70,000 monthly, while the minority of the participants who are getting SSP 10,000-30,000 to 50,000 were 4.6 and 17.3%, respectively.

3.2. The socio-economic impact of rural road infrastructure development

This part determines the socio-economic impacts of rural road infrastructure development.

In this Figure 1, rural road infrastructure development in Jur River County is being majorly influence by the development (34%), gentrification (24%) and time overrun cost (18%) compared to the labour (13%), efficiency of authorities (5%), political interference (3%) and by wastage and underutilisation of human resources (1%) among others. This means that road infrastructure can be affected by both negative and positive factors, as shown above.

3.3. Local Community's Perceptions of the Rural Road Infrastructure Development

This table is more on the Local Community's Perceptions of the Rural Road Infrastructure Development.

Table 1: Demographic Data

Variables		Frequency	Per cent (%)
Gender	Male	129	49.6
	Female	131	50.4
	Total	**260**	**100.0**
Age	15-19	12	4.6
	20-30	12	4.6
	31-39	79	30.4
	40-49	123	47.3
	46-55	20	7.7
	> 56	14	5.4
	Total	**260**	**100.0**
Occupation	Civil servant	67	25.8
	Peasant	15	5.8
	Student	22	8.5
	Farmer	144	55.4
	Others	12	4.6
	Total	**260**	**100.0**
Education	Primary	30	11.5
	Secondary	63	24.2
	None	167	64.3
	Total	**260**	**100.0**
Religion	Christianity	234	90.0
	Traditionalist	16	6.2
	Islam	10	3.8
	Total	**260**	**100.0**
Family level of income	10,000 – 30,000	12	4.6
	30,000 – 50,000	45	17.3
	50,000 – 70,000	156	60.0
	70,000 – 100,000	35	13.5
	100,000 – 150,000	3	1.2
	> 150,000	9	3.5
	Total	**260**	**100.0**
Residential Category	Urban	36	13.8
	Peri-urban	93	35.8
	Rural	131	50.4
	Total	**260**	**100.0**

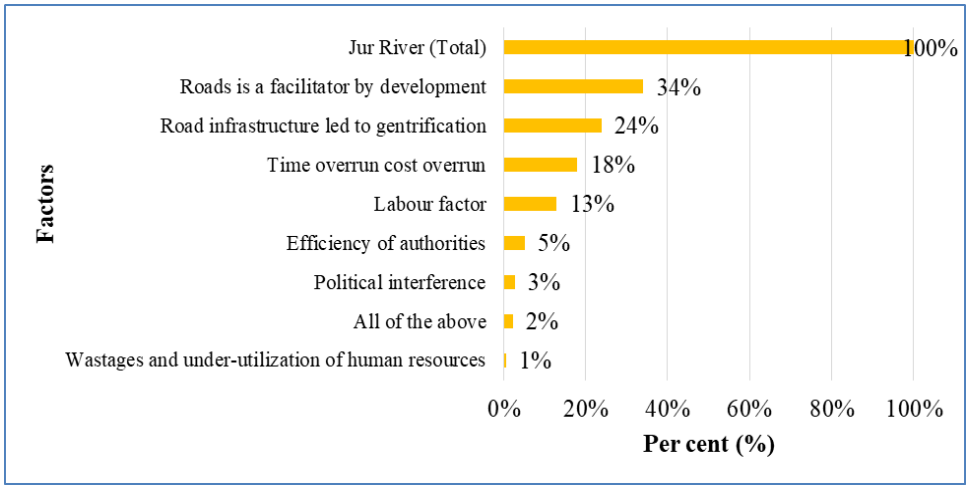

Figure 1: The socio-economic impact of Road infrastructure development

Table 2: Local Community's Perceptions of the Rural Road Infrastructure Development

