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The Effect of Village Assistance, Income, and Labor Skills on the Productivity of Village Communities (Case Study of Bumdesa Pamekasan Regency)

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Abstract:

This study aims to analyze and examine the efficiency of productivity at the village level, which is influenced by village assistance, community income, and workforce skills in Pamekasan Regency. Although the region has a relatively high Human Development Index (HDI), it is not accompanied by an increase in per capita GRDP, indicating that productivity efficiency remains suboptimal. Survey findings show that most village communities in Pamekasan produce outputs below their optimal potential. This research offers a comprehensive approach by integrating three key variables village assistance, income, and labor skills into a single case study. A non-parametric deterministic frontier method was employed using Data Envelopment Analysis (DEA) with STATA 14. The results show that some Decision Making Units (DMUs) achieved full efficiency under constant returns to scale (CRS), while others remained inefficient under decreasing returns to scale (DRS). The study concludes that village assistance, community income, and workforce skills significantly influence the productivity efficiency of rural communities. Most villages affiliated with BUMDes have shown the ability to manage their resources efficiently to support community productivity.

Keywords: *Village Assistance, