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Towards West Papua's urban green infrastructure roads framework

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Abstract

Enhancement of road network infrastructure expansion while considering the concept of sustainable development, as well as initiatives to minimize GHG emissions and community resilience to disasters. The Slovin approach and Likert scale were used in this study's methods, which included surveys and interviews with respondents from the affected community, village officials, community leaders, traditional leaders, women leaders, youth leaders, district, regency, and provincial officials. According to the research findings, respondents prefer environmental and social indicators with 35.5% and 30.0% when evaluating a sustainable development framework for urban green infrastructure. Then came the economic and technical indicators, with values of 17.3% and 17.2%, respectively. Thus, to align with the transformation of the Long-Term Strategy for Low Carbon and Climate Resilience by 2050, the respondents support the program for the sustainable development of road network infrastructure in Manokwari Regency, West Papua Province, with a satisfactory category.

Keywords: Road; Environmental; Social; Economic; Technical; Low Carbon; Climate Resilience

1. Introduction

This study starts by looking at external components from the Threats, Opportunities, Weaknesses, and Strengths (TOWS) analysis connected to risks from hydrometeorological catastrophes, as shown by the high category of disaster risk index in West Papua, notably in the study areas in Manokwari Regency [1,2]. Due to the effects of extreme weather brought on by tropical storms that cross Papua's north coast and cause flash floods, landslides, and erosion, this tragedy is more likely to occur due to climate change [3,4]. The possibility of this hydrometeorological disaster also affects the infrastructure of the roads, where there has been damage to drainage and outlets installed improperly in a number of locations [5,6].

The chance to enlarge the road from Drs. Esau Sesa to Maruni, 21.43 km long with a total length of 25 meters from the beginning of only 4-6 meters, is another external aspect for opportunities factor that may be attributed to funds from the central government [7]. In addition, the provincial and district governments have agreed to split the cost of paying out compensation for impacted land [8].

An increase in population and car ownership, road lanes for district and provincial offices, and a decrease in the current road capacity are internal elements from the weaknesses side that were discovered in this study. These conditions impact high noise levels, vibration, pollutants, air pollution, emission, and the comfort of road users and nearby residents [9,10,11,12].

Additionally, the idea of low-carbon and climate-resilient development has not been considered in the building and enlarging of this road infrastructure, which will prevent local communities and road users from living in poverty and

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being vulnerable to the effects of hydro-meteorological disasters, which have become more frequent and severe in recent years.

In terms of the strengths of other internal factors, it is demonstrated that the road infrastructure, which was initially constructed with a width of 4-6 m, has facilitated access to work mobility, boosted the economy by enabling people to sell agricultural products, reduced travel distances, accelerated local economic growth, improved infrastructure as one of the minimum service standards, and aided the operation of social and other systems [13,14,15,16,17].

In attempts to combat risks and weaknesses identified by the TOWS analysis, the development of urban green infrastructure roads (UGIR) is one of the solutions for climate change and disasters, as well as an effort to be environmental, provide economic, and social benefits which are included in the pillars of sustainable development goals in the Land of Papua and low carbon development planning in West Papua along with climate resilience development in support of the central government to achieve the Long-Term Strategy for Low Carbon and Climate Resilience 2050 [18,19].

2. Material and methods

2.1. Study area

The road widening activity occurred on Maruni Street - Boundary of Manokwari City for a distance of 17.52 km, beginning at the intersection of four streets with non-Traffic Signaling Equipment Maruni Street – Base Transceiver Station (BTS). Manokwari City - access to Conch Cement Factory Street - Prafi-Warmare-Maruni Streets - Maruni – Oransbari Streets, with geographic coordinates 0°59'41.90"S 134° 1'33.80" E and the end of the section near the intersection of four streets with non-Traffic Signaling Equipment Drs. Esau Sesa street –Maf – access the Aston Niu Hotel Streets with geographical coordinates 0°53'56.92"S 134° 2'35.35" E. Coupled with the Drs. Esau Sesa Street along 3.91 km starting from the intersection of three streets with Traffic Signaling Equipment Trikora-Wosi –Rendani –Drs. Esau Sesa Streets, with geographical coordinates 0°52'2.80"S 134° 2'46.20" E and the end of the section near the intersection of four streets with non-Traffic Signaling Equipment Drs. Esau Sesa –Maf – access Hotel Aston Niu Streets with geographic coordinates 0°53'56.92"S 134° 2'35.35" E (Figure 1).

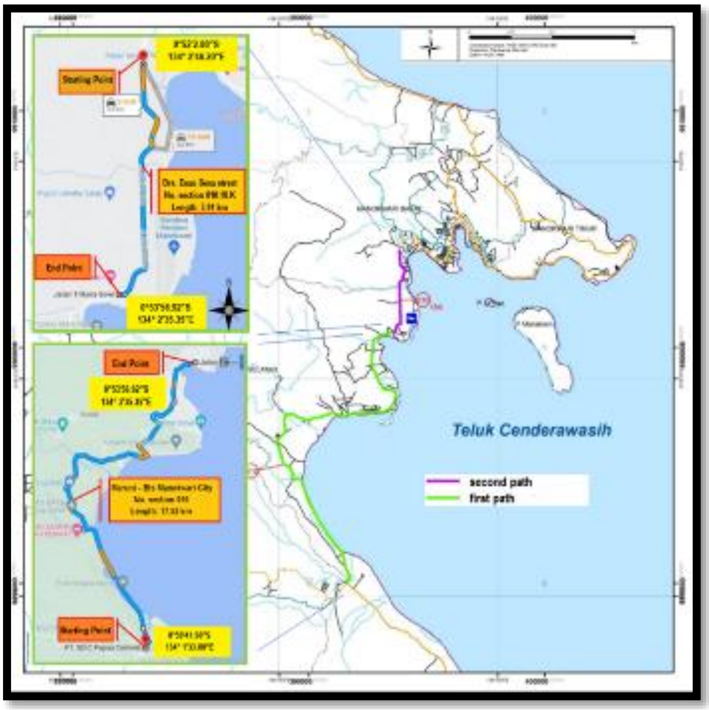

Figure 1 Map of the road widening location for Manokwari Regency, West Papua Province

2.2. Method of data analysis

The Slovin method [20] is used in this study to collect data from a sample of respondents using the following formula:

$$n = \frac{N}{1+N.e^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 1$$

where:
The required sample size is n, the population size is N, and the tolerance margin of error is e.

With a margin of error of 5% and a population of 95,837 people [21], West Manokwari District is the location for increasing the road infrastructure. The sample size obtained is 398 people, and the calculations are as follows:

$$= \frac{95{,}837}{1 + (95{,}837x(0.05)^2)}$$

$$= \frac{95{,}837}{241}$$

$$= 398 \; people$$

Assuming that each family has six (6) members, the 398 people in the data sample are divided into 53 families for the first path and 13 for the second.

Of the nine groups of respondents, 60% were from affected communities, and 5% came from other categories. As a result, 32 families from affected communities are required for the first path of road infrastructure development, as well as 2 families for each district, regency, and provincial official and 3 families for other categories. Under the second path, 8 households will be distributed to the afflicted areas, along with 1 household for each village official, community leader, traditional leader, women leader, and youth leader.

Figure 2 West Papua’s urban green infrastructure roads (UGIR) framework

The Urban Green Infrastructure Roads (UGIR) Framework is additionally used for analysis, as well as for best practices, lessons learned, and initial information in natural resource management based on sustainable development objectives, with a primary focus on the 4 assessment pillars of environment, technical, economics, and social (Figure 2) [22,23,24,25].

Moreover, survey data is analyzed using a Likert scale [26] with the following categories: strongly agree (SA,5), agree (A,4), neutral (N,3), disagree (D,2), and strongly disagree (DS,1)), and the formula below is used to find the overall percentage:

$$Index\ \% = \frac{Total\ score}{Y} x\ 100\% \ldots\ldots\ldots\ldots \quad 1$$

where:
Index% is expressed as a percentage (%), the Total score is the respondents' evaluation, and Y is the highest score times the total number of respondents.

3. Results and discussion

3.1. Attributes of the respondent

Table 1 presents respondent data from 66 families, with an average of 6 individuals per family, on road infrastructure development in both paths.

