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Sustainability Analysis of Farming Roads for Increased Food Security (Case Study on Woro Village, Kepohbaru Subdistrict, Bojonegoro Regency)

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Abstract: Villages are often serve as primary centers for agricultural activities and play a crucial role as the main supporters of national food security. Numerous efforts have been undertaken to food security, with the development of farm road infrastructure being one significant initiative. The village government, aligning with its commitment to support the national program, initiated out the construction of farm roads in 2021-2022. This research explores the sustainability of farm road development with the objective of enhancing agricultural productivity, examining five pillars: environment, social aspects, economic considerations, institutional dimension, and law enforcement. The case analysis on Woro Village in the Kepohbaru District, Bojonegoro Region.A quantitative research methodology was employed, collecting data through a questionnaire distributed to 84 respondents who are members of the village community. The data analysis employed Structural Equation Modeling - Partial Least Squares (SEM-PLS) using SMartPLS 4.0 software. The result is indicated by the path-coefficient values of 0.286; 0.294; 0.351; 0.174; and 0.131; with corresponding t-statistic values of 3.746; 2.517; 3.108, 2.154, and 2.393. The associated p-values were 0.00; 0.012; 0.002; 0.031; and 0.017; respectively. The research findings highlight a notable and positive impact stemming from the five development pillars, namely environment, social, economic, institutional, and law enforcement, on the sustainability of agriculture road development.

Keywords: Agriculture; Environmental; Road; Sustainability

Introduction

Villages play a crucial role in the national economy (Arifin, et al., 2020) However, despite their significance, villages often grapple with substantial economic challenges, which, in turn, have repercussions on overall economic growth, public welfare, and sustainable development (Adamowicz, 2020; Zul et al., 2023). Examples of issues in villages are limited employment opportunities (Arifin, et al., 2020), dependence on the agricultural sector without economic diversification (Aizen et al., 2019), a lack of capital and access to financial (Arifin, et al., 2020), and insufficient access to quality education and skills training relevant to the job market. This lack hampers increased productivity and competitiveness of the village economy (Golovina et al., 2021).

One of the most pressing challenges faced by villages is the restricted access resulting from inadequate road and transportation infrastructure. This limitation poses a significant to economic growth and contributes to the widening economic gap between rural and urban areas (Sewell et al., 2019). The insufficiency in transportation infrastructure not only impedes

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economic activities, but also exacerbates economic disparities, emphasizing the critical need for targeted interventions to address this fundamental issue in village development.

Food security is pivotal element in ensuring the sustainability of a country, encompassing the availability, accessibility and sustainability of food for the entire population. In this context, the role of villages as entities that integrate social, economic and environmental aspects becomes exceedingly significant. Villages are not merely geographical location, rather serve as the focal point of community life, playing a strategic role in supporting national food security (Pawlak, 2020)..

Villages are the main foundation of food security because they carry various agricultural activities and food production. The lives of rural communities are closely linked to the agricultural cycle, spanning from planting to harvesting. In addition, villages are also home to the majority of farmers, fishermen and micro-entrepreneurs who contribute significantly to national food production (Kopittke et al., 2019).

The crucial role of villages in food security extends beyond production to encompass environmental sustainability, preservation of local culture, and community empowerment. Villages create a balance between human needs and environmental protection, making them central to supporting sustainable food systems (Level et al., 2019).

Several research has been conducted to enhance agricultural production, including the analysis of the sustainability of opening new land for agriculture. However, challenges such as low wages from farm laborers, particularly hoe laborers, have kept many farmers in Indonesia economically disadvantaged. For instance, research by Chaniago, (2023) has investigated the impact of low wages on the economic status of farmers. Effectiveness the corporate farming model can increase production and technical efficient of agriculture (Iskandar et al., 2022),

Other research initiatives focus on specific agricultural practice to boost productivity. Hasanuddin et al., 2(023) conducted research on optimize fertilizer doses to increase corn agricultural production. Similarly, studies by Raksun et al., (2023) have explored the application of compost fertilizer to enhance soil fertility, aiming to reduce production costs and promote plant growth. Additionally, study by Pratiwi et al., 2023) demonstrated the effects of potassium application, fruit pruning, and water quality on crop production, highlighting the multifaced factors influencing agricultural outcomes.

One effective approach to address issues in the village is the implementation of the Village Medium – Term Development Plan (RPJMDes). Through the RPJMDesa, the village can plan and guide development activities in line with local needs and potentials, as well as provide direction for the utilization of available resources (Akhyar et al., 2023; Hasanati et al., 2023).

The RPJMDesa functions as a guiding document for the village government, playing a vital role in the allocation of funds, coordination of development activities, and the ongoing monitoring and evaluation of the development accomplishments (Hasanati et al., 2023). Furthermore, it serves as a foundational document for soliciting support and assistance from the district/city government or the central government to materialize essential farm infrastructure development initiatives (Akhyar et al., 2023). In essence, the RPJMDesa stands as a key instrument in empowering villages to strategically plan, implement, and secure support for their sustained development.

The Woro Village Regulation Number 6 of 2020 outlines the implementation of development guided by the RPJMDesa through consensus discussions, with a priority on evenly distributing infrastructure development in the Woro, Ngujo, and Sidonganti hamlets. This prioritization is notably achieved the construction of the village's main road, emphasizing the development of farm roads to enhance agricultural productivity.

In a concerted effort to contribute to national programs focused on food security, the Village is actively engaged in infrastructure development within the agricultural sector, specifically through the construction of farm roads. This initiative is aimed at supporting the sustainability of food security and promoting national economic equity. In accordance with PMK 201 at 2022, which pertains to the prioritization of the use of village funds in 2023, Woro Village has undertaken the construction of farm roads. Additionally, with the support of the Bojonegoro Regency government, Woro Village has received a BKK Road, serving as the primary access point in the agricultural sector. Consequently, it is imperative to conduct an evaluation of farm road construction to ensure its effectiveness and impact.