Responses	Number	Per cent (%)
(a) Accident on site	58	22.3
(b) Price inflation in goods and services	20	7.7
(c) Increase in noise pollution	74	28.5
(d) Increased air pollution due to dust and particulates	21	8.1
(e) Perception of ignorance	13	5.0
(f) Residents' development of nuisance perception	5	1.9
(g) Causing resistance and conflict	33	12.7
(h) All of the above	36	13.8
Total	**260**	**100.0**

According to the finding in Table 2 above, people perceived that road infrastructure development come with Accident on site 58 (22.3%), Price inflation in goods and services 20 (7.7%), Increase in noise pollution 74 (28.5%), Increased in air pollution due to dust and particulates 21 (8.1%), Perception of ignorance 13 (5.0%), Residents' development of nuisance perception 5 (1.9%), Causing resistance and conflict 3 (12.7%), in total, the community perception on road construction is 36 (13.8%).

3.4. The environmental impacts associated with Rural Roads infrastructure development

The table focused on the factors affecting the sustainability of rural roads infrastructure development.

Table 3: The environmental impacts associated with Rural Roads infrastructure development

Responses	Number	Per cent (%)
(a) Material selections	45	17.3
(b) Climate change	28	10.8
(c) Maintenance and management	21	8.1
(d) Funding	5	1.9
(e) Construction costs	5	1.9
(f) Community participation	6	2.3
(g) Economic well-being of the local community	2	0.8
(h) Level of education in the area	2	0.8
(i) Geological formation	10	3.8
(j) Dredge and erosion	12	4.6
(k) Pollution	1	0.4
(l) Minimising carbon emissions	5	1.9
(m) Conserving natural resources	8	3.1
(n) Promoting eco-friendly materials	33	12.7
(o) Mitigating adverse effects on ecosystems and communities	62	23.8
(p) All of the above	15	5.8
Total	**260**	**100.0**

The finding in Table 3 above revealed that the sustainability of constructed road helped in Material selections (17.3%), Climate change (10.8%), Maintenance and management (8.1%), Funding (1.9%), Construction costs (1.9%), Community participation (2.3%), Economic wellbeing of the local community (0.8%), Level of education in the area (0.8%), Geological formation (3.8%). Drainage and erosion (4.6%), Pollution (0.4%), Minimizing carbon emissions (1.9%), Conserving natural resources (3.1%), Promoting eco-friendly materials (12.7%), Mitigating adverse effects on ecosystems and communities (23.8%). This also showed that the sustainability of constructed roads was not easy due to the following factors, namely: material selection, climate change, maintenance and management, funding, construction cost, community participation, Economic wellbeing of the local community, Level of education in the area, geological formation, drainage/erosion and pollution.

3.5. The effects of rural road infrastructure construction

This table describes the effects of road construction on the socio-economic, environment, and Community Health.

Table 4: The effects of rural road infrastructure construction on the socio-economic, environment, and Community Health

Economics way of life	Number	Per cent (%)
(a) Contributed to Housing Rents	31	11.9
(b) Better access to agricultural areas and markets	67	25.8
(c) Delayed payment of compensation	5	1.9
(d) Economic displacement	3	1.2
(e) Disruption to the livelihoods of local people	7	2.7
(f) Increase employment opportunities	34	13.1
(g) Reduce travelling time and cost	61	23.5
(h) Displacement of business, customers and income	11	4.2
(i) Loss of farmlands	9	3.5
(j) Improve business and markets	32	12.3
Total	**260**	**100.0**

According to the results shown in Table 4 above, indicated that the effects of road infrastructure development on economics, environments, social life and community health have both positive and negative effects. Economically the constructed road contributed positively contributed to Housing Rents (11.9%), Better access to agricultural areas and markets (25.8%), Delayed payment of compensation (1.9%), Economic displacement (1.2%), Disruption to the livelihoods of local people (2.7%), Increase employment opportunities (13.1%), Reduce in travelling time and cost (23.5%), Displacement of business, customers and income (4.2%), Loss of farmlands (3.5%), Improve business and markets (12.3%).

3.6. The effects of rural road infrastructure on the Environment

This is Table 5 below describes the effects of rural road infrastructure on the Environment

Table 5: The effects of rural road infrastructure on the Environment

Environment	Number	Per cent (%)
(a) Increase in floods	36	13.8
(b) Loss of vegetable covers	25	9.6
(c) Increase in green area and road landscape	9	3.5
(d) Loss of wildlife habitat by transforming natural habitats	35	13.5
(e) Land contamination	7	2.7
(f) Dirt tracks	1	0.4
(g) Cleared roadsides or rights-of-way	4	1.5
(h) Ecological effects	12	4.6
(i) Dust reduction where roads became sealed	4	1.5
(j) Disturb exotic species and a native species	16	6.2
(k) Trees may prevent landslides onto roads	1	0.4
(l) Noise, air pollution, changes in the natural/human environment	31	11.9
(m) Altering the hydrology of an area/Hydrogeological degradation	56	21.5
(n) Sediment flow	8	3.1
(o) Habitat fragmentation	11	4.2
(p) Improved road infrastructure	3	1.2
(q) Reducing Emissions	1	0.4
Total	**260**	**100.0**

Environmentally, Increase in floods (13.8%), Loss of vegetable covers (9.6%), Increase of green area and road landscape (3.5%), Loss of wildlife habitat by transforming natural habitats (13.5%), Land contamination (2.7%), Dirt tracks (0.4%), Cleared roadsides or rights-of-way (1.5%), Ecological effects (4.6%), Dust reduction where roads became sealed (1.5%), Disturb exotic species and a native species (6.2%), Trees may prevent land slips onto roads (0.4%), Noise, air pollution, changes in the natural/human environment (11.9%), Altering hydrology of an area/Hydrogeological degradation (21.5%), Sediment flow (3.1%), Habitat fragmentation (4.2%). Improved road infrastructure (1.2%), Reducing Emissions (0.4%), which means the environment can be affected by road construction if it was not scientifically and professionally handled.

3.7. The effects of rural road infrastructure on the Social Aspects

On this part, the researcher assesses the effects of rural road infrastructure on the Social Aspects.

Table 6: The effects of rural road infrastructure on the Social Aspects

Social aspects	Number	Per cent (%)
(a) Better access to social services	42	16.2
(b) Induced in-migration or influx	47	18.1
(c) Gender-based violence	13	5.0
(d) Inadequate community engagement	20	7.7
(e) Physical displacement	37	14.2
(f) Improve social interaction	18	6.9
(g) Improve security	56	21.5
(h) Insecurity	19	7.3
(i) Increase in crimes	8	3.1
Total	**260**	**100.0**

Rural Road infrastructure development positively affects social life by influencing better access to social services (16.2%), Induced in-migration or influx (18.1%), Gender-based violence (5.0%), Inadequate community engagement (7.7%), Physical displacement (14.2%), Improve social interaction (6.9%), Improve security (21.5%), increase crimes (3.1%). Therefore, road infrastructure development in Jur Rive had more positive effects than tribulations.

3.8. The effects of rural road infrastructure development on community' Health

This Table 7 below describes the effects of rural road infrastructure development on community' Health.

Table 7: Effects of rural road infrastructure development on community' Health

Health of Community	Number	Per cent (%)
(a) Poor road construction practice causes community safety issues	43	16.5
(b) Airborne disease	54	20.8
(c) Noise and Atmospheric pollutions	63	24.2
(d) Increase Injury incidence	78	30.0
(e) Roads increase disturbance and severance	18	6.9
(f) Traffic disruption	4	1.5
Total	**260**	**100.0**

In terms of community health, poor rural road infrastructure development practice caused community safety (16.5%), airborne disease (20.8%), noise and atmospheric pollution (24.2%), increased injury incidence (30.0%), increased disturbance and severance (6.9%) and traffic disruption (1.5%). Thus, road infrastructure development affected the health of the communities in Jur River more than good. For these reasons, the negative effects outweighed the positives.