Table 1 Respondent attributes data

Family Attribute (unit)	**(Min-Max; Average)**
Man’s age (year)	31.0 – 60.0; 46.0
Woman’s age (year)	28.0 – 65.0; 47.0
Man’s education (year)	0.0 – 16.0; 8.0
Woman’s education (year)	0.0 – 12.0; 6.0
Family size in numbers (people)	5.0 – 7.0; 6.0
Income/capita/month (thousand Rp)	3,750.0 – 12,000.0; 7,875.0

The mean value of the ages of men and women in the respondent's data is included in the productive age group (15-64 years) [27]. The educational data found interesting things that there were officials. They impacted communities in West Manokwari District who had completed the Undergraduate levels, so their knowledge was above average, and they understood the build urban green infrastructure roads. The average income obtained from the results of the two paths of roads was 7,875.0 thousand rupiahs, which was obtained from civil servant salaries until private workers dominated it. In contrast, women who sell produce and other agricultural items might make up to 3,750,0 thousand rupiahs

3.2. Smart Environmental of UGIR

Descriptive frequencies of environmental indicator data for the 10 questions presented can be viewed in Table 2. The table demonstrates the need for additional studies to implement issues like choosing tree species, collecting rainwater, reducing climate change, and using green energy.

Community members' opinions on smart environment received the highest overall score of 35.5% in West Papua’s UGIR Framework. The three main groups of these components are treatment (53.2%), ecology (30.4%), and safety (16.4%) which are presented in Figure 3. And the response percentage from those who answered each question based on the Likert scale can be seen in Figure 4.

Some factors in the treatment component require specific consideration for future advancements in rainwater harvesting [28,29]. Although this technology is required to predict extreme droughts in an effort to provide irrigation for agricultural, plantation, and home washing needs, this technology has not been properly developed in West Papua [30]. Also, this technology is required to anticipate extreme rains to prevent flooding that would damage the road infrastructure and affect the surrounding community [31].

In order to widen roads in a way that will benefit the environment and the neighborhood, it is ecologically important to choose tree species carefully and consider the features of urban green spaces. For instance, tree species with high energy calorific values can be used as pelleted biomass to meet human energy needs sustainably [32,33].

Table 2 Statistical description of smart environmental

		Env_1	Env_2	Env_3	Env_4	Env_5	Env_6	Env_7	Env_8	Env_9	Env_10
N	Valid	66	66	66	66	66	66	66	66	66	66
	Missing	0	0	0	0	0	0	0	0	0	0
Mean		4.47	4.58	3.52	4.73	4.68	4.59	4.77	3.20	3.47	3.32
Median		4.00	5.00	4.00	5.00	5.00	5.00	5.00	3.00	3.00	3.00
Mode		4	5	4	5	5	5	5	3	3	3
Standard Deviation		0.50	0.50	0.50	0.45	0.47	0.50	0.42	0.40	0.50	0.47
Range		1	1	1	1	1	1	1	1	1	1
Sum		295	302	232	312	309	303	315	211	229	219
Percentiles	25	4.00	4.00	3.00	4.00	4.00	4.00	5.00	3.00	3.00	3.00
	50	4.00	5.00	4.00	5.00	5.00	5.00	5.00	3.00	3.00	3.00
	75	5.00	5.00	4.00	5.00	5.00	5.00	5.00	3.00	4.00	4.00

Figure 3 Smart environmental components

As a result of the community's response, a number of safety-related factors require additional efforts to collaborate with the local universities (University of Papua) in order to provide technology from climate change mitigation, renewable energy, and drainage management that must be added to the construction of the road widening [34,35,36].

Respondents indicated that they strongly agreed with a number of environmental factors, including urban green biodiversity, wildlife habitat with the gathering of various bird species in the morning and evening, fresh air from trees and a reduction in urban heat from the function of shady trees, ecotourism from some visitors as photo subjects, and noise reduction, particularly in key roadside areas [37,38].