The criteria for the construction of farming roads are as follows: farmers must be willing to work in groups, release part of their land without compensation, and carry out maintenance of agricultural roads independently (Maritin et al., 2023). The farming road development program in Woro Village is managed through a self-management approach, with the construction strategically starting at point 0 to the east of the village along the border with Bumirejo Village. The road extends through Woro Hamlet, connecting to the Public Main Road of the Subdistrict (PUK), and then proceeding to the village main road, linking Sidonganti Hamlet. This development project traverses agricultural areas and features minimal settlements, particularly as

Sidonganti Hamlet is positioned in the western part of the village.

The construction of this road infrastructure aligns with Sustainable Development Goal (SDG) number 9, focusing on "Industry, Innovation, and Infrastructure." The overarching aim of this SDG is to establish robust, inclusive, and sustainable infrastructure, enhance access to basic services and technology, and augment economic and productive capacity within communities. However, it is essential to acknowledge that in reality, roads construction can also introduce environmental and social challenges. Horizontal challenges may include heightened traffic density, air pollution, noise pollution, and potential issues related to criminal activity (Rudiyanto, 2020).

Farming roads serve not only as transportation channels, but also as means of connecting farmers to markets, facilitating accessibility and improving efficiency in the food supply chain. This evaluation specifically focuses on the contribution of farm roads to farm development and productivity improvement (Maritin et al., 2023).

Farm roads not only serve as transportation routes but also play a crucial role in driving economic growth in the agricultural sector and strengthening social communication within Farm communities (Munday et al., 2023). Often, village roads become the lifeblood of a village, connecting farmlands, local markets, and community centers. Therefore, the development of road in farm areas is not just about providing physical access but also opening doors to new opportunities that enhance local well-being and sustainability (Aggarwal, 2018).

Farm development worldwide, particularly in the context of basic infrastructure like farm roads, plays a pivotal role in enhancing the quality of life for rural populations. However, in the face of deepening global challenges, the urgency of sustainable development issues has increased. This necessitates research, considering the effects of climate change, environmental concerns, social issues, horizontal challenges, and escalating criminal activities that are gradually undermining existing infrastructure structures (Sangeeta Pal, 2023).

In addressing the question of how to evaluate the sustainability of farm road development for agriculture, researchers are adopting an innovative approach. Several studies have been conducted to support sustainable development as a foundation for environmentally friendly policies and practices. Some of these include the involvement of women in decision-making (Wahyuni et al., 2023), environmental protection for wastewater (Mukwarami & Poll, 2023), prevention and quality improvement of urban slump (Moita et al., 2021) and efforts to preserve the environment, such as forest management activities (Gautam et al., 2021; Paudel & Paudel, 2021). Moreover, building relationship to support sustainable development (Tuwu & Arsyad, 2021), agriculture sustainability (Adeoye et al., 2021; Paudel & Paudel, 2021), environmental management to certified SDG management (Andong et al., 2023) and renewable energy (Serag & Adil, 2021) are integral components of this comprehensive research effort.

Evaluating the construction of farm roads is an important step to ensure their effectiveness in increasing food production and distribution. Sustainability evaluation includes not only economic aspects, but also environmental, social, institutional and law enforcement dimensions. This research aims to measure the impact of farm road development in all aspects of sustainability, creating a holistic understanding. With the construction of farm roads, the main goal is to achieve a sustainable increase in food production. This evaluation provides insight into the extent to which such development supports the achievement of long-term food security goals.

There has been a lot of research on road construction evaluation, as it goes beyond evaluating road construction from the perspective of a single aspect, as previously conducted in studies focusing on the environment (Bella et al., 2019; Edward et al., 2019; Eremina, 2018; Giunta, 2023), social aspects such as schooling decisions, gendered and youth employment (Shimamura et al., 2023), traffic safety (Gaber et al., 2023), and community economy (Wan et al., 2022), accessibility (Nissanka & Gunasekara, 2023), agriculture economy (Lu et al., 2023) industry, trade, tourism, and logistics (Chen et al., 2023; Li et al., 2023; Saidi et al., 2020). Some of the programs that have been evaluated are CRS programs provided by oil and gas companies (Prananta et al., 2023). However, limited research exists on farm road construction, particular farm road development, as conducted by Maritin et al., (2023), specifically related to farm road planning and its connection to the development of ecotourism infrastructure.

This research employs indicators related to sustainable development goals, particularly in the context of village food security. The adoption of SDGs indicators ensures that the evaluation is measurable and relevant to the global development agenda. The evaluation not only covers infrastructure performance but also involves the perspective of local communities. The active participation of the community in this evaluation is considered a key factor to understand the real impacts and ensure sustainable solutions. Building on the aforementioned context, this research delves into the critical significance of prioritizing road development in Farm areas. Elevating road infrastructure in farm settings holds substantial potential for widespread positive outcomes, extending beyond the enhancement of physical mobility. It plays a pivot role in catalyzing

local economic growth and strengthening social bonds within the Farm community. The focus of this research is a comprehensive analysis of the sustainability of road development, considering environmental, social, economic, institutional, and law enforcement factors within the construction site of Woro Farm Road in Kepohbaru Subdistrict, Bojonegoro Regency.

Method

The research was conducted in Woro Village, Kepohbaru Subdistrict, Bojonegoro Regency. Data collection involved both primary data and secondary sources, utilizing questionnaires and literature reviews. The questionnaire focused on of five dimensions of sustainability, representing the pillars of development: environmental, social, economic, institutional, and law enforcement dimensions. Indicators were adapted from the 18 points of SDGs for villages, aligning with the goals of sustainable village development.