3.9. Advantages of new road infrastructure in the community

Table 8 elaborates on the Advantages of new road infrastructure in the community

Table 8: Advantages of new road infrastructure in the community

Responses	Number	Per cent (%)
(a) Reduction of travelling times	76	29.2
(b) Easier access to social services (Schools, Health, Education)	88	33.8
(c) Creation of Job opportunities	14	5.4
(d) Increased property values	8	3.1
(e) Improved safety	9	3.5
(f) Better access to social events	15	5.8
(g) Community cohesion (more connected)	11	4.2
(h) Reduction of Traffic congestion	10	3.8
(i) Better drainage	29	11.2
Total	**260**	**100.0**

The results in Table 8 showed that the new road infrastructure development in the community has advantages or benefits, hence there was high need to have modern road constructed through participation of local communities because road influence the community's easier access to basic and social services, it caused reduction of traveling times, better drainage, better access to social events, it bring cohesion among communities, it creation of Job opportunities, improved safety, it increased property values, and caused reduction of Traffic congestion by 29.2%, 33.8%, 5.4%, 3.1%, 3.5%, 5.8%, 4.2%, 3.8%, and 11.2% respectively.

3.10. Roles of local government in handling the sustainability of rural roads infrastructure

Table 9 elaborates on the roles of local government in handling the sustainability of rural roads infrastructure

Table 9: Roles of local government in handling the sustainability of rural roads

Responses	Number	Per cent (%)
Establish strategic planning and policy	5	1.9
Funding and resource allocation	33	12.7
Construction and maintenance practices	53	20.4
Conduct an environmental and socioeconomic impact assessment	37	14.2
Community engagement and stakeholder involvement	23	8.8
Technological innovation and research	8	3.1
Monitoring and Evaluation	78	30.0
Addressing socioeconomic impacts caused by road construction projection	23	8.8
Total	**260**	**100.0**

Table 9 revealed the following were some of the roles of state and county government to avert the environmental impacts associated with Rural Roads infrastructure development regarding the sustainability of rural roads. Among them was the establish strategic planning and policy (1.9%), funding and resource allocation (12%), construction and maintenance practices of road (20.4%), conduct Environmental and socioeconomic impact assessment (14.2%), community engagement and stakeholder involvement (8.8%), technological innovation and research work (3.1%), conduct of monitoring and evaluation (30.0%) and addressing socioeconomic impacts caused by road construction (8.8%). As per the findings, it means that the local government has put more attention on Monitoring and Evaluation, Construction and maintenance practices, Conduct Environmental and socioeconomic impact assessment.

3.11. General Information related to ESIA in South Sudan

This figure below focused on legal policies, the practicality of ESIA, level of knowledge about the importance of ESIA in South Sudan.