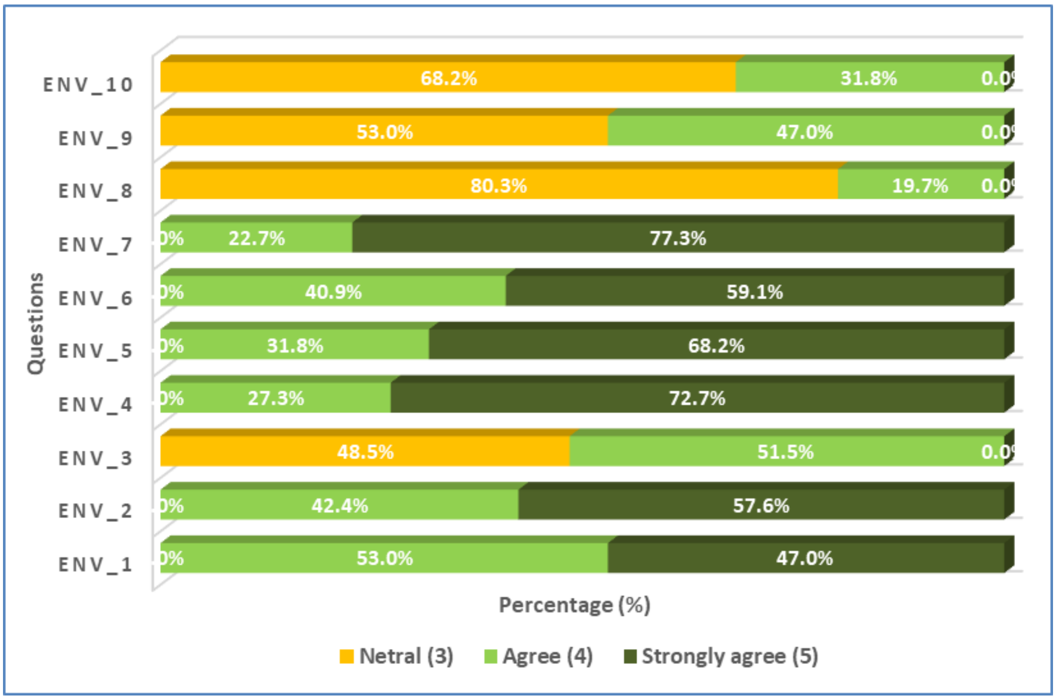

Figure 4 **P**ercentage of environmental indicators responses

3.3. Smart Social of UGIR

Table 3 displays the descriptive frequency of social indicator data for each of the eight questions. The table reveals that further research is needed to address topics such as youth leadership development and social cohesion to the depth of relationships and a sense of solidarity among community members.

Table 3 Statistical description of smart social

		Soc_1	**Soc_2**	**Soc_3**	**Soc_4**	**Soc_5**	**Soc_6**	**Soc_7**	**Soc_8**
N	Valid	66	66	66	66	66	66	66	66
	Missing	0	0	0	0	0	0	0	0
Mean		4.52	4.67	4.61	4.52	4.77	3.64	4.27	4.00
Median		5.00	5.00	5.00	5.00	5.00	4.00	4.00	4.00
Mode		5.00	5.00	5.00	5.00	5.00	4.00	4.00	4.00
Standard Deviation		0.50	0.48	0.49	0.50	0.42	0.48	0.45	0.53
Range		1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00
Sum		298.00	308.00	304.00	298.00	315.00	240.00	282.00	264.00
Percentiles	25	4.00	4.00	4.00	4.00	5.00	3.00	4.00	4.00
	50	5.00	5.00	5.00	5.00	5.00	4.00	4.00	4.00
	75	5.00	5.00	5.00	5.00	5.00	4.00	5.00	4.00

The social component of the UGIR Framework comes in second with a percentage of 30.0%, right behind the smart environment component. Additionally, Figure 5 illustrates how these elements are divided into two main categories: lifestyle (52.3%) and development (47.7%). At the same time, the percentage of responses of those who answered particular questions established on the Likert scale can be described in Figure 6.

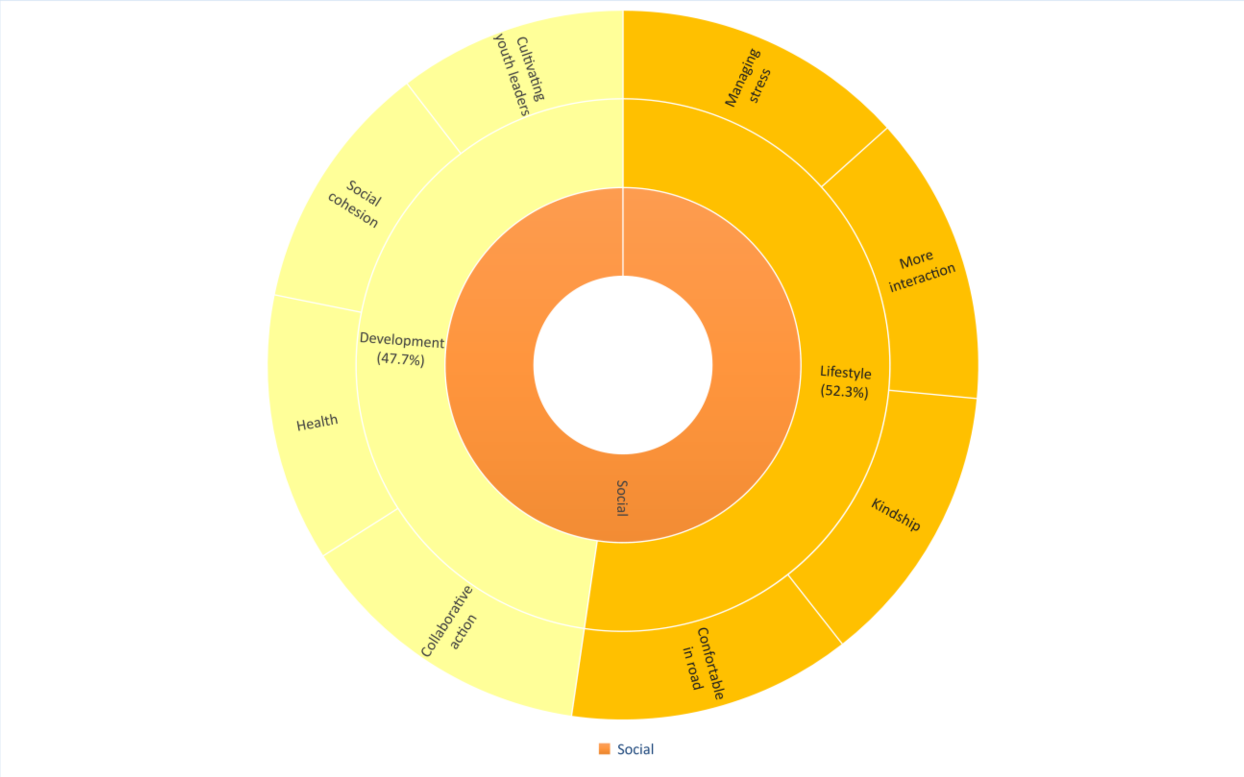

Figure 5 Smart social components

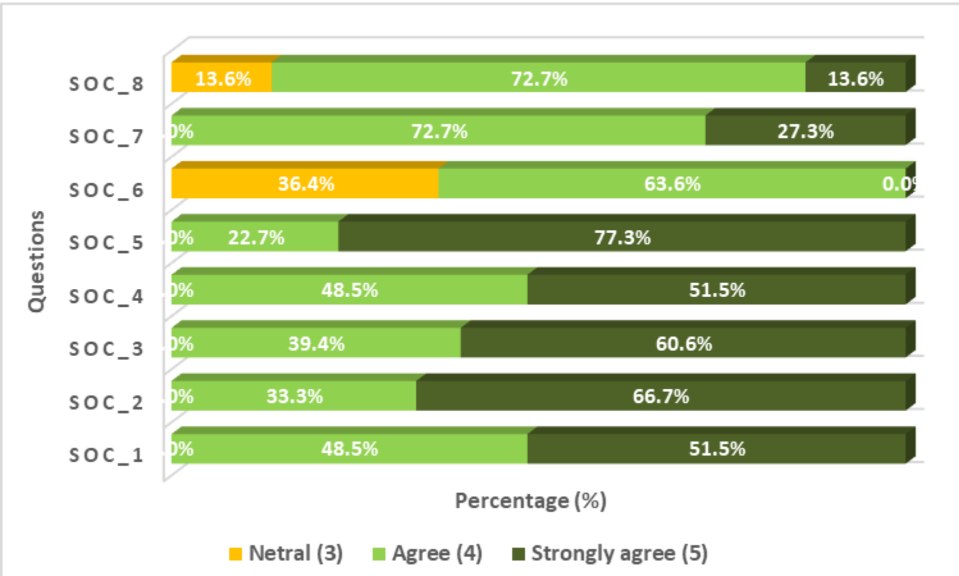

Figure 6 Percentage of social indicators responses

Increased public livability, which is indicated by environmental sustainability and surrounding comfort, should be taken into account as a lifestyle factor from the results of the community opinion survey in order to lessen stress and the burden of living for those who are already exhausted from their daily jobs [39,40].

The component development portion of smart social needs to further develop public health factors and enhance community aesthetics. Because of the current circumstances and the scarcity of urban green space, there is little beauty to be seen along the road. Also, it was challenging to locate green open areas to take in the pure, wholesome air during the Covid-19 pandemic. People, therefore, tend to only be at home when they are extremely stressed and anxious [41,42].

Respondents need to concentrate on stress management, increased communication, relationships, teamwork, and road comfort, as in smart green cities in several cities in Indonesia and abroad, so that the local community and road users can benefit socially while also paying important attention to the development of road width.

3.4. Smart Economic of UGIR

The distribution of descriptive data can be examined in Table 4, along with the five questions' economic indicators. These findings demonstrate the need for more work on issues relating to a sustainable system and eco-friendly products in the context of lowering waste, energy use, and chemical exposure.

Table 4 Statistical description of smart economic

		Eco_1	Eco_2	Eco_3	Eco_4	Eco_5
N	Valid	66	66	66	66	66
	Missing	0	0	0	0	0
Mean		4.73	4.12	3.23	3.88	4.18
Median		5.00	4.00	3.00	4.00	4.00
Mode		5.00	4.00	3.00	4.00	4.00
Standard Deviation		0.45	0.78	0.422	0.73	0.61
Range		1.00	2.00	1.00	2.00	2.00
Sum		312.00	272.00	213.00	256.00	276.00
Percentiles	25	4.00	3.75	3.00	3.00	4.00
	50	5.00	4.00	3.00	4.00	4.00
	75	5.00	5.00	3.00	4.00	5.00

As shown in Figure 7, smart economics is ranked third in the UGIR Framework with a value of 17.3%, divided into two major components: financial technologies (57.7%) and industry (42.3%). Furthermore, the percentage of each question related to the answers from the respondents can be seen in Figure 8.

The variable that requires special consideration from the financial technology component is the minimum input in precise and efficient technology to establish sustainable financial technologies. In order to build suitable road technology that fits the soil's requirements and texture as well as the technology necessary to adapt to climate change and disaster mitigation, which is covered in greater detail in the technical component, it is necessary to work with academia [43].

The minimum input effort and changing the mode of transportation are still factors in the development component that require the most focus so that the community can take advantage of road widening and transportation access for simple food distribution to ensure food security and other plantation agricultural products [44,45].

The respondents also highly valued the old roads that offered social services, ecological benefits, and economic growth. As a result, the respondents support road widening to improve road quality, which will impact the community's economy and social and environmental benefits.