The research subjects were the residents of Woro Village, and the number of respondents was determined using the Slovin formula (Andong et al., 2023). With a population coverage of 495 households, the minimum number of respondents obtained was 84. The measurement of environmental, social, economic, institutional, and law variables was conducted using a Likert scale with five levels of assessment. The analysis method employed is inferential analysis using the Structural Equation Modeling - Partial Least Squares (SEM-PLS) analysis technique with SmartPLS 4.0 software. The indicators used for these variables were derived from the 18 points of the Village SDGs (Sustainable Development Goals) listed Table 1.

Table 1. Variable and Indicators of SDG's for Village (Kurniawan et al., 2022)

Variable		Indicator
Environment (X1)	X1_1	Clean water and sanitation
	X1_2	The village residential area is safe and comfortable
	X1_3	Sustainable consumption and production
	X1-4	Responding to climate change
	X1_5	Terrestrial and environmentally friendly ecosystem
Social (X2)	X2_1	No Poverty
	X2_2	No Hunger
	X2_3	Healthy and prosperous village
	X2_4	Quality education
	X2_5	Involvement of women in village
Economy (X3)	X3_1	Clean and renewable energy
	X3_2	Economic growth is even
	X3_3	Industry, innovation and infrastructure4
	X3_4	A village without gaps
Institutional	X4_1	Mutual cooperation in road construction
(adaptive and dynamic culture)	X4_2	Participation of religious leaders in village development
(X4)	X4_3	Preserving village culture, (alms to the earth)
	X4_4	Resolving road conflicts in villages using a cultural approach (compromise)
Law Enforcement	X5_1	Horizontal conflict and crime
(X5)	X5_2	Peace and justice village
	X5_3	Partnership for village development
	X5_4	Availability of internet network in the village
Sustainability of Farm Road	Y1	Support for improvement productivity
Development	Y2	Inclusive and sustainable industrialization
(Y)	Y3	Support economic development

Result and Discussion

Measurement Model Evaluation

The validity of the measurement model is considered satisfactory when it meets the criteria of adequate convergent validity and discriminant validity. Convergent Validity assesses the extent to which all measurement items reflect the measured variable. This quality indicator includes loading factors exceeding 0.70, Composite Reliability above 0.70, Cronbach's Alpha above 0.70, and Average Variance Extracted (AVE) above 0.50 (Hair et al., 2021). In addition, the excellence of the measurement model is assessed through discriminant validity based on the Fornell and Larcker Criterion. According to this criterion, the square root of AVE should be greater than the correlation between variables or dimensions, as presented in Table 2.

Table 2. Measurement Model Evaluation

Variable	Indicator	LF	CA	CR	AVE
(X1)	X1_1	0.847	0.927	0.977	0.771
	X1_2	0.886			
	X1_3	0.902			
	X1-4	0.861			
	X1_5	0.894			
(X2)	X2_1	0.858	0.892	0.894	0.698
	X2_2	0.844			
	X2_3	0.876			
	X2_4	0.823			
	X2_5	0.774			
(X3)	X3_1	0.783	0.827	0.856	0.648
	X3_2	0.842			
	X3_3	0.774			
	X3_4	0.820			
(X4)	X4_1	0.950	0.907	1384,000	0.744
	X4_2	0.747			
	X4_3	0.899			
	X4_4	0.841			
(X5)	X5_1	0.845	0.913	0.955	0.791
	X5_2	0.927			
	X5_3	0.884			
	X5_4	0.900			
(Y)	Y1	0.798	0.775	0.776	0.690
	Y2	0.847			
	Y3	0.846			

Results of loading factor tests above >0.7 indicate that the data show that all indicators contribute and play a crucial role in explaining the variable. According to (Hair et al., 2021) A loading factor value >0.7 indicates that the indicator has a significant contribution to the variable. This implies that the indicators are highly relevant in explaining each variable in this research, encompassing the five pillars of sustainable development, which include Environment, Social, Economic, Institutional, Law Enforcement, and the sustainability of farm road development.

The use of the Fornell-Larcker Criterion involves comparing the √AVE values with other latent variables in the analysis. The main principle is the correlation between √AVE and the same construct should be higher than the correlation with constructs from other variables. This outcome is evident in the diagonal and vertical relationships within the columns of the respective variables, as presented in Table 3.

Table 3. Fornell Larker Criterion

Variable	X1	X2	X3	X4	X5	Y
X1	0.878					
X2	0.427	0.836				
X3	0.188	0.456	0.805			
X4	-0.080	0.416	0.184	0.862		
X5	0.216	0.237	0.302	-0.044	0.889	
Y	0.492	0.680	0.610	0.332	0.361	0.83

Table 3 shows that the √AVE value for the In Table 3, the √AVE value for the Environment variable with the Environment variable itself is 0.878, which is higher compared to the √AVE values for other variables such as Social, Economy, Institutional, Law Enforcement, and the Sustainability of Village Road Development. This is also applicable to the √AVE value for the Social variable, which is 0.863, the √AVE value for the Economy variable, which is 0.805, the √AVE value for the Institutional variable, which is 0.862, the √AVE value for the Law Enforcement variable, which is 0.889, and the √AVE value for the Sustainability of Farm Road Development variable, which is 0.830. The √AVE values indicate diagonal and vertical relationships within the columns of the variables. According to (Hair et al., 2021) in his book states that the main principle of the Fornell-Larcker Criterion is that the correlation between √AVE within the same variable should be higher than the correlation with other variables. The data in Table 3 affirm that the Fornell-Larcker Criterion values for all variables adhere to this principle.

Cross-loading tests are part of the next stage of discriminant validity. Cross-loading tests evaluate the extent to which the indicators used to measure latent

variables have strong correlations or relationships compared to other variables within a research construct (Ghozali, 2014). The results of the cross-loading test are presented in Table 4.