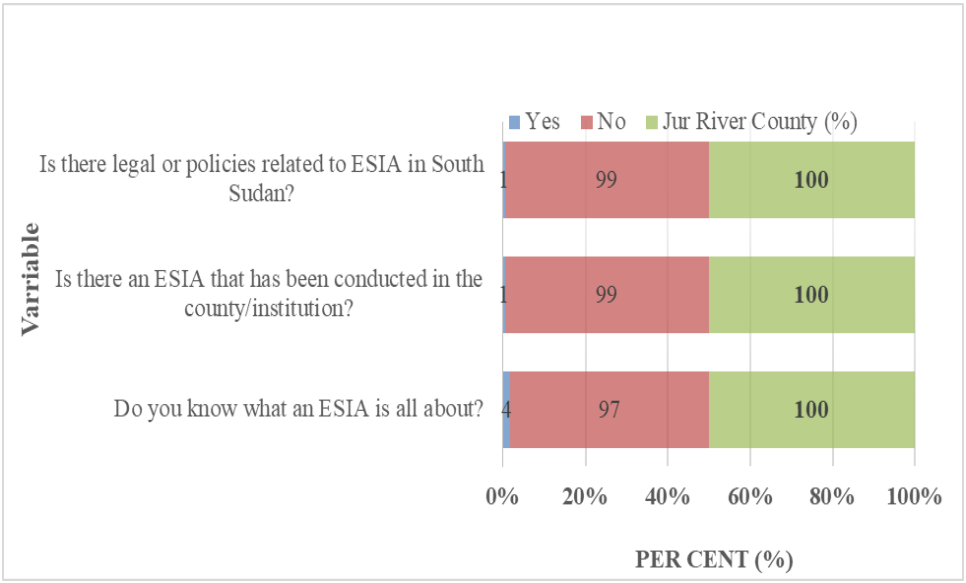

Figure 2: General information related to ESIA awareness among respondents

Figure 2 showed the findings on the general information related to Environmental and Socio-economic Impact Assessment (ESIA). About 99.0% of the respondents stated that there has been neither use of ESIA nor conduct of Economic, social impact Assessment (ESIA) before any road infrastructure development in Jur River County. Only 4.0% knows the importance of the Economics, Social Impact Assessment (ESIA).

4. Discussions

Table 1 showed the percentage distribution of the demographic information of the participants in Jur River County. It was seen that 131 (50.4.7%) interviewed in Jur River County were dominated by females than males, 129 (49.6%), while the study done by [12] differed because most of the respondents were male, 104 (89.4%), and the female represent of 104 (10.6%). All these studies' outcomes depend on the country context and the people found during the interview.

Regarding age distribution, 123 (47.3%) participants were aged 40-49, while 79 (30.4%) were aged 31-39, (7.7%) were aged 50-55, 24 (9.2%) were aged 15-30, and 14 (5.4%) were aged $>$ 56. This means that most of the participants were middle-aged. Similarly, the middle-aged group falls between 25 and 60 years of age, and 50% of the respondents were under 50 years.

About the occupational status of participants, the majority were 144 (55.4%) farmers, followed by civil servants with 67 (25.8%), while students, peasants, and others are 5.8%, 8.5%, and 4.6%, respectively. Of the 104 local contractors sampled, 51% had fewer than 12 employees, but according to them, they could raise more than 100 at any time required. It means that the employment rate was good in the developed countries compared to that of South Sudan (a developing country).

However, the level of education showed that 167 (64.3%) were uneducated, while 60 (21.1%) attained secondary. The findings from this study indicated that the primary and tertiary level was 11.1% and 1.2%, respectively. Its oblique access to universal education is at the minimum levels in Jur River County. According to [12] Of this total, 62% had formal education beyond secondary school level, while 45% had attended labour-based training on road construction/maintenance, and 8% had a degree and postgraduate qualifications. On religions, most of the people living in Jur River County practiced Christianity (90.0%), compared to traditionalists and Islamists, which represent 6.2% and 3.8% respectively.

In contrast to the Constitution of South Sudan, there is freedom of religion as seen in the results above, which agreed with finding of [13] as that of Uganda, which stated that the constitution stresses the importance of the protection of human rights by stating that "fundamental rights and freedoms of the individual were agreed inherent and not granted by the State" and guarantees specific rights and freedoms like, amongst others, the freedom from discrimination, freedom of religion.

This research's outcomes on the level of income indicated that 156 (60%) get SSP 50,000-70,000 monthly, while the minority of the participants who were getting SSP 10,000-30,000 to 50,000 are 4.6 and 17.3%, respectively, which, when compared with the findings by [14], they concluded that with every 10,000 Yuan (about $1200) spent on rural roads, eleven persons were lifted above the poverty line.

In terms of impact on growth, for every yuan invested in roads, 8.83 yuan in rural GDP was produced. Roads yielded the largest return to rural nonfarm GDP, at 6.71 yuan for every yuan invested, 35 per cent higher than the return to education investment. In other hand, Escobal [2] argued that rural roads should be improved in locations where poverty was most severe, as improvement in access to markets provides opportunities for subsistence farmers to integrate into the market economy. Others argued that rural road access should be primarily improved in locations where economic opportunities were already better and thus accelerate a dynamic process for commercial farming and manufacturing.