Figure 7 Smart economic components

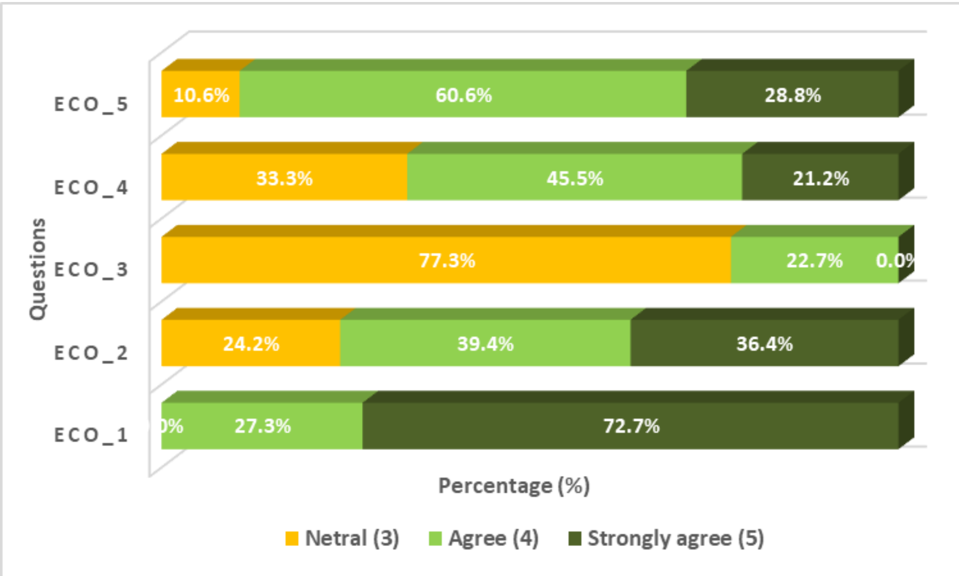

Figure 8 Percentage of economic indicators responses

3.5. Smart Technical of UGIR

The questions about technical indicators according to the frequency description can be seen in Table 5. The obtained results show that the questions related to building materials need more attention, especially those related to construction materials. related to environmentally friendly.

Smart technical is the final component of the UGIR Framework in an effort to improve road quality in West Papua, with a percentage of 17.2% divided into two components, namely utility (61.5%) and facility (38.5%) in Figure 8. For more details on percentage responses to technical indicator questions, see Figure 9.

This component of the facility still requires special attention to be further developed, as it contains several variables such as water efficiency, building materials, ecological adaptation, waste systems, and energy systems that have not been well developed in the conventional manner [46,47].

Table 5 Statistical description of smart technical

Statistics						
		Tech_1	Tech_2	Tech_3	Tech_4	Tech_5
N	Valid	66	66	66	66	66
	Missing	0	0	0	0	0
Mean		4.03	3.71	4.02	4.26	3.98
Median		4.00	4.00	4.00	4.00	4.00
Mode		4.00	4.00	4.00	4.00	4.00
Standard Deviation		0.70	0.58	0.69	0.62	0.67
Range		2.00	2.00	2.00	2.00	2.00
Sum		266.00	245.00	265.00	281.00	263.00
Percentiles	25	4.00	3.00	4.00	4.00	4.00
	50	4.00	4.00	4.00	4.00	4.00
	75	5.00	4.00	4.25	5.00	4.00