Table 4. Cross Loading

Indicators	X1	X2	X3	X4	X5	Y
X1_1	0.847	0.355	0.029	-0.086	0.113	0.333
X1_2	0.886	0.291	0.165	-0.111	0.179	0.334
X1_3	0.902	0.446	0.229	0.012	0.273	0.590
X1_4	0.861	0.237	-0.006	-0.086	0.058	0.318
X1_5	0.894	0.460	0.305	-0.123	0.241	0.460
X2_1	0.452	0.858	0.324	0.378	0.268	0.604
X2_2	0.308	0.844	0.366	0.272	0.202	0.484
X2_3	0.407	0.876	0.328	0.279	0.171	0.578
X2_4	0.278	0.823	0.413	0.300	0.236	0.541
X2_5	0.320	0.774	0.470	0.483	0.116	0.609
X3_1	0.135	0.225	0.783	0.094	0.181	0.296
X3_2	0.174	0.445	0.842	0.178	0.319	0.562
X3_3	0.265	0.272	0.774	0.035	0.134	0.401
X3_4	0.065	0.437	0.820	0.226	0.282	0.593
X4_1	-0.078	0.470	0.252	0.950	0.037	0.432
X4_2	-0.156	0.050	0.034	0.747	-0.189	0.058
X4_3	-0.094	0.317	0.138	0.899	-0.119	0197
X4_4	0.013	0.305	-0.007	0.841	-0.106	0.136
X5_1	0.214	0.201	0.212	-0.065	0.845	0.232
X5_2	0.293	0.263	0.381	-0.038	0.927	0.410
X5_3	0.115	0.189	0.216	-0.020	0.884	0.296
X5_4	0.118	0.174	0.218	-0.039	0.900	0.301
Y_1	0.414	0.520	0.485	0.280	0.312	0.798
Y_2	0.378	0.544	0.575	0.287	0.383	0.847
Y_3	0.437	0.629	0.457	0.260	0.201	0.846

Table 4 shows that the higher cross loading values on indicators (X1_1 to X1_5) to the Environment variable (X1) compared to other indicators in the research construct. Similarly, indicators (X2_1; X2_2; X2_3; X2_4; and X2_5) on the Social variable (X2) have higher values than the cross-loading values of other indicators on the Social variable. This pattern also holds for cross-loading values on other indicators and variables.

Discriminant validity in a measurement is considered to be met in research if the indicators have higher correlations with the latent variable being measured (Hair et al., 2019). The data from the Fornell-Larcker Criterion and cross-loading test for discriminant validity are satisfied. Through a series of validity tests, including both convergent validity and discriminant validity, all data in this measurement indicate valid results.

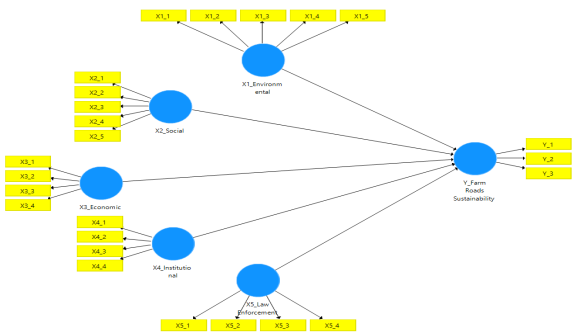

Figure 1. The Diagram of SEM PLS

The assessment of the measurement model's reliability or consistency is done by testing internal reliability with Composite Reliability (CR) and Cronbach's Alpha. Composite reliability and Cronbach's Alpha are useful for assessing the extent to which latent variables are consistent and reliable. Both CR and CA values range from 0 to 1, with higher values indicating better internal reliability (Hair et al., 2019).

In Table 2, the observed high CR values (>0.7) indicate good construct reliability (Hair et al., 2019); Similarly, with Cronbach's Alpha values in the measurement also >0.7, indicating that it meets the standard (Hair et al., 2019).The results of both the Composite Reliability and Cronbach's Alpha reliability tests indicate that the instrument is consistent and reliable, providing consistent results under various conditions.

The results of validity and reliability analyses using the Measurement Model on the outer model above confirm that the data collection instrument used in this research is valid and reliable. These findings indicate that the measurement tool in this research has good consistency and assurance.

Hypotesis Evaluation

The structural model evaluation involves hypothesis testing using the bootstrapping technique, with comparisons made with the t-statistic or pre-determined t-values. The t-test result in bootstrapping

should surpass the critical t-value (one-tailed) equivalent to 1.663 for a 5% significance level or a p-value less than 0.05. The evaluation of variable influences at the structural level is done with f-square, where low influence is indicated by f-square = 0.02, moderate influence by f-square = 0.15, and high influence by f-square = 0.35 (Hair et al., 2019); (Henseler & Sarstedt, 2013). The detailed results of the hypothesis testing are presented in Table 5.

Table 5. Hypotesis Testing and Strcture Model

Influence	Path Coef.	T statistic	P Values	f square	R square	Q square
X1_ -> Y	0.286	3.746	0	0.176	0.66	0.412
X2_ -> Y	0.294	2.517	0.012	0.132		
X3_ -> Y	0.351	3.108	0.002	0.271		
X4_ -> Y	0.174	2.154	0.031	0.065		
X5_ -> Y	0.131	2.393	0.017	0.043		

Based on the description analysis, the hypothesis testing indicates that the path coefficient is >0, meaning each variable has a positive influence on the sustainability of farm road development. The test results also show a P-value <0.05 and a T-statistic value > T-table (1.663), meaning that variables in the development pillars have a significant impact on the sustainability of farm road development. In conclusion, the hypothesis test supports the acceptance of H1, indicating that all five variables representing the five pillars of development positively and significantly influence the sustainability of farm road development.