The finding of this study in Figure 1, road infrastructure development was majorly influenced by the development (34%), gentrification (24%) and time overrun cost compared to the labour (13%), efficiency of authorities (5%), political interference (3%) and by wastage and underutilization of human resources (1%) among others while the finding from [15] intensify on the same factors that include labour factor, project factor, contractor factor and consultant factor. Time overrun, cost overrun, wastages and under-utilization of human resources, cost inflation for equipment and materials due to extension of time, and the reputation of all parties involved in the projects were the impacts of delays. This means that rural road infrastructure development can be affected by both negative and positive factors.

In Table 2, people perceived that road infrastructure come with the followings; Accident on site 58 (22.3%), Price inflation in goods and services 20 (7.7%), Increase in noise pollution 74 (28.5%), Increased in air pollution due to dust and particulates 21 (8.1%), Perception of ignorance 13 (5.0%), Residents' development of nuisance perception 5 (1.9%), Causing resistance and conflict 3 (12.7%), in total, the community perception on road construction was 36 (13.8%). All the people in the communities of Jur River perceived the rural road infrastructure development is harmful due to ignorance by 36 of them (13.8%) rather than good. Both studies had similar findings because the study done by [16] revealed that the most preferred measures were night-time restrictions to HGVs (Human Genome Variation society), parking restrictions and safety measures for pedestrians and cyclists. While the study done by [17] differ because community perception was more of a positive, that the road come with the safety needs of neighbourhoods, varied and the pathways for generating improvements included: crime prevention through environmental design, surveillance, homeownership potential development; social interaction and improvement in the concepts of territoriality, surveillance, milieu and image. Therefore, the differences are seen in this study because the communities of Jur River had a negative perception compared to the communities where Makinde conducted his study.

The finding in Table 3 above revealed that the sustainability of constructed road help in in Material selections, Climate change, Maintenance and management, Funding, Construction costs, Community participation, Economic wellbeing of the local community, Level of education in the area (0.8%), Geological formation, Dredge and erosion, Pollution, Minimising carbon emissions (1.9%), Conserving natural resources, Promoting eco-friendly materials, Mitigating adverse effects on ecosystems and communities. by (17.3%), (10.8%), (8.1%), (1.9%), (1.9%), (2.3%), (0.8%), (0.8%), (3.8%), (4.6%), (0.4%), (1.9%), (3.1%), (12.7%), (23.8%) respectively.

All the participants interviewed stated that the sustainability of constructed roads in the community reduced carbon emissions, conserving natural resources, promoting eco-friendly materials and mitigating adverse effects on ecosystems and communities by (5.8%). As per the study done by [18], the timely availability of Construction Resources, Conflicts towards the realisation of increased performance of road construction projects in arid areas, the contractor's competency variable led to the greatest change in performance, followed by the conflict variable, construction parties' financial management variable and the timely availability of construction resources.

Therefore, both studies had similar outcomes that can be viewed in terms of a specific country's operating system. Also, the study done by [19] stated that social sustainability promotes the concepts of respect, awareness, diversity, vitality, and responsibility toward the workforce and society by keeping them healthy and safe from harm during the different phases of a project. Highway projects were one of the most critical infrastructure projects in the construction industry. This was due to their high budgets, frequent occurrences, and the inevitable disturbance they caused to the existing communities and environment.

Nevertheless, the sustainability of constructed roads remains a major challenge which require serious attention. Due to the importance of roads in the socio-economic development of the country, the government had, in the recent past, steadily increased budget allocation to the road sub-sector. However, road projects have been faced with various challenges, which include delays in completion, cost overruns, demolition of residential and business houses and abortive works [18].