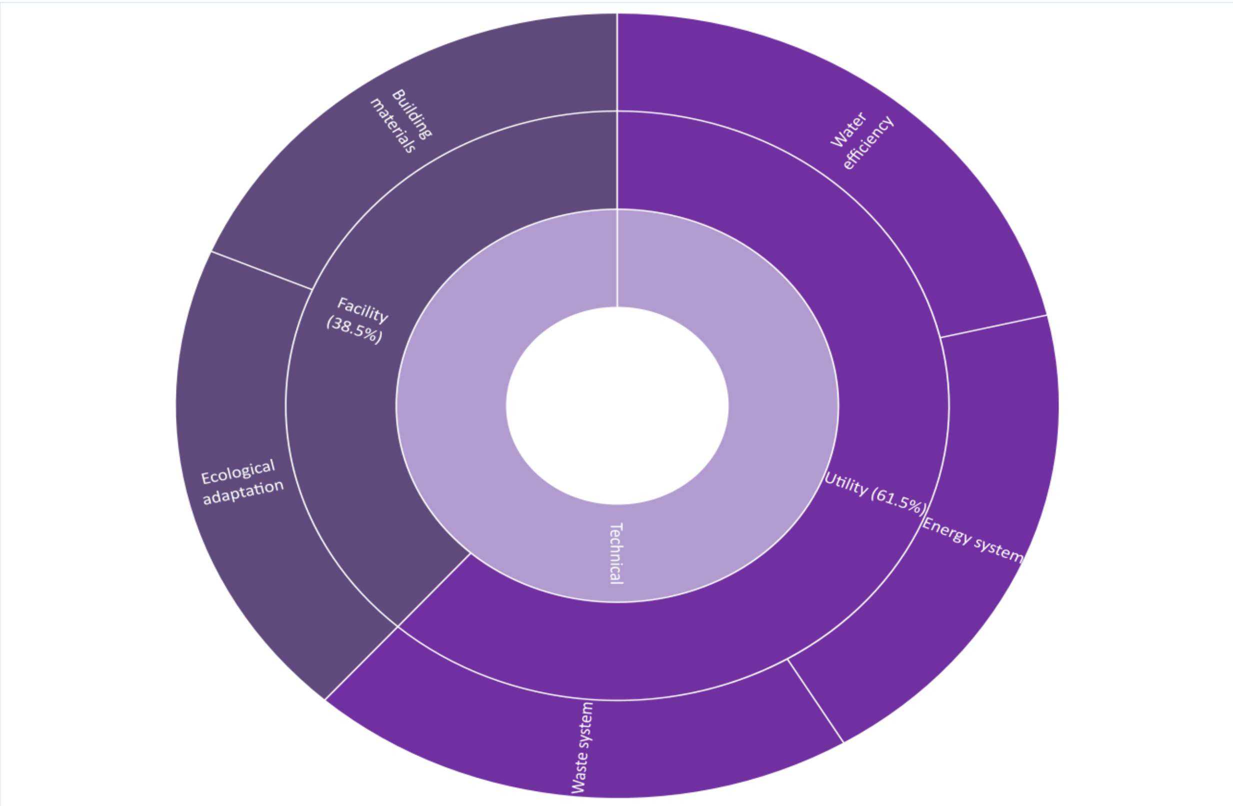

Figure 9 Smart technical components

This is an important reminder that technology development must consider climate change and disasters. In the utility component, several variables need to be developed further, particularly pedestrian and bicycle safety and preventing localized flooding due to several drainage channels that are not yet available and not functioning properly. Moreover, the destruction of mangrove habitats around Maruni was brought on by building highways in coastal areas with the worst erosion [48,49].

This technical aspect complements the UGIR Framework in West Papua to include a number of variables that have not previously been considered during road construction. At the same time, we also reference low-carbon and climate-resilient development as required by the Government of Indonesia to realize the Long-Term Strategy for Low Carbon and Climate Resilience (LTS LCCR) 2050 [50].

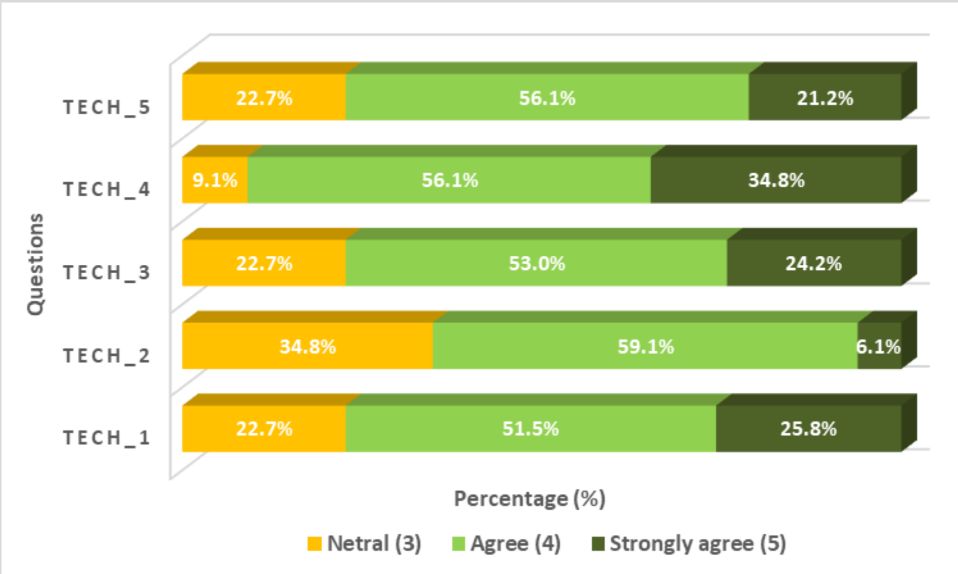

Figure 10 Percentage of technical indicators responses

4. Conclusion

Respondents strongly support road widening to improve road quality, with special emphasis on the development of West Papua's UGIR Framework, with a primary focus on smart ecology (35.5%), followed by smart social (30.3%), smart economics (17.3%), and smart technical (17.2%).

Each indicator has a positive correlation with the development of the UGIR framework, with several questions that require further development with local universities in developing road network widening in Manokwari Regency, West Papua Province, according to the results of the questions given to respondents.

Growing elements in sustainable development have gotten much attention since they are predicted to play the most important complementary role in establishing West Papua's UGIR Framework as a model in Eastern Indonesia, which aims to reach the LTS LCCR 2050.

Compliance with ethical standards

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Disclosure of Conflict of Interest

There is no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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