Structural Model Evaluation

SEM-PLS, as a predictive data analysis method, necessitates testing the developed constructs for the quality of their predictions. Essential test such as R square, Q square, and the Goodness of Fit Index (GoF) are employed for this purpose (Hair et al., 2021; Henseler & Sarstedt, 2013). The R square test in Table 6 indicates that the five pillars of development, consist of Environment, Social, Economy, Institutional, and Law Enforcement, collectively have an influence of 0.66 or 66% on the sustainability of farm road development. The remaining 0.33 or 33% is influenced by other variables not examined in this research. The f-square test reveals the influence of each independent variable on the dependent variable in sequence, starting from the strongest to the weakest: Economy > Environment > Social > Institutional > Law Enforcement. Furthermore, the Q square test, where a value of Q2>0 indicates that exogenous variables have predictive relevance for the variance of endogenous constructs. According to (Hair et al., 2021) Q2>0.35 indicates that the path model has strong predictions and relevance. Table 6 demonstrates that the path model has strong predictive power and relevance, suggesting that the model remains consistent even with the addition of extra variables.

The next evaluation metric is the Goodness of Fit Index (GoF Index), which is an overall evaluation of the measurement and structural model. This index is exclusively calculated from a reflective measurement model, which is the square root of the geometric mean of the average communality multiplied by the average R square (Henseler & Sarstedt, 2013). The GoF is indicated through manual calculation using the formula below (Henseler & Sarstedt, 2013; Sarr & Ba, 2017)

$$GoF = \sqrt{\overline{Com}\ x\ R^2} \quad (1)$$

Table 6. Communalities and Goodness of Fit

Variable	Com	Average Communalities	GoF
X1	0.642	= 3.154 / 6	0.589
X2	0.539	= 0.5256667	
X3	0.411		
X4	0.558		
X5	0.630		
	0.374		
Sum	3.154	0.52566667	

The calculation of the Goodness of Fit (GoF) for this research is 0.589, which falls into the category of large (>0.35). This means that the construct model has a high fit in describing the research sample.

Discussion

Environmental Conditions after the Development of the Farm Road

The environmental conditions after the construction of the village road remain preserved, as evidenced by the availability of clean water. Even during the prolonged dry season in 2024, which is longer than the previous year, the community of Woro Village does not face a shortage of clean water, and there is no threat of drought, eliminating the need for government assistance in providing clean water. Additionally, based on the 2023 profile data of Woro Village, out of 808 families, 695 use village tap water (PAM), and 113 households use well water. It can be concluded that the water needs of the Woro Village community are 100% met. his research aligns with studies conducted by (Eremina, 2018; Giunta, 2023), and meets the criteria outlined in the SDG's Village points. The results of this research demonstrate alignment with the hypothesis that the construction of farm roads has a positive and

significant impact on the environment, emphasizing the need for the sustainable development of village roads.

The residents of Sidonganti Hamlet have gained access to a suitable, safe, affordable, and easily accessible road to reach markets, sub-districts, and other public facilities. The community now has easier access for buying and selling, fulfilling their daily needs. The construction of the village road, carried out through planning, implementation, and supervision processes involving the community, did not compromise the aesthetic aspects of the environment. According to residents, the development of the village road has even enhanced the beauty, tranquility, and serenity of the surrounding environment.

Social Conditions after the Development of the Farm Road.

The social conditions are evident in the changes to community access to basic services, such as the facilitation of buying and selling processes, ease in meeting food needs, and access to healthcare services, resulting in an improved quality of life for the community. Observations indicate an increase in the number of small shops and convenience stores, highlighting that the community finds it easier to fulfill their daily needs. The respondent feedback indicates that with the construction of the village road, the community finds it easier to access the village health post (Poskesdes) to enhance public health. This is evidenced by the increased number of visitors. Significant changes also stem from the emergence of entrepreneurs in the tobacco collection sector, expanding the community's involvement not only in production but also in the buying and selling of tobacco. Gender equality is also significantly impacted by the construction of the road. An example is the increased participation and empowerment of women in the village government sector. In Woro Village, out of the 11 government officials, 2 of them are women, holding the positions of Village Secretary and Planning Staff. These positions are functional roles with high responsibilities. These positive developments align with research conduted by Shimamura et al., (2023) and Wahyuni et al., (2023).

Economy Conditions after the Development of the Farm Road

The economic impact of the farm road construction is apparent in the community's increased income. This is evidenced by the emergence of various businesses, including workshops, stalls, and stores, which in turn creates employment opportunities. The provision of smooth and easy road access allows the community to save on fuel costs, as travel becomes smoother and more unhindered.

Furthermore, the road development significantly facilitates the transportation of agricultural products, such as tobacco. This not only reduces production costs but also increases profit margins, as outlined in research conducted by Wan et al., (2022). The improved economic conditions underscore the positive outcomes resulting from the strategic development of the village road.

The positive and significant economic aspects contributing to the sustainability of road development are also reflected in the decrease in the poverty rate in Woro Village, as indicated by the Regional Poverty Data (Damisda). In 2022, the poverty rate in Woro Village was 118 families, according to the Decree of the Woro Village Head No. 29 of 2022, and experienced a decline in 2023 to 61 families based on the Decree of the Village Head No. 32 of 2023. This positive trend aligns with finding from research conducted by Saidi et al., (2020).

Institutional Conditions after the Development of the Farm Road

This research is in line with studies conducted by This research is in line with studies conducted by Akhyar et al., (2023); Nissanka & Gunasekara, (2023); and Zavratnik et al., (2020) .The research findings align with the hypothesis that the construction of village roads has a positive and significant impact on institutional aspects, emphasizing the need for the sustainable development of Farm roads.

Following the construction of the village road, there has been an observable increase in the contributions of the village government, community elements, and community leaders in various development activities. Many initiatives involving community elements have been undertaken, aligning with research conducted by Masuda et al., (2022); Purnomo et al., (2020); Wan et al., (2022). These collective efforts underscore the positive institutional changes and increased community engagement resulting from the strategic development of the farm road.