According to the results shown in the Table 4 above, indicated that effects of road infrastructure development on economics, environments, social life and community health had both positive and negative effects. Economically the constructed road contributed positively to Housing Rents by (11.9%), Better access to agricultural areas and markets (25.8%), Delayed payment of compensation (1.9%), Economic displacement (1.2%), Disruption to the livelihoods of local people (2.7%), Increase employment opportunities (13.1%), Reduce in travelling time and

cost (23.5%), Displacement of business, customers and income (4.2%), Loss of farmlands (3.5%), Improve business and markets (12.3%). Therefore, the findings from [20] also impacts on economic development, reduced the cost of raw materials transportation, labour and other products, reducing the cost of production directly, reduced cost and improved quality of services, promote regional and international trade (Resulting increases in farm-gate prices should raise farmer incomes), roads infrastructure development played an important role in the development of rural community, however, some consequences were of negative impacts/influences [21]. Also, new technology provided an opportunity to intervene in and transform nature and the landscape in a way that gave rise to industrialisation and economic growth, which in many ways is still a basis for welfare today [4]. Table 5 showed that Environmentally, Increased in floods (13.8%), Loss of vegetable covers (9.6%), Increased of green area and road landscape (3.5%), Loss of wildlife habitat by transforming natural habitats (13.5%), Land contamination (2.7%), Dirt tracks (0.4%), Cleared roadsides or rights-of-way (1.5%), Ecological effects (4.6%), Dust reduction where roads became sealed (1.5%), Disturb exotic species and a native species (6.2%), Trees may prevent land slips onto roads (0.4%), Noise, air pollution, changes in the natural/human environment (11.9%), Altering hydrology of an area/Hydrogeological degradation (21.5%), Sediment flow (3.1%), Habitat fragmentation (4.2%) Improved road infrastructure (1.2%), Reducing Emissions (0.4%), which means the environment can be affected by the road construction once it is not scientifically and professionally handle which means the environment can be affected by the road construction once it is not scientifically and professionally handled.

The findings showed in the study done by [6] revealed that the effects of roads on ecosystems in Sub-Saharan Africa (SSA) is growing and not limited to the field of road ecology; the negative effects of roads on species were reported at a similar frequency within and outside of protected areas; the road-effect zone varied with effect but typically is between 1 and 7 km for larger mammals; access to surrounding ecosystems through roads was the main mechanism driving effects.

In contrast, there was less certainty around mechanisms by which rural roads had no significant or a positive impact, since many of these were either speculated or unknown compared to the finding from this study results Table 6. Road construction positively affects social life by influencing better access to social services (16.2%), Induced in-migration or influx (18.1%), Gender-based violence (5.0%), Inadequate community engagement (7.7%), Physical displacement (14.2%), Improve social interaction (6.9%), Improve security (21.5%), increase crimes (3.1%). Research on Farm-to-Market Roads (FMRs) have improved waste management practices and facility access for most communities, leading to cleaner environments and greater community participation in sustainable disposal methods [22, 23].

Therefore, rural road construction in Jur River had more positive effects than tribulations. The studies done showed clearly how rural road infrastructure development contributed to transforming the socio-spatial landscape and economic development, and how it affected the social groups. According to [6] new major road infrastructure projects were planned or underway across sub-Saharan Africa (SSA) and were expected to have complex, and often deleterious impacts on natural ecosystems across the region when compared with the study's results of [5] that road infrastructure projects scaled up residential development contributed to housing rents and land prices to increase and rendered peri-urban communities along them as attractive zones for real estate developers.

The rural road infrastructure projects benefited the rich, who own land, at the expense of the poor. The findings that the impacts of road infrastructure appear to differ in locational context and class of individuals within peri-urban areas make us suggest that place-based and people-based policies need to be combined to address the consequences of road infrastructure projects. Table 7 illustrated on the effects of rural road infrastructure development on community' Health. In South Sudan, the emphasis was on connection to access services and transportation of people and goods. In terms of community health, poor road construction practice causes community safety (13%), airborne disease (14%), noise and atmospheric pollution (31%), increase Injury incidence (34%), increased disturbance and severance (7%) and traffic disruption (1%). Thus, rural road construction affected the health of the communities in Jur River more than good. For these reasons, the negative effects outweigh the positives.