Law Enforcement Conditions after the Development of the Farm Road

Woro Village is one of the self-sufficient villages that has internet network access reaching every corner of the village. This is evidenced by one of the villagers, Mr. Ahmad Syafi'i, S.Pd.I, who is an internet network entrepreneur with 580 customers in Woro Village. This shows that the development of Farm roads has a positive impact on the development and progress of the internet network in the village.

The planning, implementation, and supervision of village development also involve all aspects of various fields such as education, health, and the economy. It engages all elements of the community, including community leaders, youth, Village Consultative Body (BPD), and academics, to assess development from all perspectives. This approach helps minimize negative impacts such as conflicts and criminal activities, and the outcomes are documented in official reports approved

by all parties involved. The Village Government is committed to carrying out development fairly and evenly, supported and overseen by the Village Consultative Body (BPD), which represents each region. The implementation team comprises community leaders and representatives from each region, instilling trust in the community regarding the village government's performance, as the planning, execution, and oversight are conducted by the community itself. Notably, the planning, execution, and oversight are conducted by the community itself, aligning with research conducted by (Dai et al., 2023) and Handayani et al., (2023).

In conclusion, the comprehensive evaluation of sustainability consistently indicates that the development of Farm roads is an ongoing and sustainable process. However, it is noteworthy that among the evaluated variables, the institutional aspect receives the lowest sustainability score. This underscores the importance of concerted efforts to enhance and manage institutional aspects to further strengthen the overall sustainability of farm road development.

Conclusion

This research report provides an analyzes of the relationship between the pillars of development, namely Environment, Social, Economy, and Law Enforcement, on the sustainability of farm road development in the Woro Village, Kepohbaru District, Bojonegoro Regency. The findings of the research reveal that the five pillars of development have a positive and significant influence on the sustainability of farm road development. The assessment of these pillars plays a crucial role in determining the quality of infrastructure, the well-being of the community, economic growth, and overall food security. The research underscores that a favorable evaluation across the five pillars contributes to higher-quality infrastructure, improved community welfare, enhanced economic growth, and an overall boost in food security. This highlights the interconnectedness of various development aspects in fostering sustainable farm road development.

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The authors declare no conflict of interest

References

Adamowicz, M. (2020). *The "Smart Village" as a Way to Achieve Sustainable Development in Rural Areas of Poland*. https://doi.org/10.3390/su12166503

Adeoye, A. S., Oke, O. O., & Smart, M. O. (2021). *Relevance of Farmers ' Cultivation of Jatropha Plant for Sustainable Environment in Lagelu Community Oyo State*. *2*(1). https://doi.org/10.47540/ijsei.v2i1.140

Aggarwal, S. (2018). Do rural roads create pathways out of poverty? Evidence from India. *Journal of Development Economics*, *133*, 375–395. https://doi.org/10.1016/j.jdeveco.2018.01.004

Aizen, M. A., Aguiar, S., Biesmeijer, J. C., Garibaldi, L. A., Inouye, D. W., Jung, C., Martins, D. J., Medel, R., Morales, C. L., Ngo, H., Pauw, A., Paxton, R. J., Sáez, A., & Seymour, C. L. (2019). Global agricultural productivity is threatened by increasing pollinator dependence without a parallel increase in crop diversification. *Global Change Biology*, *25*(10), 3516–3527. https://doi.org/10.1111/gcb.14736

Akhyar, Usman, Saifuddin, Sadhana, K., & Musriandi, R. (2023). Freies Ermessen in the Delegation of Authority From District Government To Village Government. *Jurnal Ilmiah Peuradeun*, *11*(2), 615–632. https://doi.org/10.26811/peuradeun.v11i2.851

Andong, F. A., Ossai, N. I., Echude, D., Okoye, C. O., & Igwe, E. E. (2023). Motives, other meat sources and socioeconomic status predict number of consumers with preference for two antelope species served in Enugu-Nigeria. *Global Ecology and Conservation*, *42*(January), e02387. https://doi.org/10.1016/j.gecco.2023.e02387

Arifin, B., Tenrini, R., Wicaksono, E., Rahman, A., Wardhana, I., Setiawan, H., & Damayanti, S. (2020). Labour Standards in the Global Supply Chain: Village Fund and Labour Working Hours in Indonesia Public Policy View project BUM Desa View project Labour Standards in the Global Supply Chain; Village Fund and Labour Working Hours in Indonesia. *Int. J Sup. Chain. Mgt*, *9*(5), 1189–1194. https://doi.org/10.59160/ijscm.v9i5.5610

Arifin, B., Wicaksono, E., Tenrini, R., Wardhana, I. W., Setiawan, H., Sofia, D., Solikin, A., Suhendra, M., Acwin, H., Ariutama, G. A., Djunaedi, P., & Arif, B. R. (2020). Village fund, village-owned-enterprises, and employment: Evidence from Indonesia. *Journal*

of Rural Studies, *79*. https://doi.org/10.1016/j.jrurstud.2020.08.052

Bella, F., Llopis-castelló, D., Camacho-, F. J., Nobili, F., Bella, F., Camacho-, F. J., & Vito, V. (2019). Environmental Effects of Road Geometric and Operational Features Environmental Effects of Road Geometric and Operational Features. *Transportation Research Procedia*, *37*(September 2018), 385–392. https://doi.org/10.1016/j.trpro.2018.12.207

Chaniago, S. (2023). *Ethnoscience of Physics-Math : Calculation of Energy and Wages of Hoeing Farmers in Indonesia*. *9*(11), 9667–9671. https://doi.org/10.29303/jppipa.v9i11.5244

Chen, L., Lu, Y., & Nanayakkara, A. (2023). Rural road connectivity and local economic Activity: Evidence from Sri Lanka's iRoad program. *Transport Policy*, *144*(July), 49–64. https://doi.org/10.1016/j.tranpol.2023.09.022

Dai, Y., Wang, Z., & Huan, M. (2023). Shifts in Governance Modes in Vilage Redevelopment: A case Study of Beijing Lugouqiao Township. *Habitat International*, *135*(March), 102795. https://doi.org/10.1016/j.habitatint.2023.102795

Edward, J., Wennström, P., Bhatterai, A., Joslyn, A., Eriksen, S., Sillmann, J., & Asia, S. (2019). Asking the right questions in adaptation research and practice : Seeing beyond climate impacts in rural Nepal. *Environmental Science and Policy*, *94*(September 2018), 227–236. https://doi.org/10.1016/j.envsci.2019.01.013

Eremina, D. (2018). The impact of transport infrastructure on ecological status of arable land in Western Siberia. *MATEC Web of Conferences*, *170*. https://doi.org/10.1051/matecconf/201817005004

Gaber, M., Diab, A., Othman, A., & Wahaballa, A. M. (2023). *Analysis and Modeling of Rural Roads Traffic Safety Data*. *3*(1). https://doi.org/10.21608/sej.2023.195115.1032

Gautam, S., Timilsina, S., & Shrestha, M. (2021). *The Effects of Forest Management Activities on Genetic Diversity of Forest Trees*. *2*(2), 110–118. https://doi.org/10.47540/ijsei.v2i2.211

Ghozali, I. (2014). *Structural Equation Modeling, Metode Alternatif dengan Partial Least Square (PLS). Edisi 4*. Universitas Diponegoro.

Giunta, M. (2023). Sustainable Practices in Road Constructions: Estimation and Mitigation of Impact on Air Quality. *Transportation Research Procedia*, *69*(Tis 2022), 139–146. https://doi.org/10.1016/j.trpro.2023.02.155

Golovina, S., Smirnova, L., & Ruchkin, A. (2021). Education Is an Important Factor of Human Capital Development in Rural Territories. *E3S Web of Conferences*, *282*. https://doi.org/10.1051/e3sconf/202128208006

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Partial least squares structural equation modeling (PLS-SEM) using R: A workbook. In *Springer Nature*. https://doi.org/10.1080/10705511.2022.2108813

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Handayani, E., Garad, A., Suyadi, A., & Tubastuvi, N. (2023). World Development Sustainability Increasing the performance of village services with good governance and participation. *World Development Sustainability*, *3*(July 2022), 100089. https://doi.org/10.1016/j.wds.2023.100089

Hasanati, S., Rijanta, R., & Pitoyo, A. J. (2023). Rural planning study based on RPJMDes in Jepitu Village, Gunung Kidul Regency, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *1190*(1). https://doi.org/10.1088/1755-1315/1190/1/012034

Hasanuddin, R., Alim, N., & Rahma, N. R. (2023). *Characterization of Endophytic Fungi in Robusta Coffee (Coffea canephora L .) Beans Through 18S rRNA Gene Sequencing and Evaluation of Antioxidant Activity and Chlorogenic Acid Content*. *9*(11), 9964–9972. https://doi.org/10.29303/jppipa.v9i11.5106

Henseler, J., & Sarstedt, M. (2013). Goodness-of-fit indices for partial least squares path modeling. *Computational Statistics*, *28*(2), 565–580. https://doi.org/10.1007/s00180-012-0317-1

Iskandar, M. J., Prasetyowati, R. E., Ningsih, D. H., & Iskandar, M. J. (2022). *Corporate Farming as an Effort to Increase Rice Farming Production in Central Java*. *8*, 124–128. https://doi.org/10.29303/jppipa.v8iSpecialIssue.2469

Kopittke, P. M., Menzies, N. W., Wang, P., Mckenna, B. A., & Lombi, E. (2019). Soil and the intensification of agriculture for global food security. *Environment International*, *132*(May), 105078. https://doi.org/10.1016/j.envint.2019.105078

Kurniawan, E., Amidi, G., Susilowati, N., Paranti, L., & W., D. G. S. (2022). *Buku Panduan UNNES GIAT "Penguatan Generasi Milenial Mendukung SDGs Desa."*

Level, H., Security, F., & Hlpe, N. (2019). *Agroecological and Other Innovative Approaches for sustainable agriculture and food systems that enhance food security and nutrition* (Issue July).

Li, W., Bai, X., Yang, D., & Hou, Y. (2023). Maritime connectivity, transport infrastructure expansion and economic growth: A global perspective. *Transportation Research Part A: Policy and Practice*, *170*(February), 103609. https://doi.org/10.1016/j.tra.2023.103609

Lu, H., Zhao, P., Hu, H., Yan, J., & Chen, X. (2023). Exploring the heterogeneous impact of road infrastructure on rural residents' income: Evidence from nationwide panel data in China. *Transport Policy*, *134*, 155–166. https://doi.org/10.1016/j.tranpol.2023.02.019

Maritin, N. P. I., Parwata, I. W., & Kurniawan, A. (2023). Analisis Model Perencanaan Jalan Usaha Tani Subak Latu Terhadap Perkembangan Infrastruktur Ekowisata: Studi Jalan Usaha Tani Subak Latu Desa Abiansemal Kabupaten Badung. *Jurnal Indonesia Sosial Teknologi*, *4*(02), 148–165. https://doi.org/10.59141/jist.v4i02.559

Masuda, H., Kawakubo, S., Okitasari, M., & Morita, K. (2022). Exploring the role of local governments as intermediaries to facilitate partnerships for the Sustainable Development Goals. *Sustainable Cities and Society*, *82*(September 2021), 103883. https://doi.org/10.1016/j.scs.2022.103883

Moita, S., Tuwu, D., & Darmawan, A. (2021). *Strategy for Prevention and Quality Improvement of Urban Slumps Based on Community Empowerment*. *2*(2), 98–109. https://doi.org/10.47540/ijsei.v2i2.123