Table 8 showed that there was high need to have modern road constructed through the communities because it influenced easier access to basic and social services, it cause reduction of traveling times, better drainage, better access to social events, it bring cohesion among communities, creation of Job opportunities, improved safety, it increased property values, and caused reduction of Traffic congestion by 29.2%, 33.8%, 5.4%, 3.1%, 3.5%, 5.8%, 4.2%, 3.8%, and 11.2% respectively. The construction of rural roads was to get access to manage solid waste to be transported to the landfill and to recycle the materials used in the construction and demolition (debris), which means the interest was for investment [4]. The same results were obtained in the study done in Kisumu, Kenya and in Accra, Ghana; the emphasis was on poverty eradication by [5]. Just as the study done by [14] revealed that roads were a facilitator for development. Roads have economic benefits because the poor use them for various purposes, but it depends on their asset base and the entitlements to resources and opportunities. Additionally, road improvements improve access.

The results in Table 9 revealed that state and county government avert the environmental impacts associated with Rural Roads infrastructure development (sustainability) of rural roads through the development of strategic planning and policy (1.9%), funding and resource allocation (12%), construction and maintenance practices of road (20.4%), conduct Environmental and socio-economic impact assessment (14.2%), community engagement and stakeholder involvement (8.8%), technological innovation and research work (3.1%), conduct of monitoring and evaluation (30.0%) and addressing socioeconomic impacts caused by road construction (8.8%) in addressing socioeconomic impacts caused by road construction. Which has the same outcome as finding by agreement [24] because programme personnel, monitoring and evaluation, funding adequacy and management support influence the performance of rural roads maintenance projects greatly. As per the findings, it means that the local government had put more attention on Monitoring and Evaluation, Construction and maintenance practices, Conduct Environmental and socioeconomic impact assessment.

The finding of this study, as shown in Figure 2, showed the findings on the general information related to Environmental and Socio-economic Impact Assessment (ESIA). About 99.0% of the respondents stated that there has been neither use of ESIA nor conduct of ESIA before any road infrastructure development in Jur River County. Only 4.0% knows the importance of the ESIA.

The measures to make Environmental and Socio-economic Impact Assessment (ESIA) effective in South Sudan include; conduct comprehensive awareness campaigns about the importance use of ESIA tool before the development of any intervention, because it can help the country to weigh the impacts of any given projects on the lives of beneficiaries. On the other hand, South Sudan, particularly the Ministry of Environment and Forestry, as well as line Ministries (Ministry of Health, service cluster) should create policies/laws or enforcement or reactivation of laws that made the use of ESIA compulsory to instruct all the institutions and stakeholders. Practically, the use of ESIA can help the country to protect the land use for its meaningful. Seemingly, South Sudan should establish an independent body to take charge of the responsibility of environmental protection through good planning and ensure that natural resources are properly and sustainably managed.

South Sudan should ensure that all project managers and contractors must carry out ESIA before the construction commences, without any fear or favour, to avoid promises over the life of its citizens.

5. Conclusion

The local community had positive and negatives perception on the Rural Road infrastructure development in JRC and the negative effects of rural road infrastructure development outweighed the positive effects in life of rural communities in JRC.

The study revealed that there was lack of regulatory mechanisms to protect environment and community livelihood during the planning process and the sustainability of constructed roads infrastructure development in Jur River County remains a major challenge for the community in the area.

The study also revealed that none application of ESIA was the main caused of development challenges in the project area and in South Sudan in general.

Article Information

Ethical Approval: The study was approved by the University of Juba and Ministry of Roads and Bridges of Western Bahr El Ghazal State, South Sudan during the commencement of data collection on 22/8/2025 & 27/8/2025 respectively.

Informed Consent: Written informed consent was obtained from all participants before their inclusion in the study.

Data Availability: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Author Contributions: J.L.C.L. - Conceptualization, Methodology, Supervision, Project Administration; A.A.A.M. - Investigation, Resources, Writing – Original Draft; I.N. - Data Curation, Formal Analysis, Writing – Review & Editing.

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