Mukwarami, S., & Poll, H. M. Van Der. (2023). *Environmental Management Expenditure and Fiscal Sustainability of South African Urban Municipalities : A Panel Data Model*. *4*(2), 171–183. https://doi.org/10.47540/ijsei.v4i2.942

Munday, M., Reynolds, L., & Roberts, A. (2023). Re-appraising 'in-process' benefits of strategic infrastructure improvements: Capturing the unexpected socio-economic impacts for lagging regions. *Transport Policy*, *134*(February), 119–127. https://doi.org/10.1016/j.tranpol.2023.02.012

Nissanka, L. A., & Gunasekara, K. A. (2023). *Management of social sustainability and quality aspects of rural road construction in Sri Lanka*. *July*, 753–766. https://doi.org/10.31705/WCS.2023.61

Paudel, Y., & Paudel, A. (2021). *Contribution of Forestry in Economy and Employment Generation in Nepal*. *2*(2), 188–195. https://doi.org/10.47540/ijsei.v2i2.270

Pawlak, K. (2020). *The Role of Agriculture in Ensuring Food Security in Developing Countries : Considerations in the Context of the Problem of Sustainable Food Production*. https://doi.org/10.3390/agriculture13112154

Prananta, A. W., Gergorius, A., & Dasion, R. (2023). *Evaluation of the Usefulness of the CSR Program of Oil and Gas Companies in East Kalimantan on the Implementation of Accuracy , Suitability , and Usefulness*. *9*(11), 9679–9686. https://doi.org/10.29303/jppipa.v9i11.5588

Pratiwi, R. K., Mahmudi, M., Faqih, A. R., & Arfiati, D. (2023). *Dynamics of Water Quality for Vannamei Shrimp Cultivation in Intensive Ponds in Coastal Areas*. *9*(10), 8656–8664. https://doi.org/10.29303/jppipa.v9i10.4322

Purnomo, S., Rahayu, E. S., & Riani, A. L. (2020). *Empowerment Model for Sustainable Tourism Village in an Emerging Country*. *7*(2), 261–270. https://doi.org/10.13106/jafeb.2020.vol7.no2.261

Raksun, A., Ilhamdi, M. L., Merta, I. W., Mertha, I. G., & Wirajagat, G. C. (2023). *Analysis of Melon Growth Due to Application of Silver Black Plastic Mulch and Cow Manure Compost*. *9*(11), 10180–10185. https://doi.org/10.29303/jppipa.v9i11.5001

Rudiyanto, A. (2020). Pedoman Teknis Penyusunan Rencana Aksi - Edisi II Tujuan Pembangunan Berkelanjutan/ Sustainable Development Goals (TPB/SDGs). In *Kementerian PPN*.

Saidi, S., Mani, V., Mefteh, H., Shahbaz, M., & Akhtar, P. (2020). Dynamic linkages between transport, logistics, foreign direct Investment, and economic growth: Empirical evidence from developing countries. *Transportation Research Part A: Policy and Practice*, *141*, 277–293.https://doi.org/10.1016/j.tra.2020.09.020

Sangeeta Pal, P. (Dr. . S. K. C. (2023). A Review On India's Rural Development And Agricultural Infrastructure. In *Journal of Pharmaceutical Negative Results* (Vol. 14, Issue 1). https://doi.org/10.47750/pnr.2023.14.s01.92

Sarr, F., & Ba, M. (2017). The Capability Approach and Evaluation of the Well-Being in Senegal: An Operationalization with the Structural Equations Models. *Modern Economy*, *08*(01), 90–110. https://doi.org/10.4236/me.2017.81007

Serag, S., & Adil, E. (2021). *Environmental Physics Study of Natural Renewable Energy Resources in*. *2*(1). https://doi.org/10.47540/ijsei.v2i1.178

Sewell, S. J., Desai, S. A., Mutsaa, E., & Lottering, R. T. (2019). A comparative study of community perceptions regarding the role of roads as a poverty alleviation strategy in rural areas. *Journal of Rural Studies*, *Volume 71*, 73–84. https://doi.org/10.1016/j.jrurstud.2019.09.001

Shimamura, Y., Shimizutani, S., Yamada, E., & Yamada, H. (2023). The Gendered Impact of Rural Road Improvement on Schooling Decisions and Youth Employment in Morocco The Gendered Impact of Rural Road Improvement on Schooling Decisions and Youth Employment in Morocco. *The Journal of Development Studies*, *59*(3), 413–429. https://doi.org/10.1080/00220388.2022.2139608

Tuwu, D., & Arsyad, M. (2021). *Farmer Adaptation Strategy to Their Environment in the Village of Makoro Binongko Wakatobi*. *2*(1). https://doi.org/10.47540/ijsei.v2i1.66

Wahyuni, S., Syafitri, R., Niko, N., & Ahsan, Z. R. (2023). *Affirmation of Traditional Rights and Indigenous Women ' s Knowledge on Post-Mining Livelihood in Dompak Island , Riau Islands*. *4*(2), 133–141. https://doi.org/10.47540/ijsei.v4i2.940

Wan, G., Wang, X., Zhang, R., & Zhang, X. (2022). The impact of road infrastructure on economic circulation: Market expansion and input cost saving. *Economic Modelling*, *Volume 112*(105854), 112. https://doi.org/10.1016/j.econmod.2022.105854

Zavratnik, V., Podjed, D., Trilar, J., Hlebec, N., & Kos, A. (2020). *Sustainable and Community-Centred Development of Smart Cities and Villages*. 1–17. https://doi.org/10.3390/su12103961

Zul, A., Zaini, A., Vonnisa, M., Marzuki, M., & Ramadhan, R. (2023). *Seasonal Variation of Rainfall in Indonesia under Normal Conditions without ENSO and IOD Events from 1981-2021*. *9*(11), 9899–9909. https://doi.org/10.29303/jppipa.v9i11.4569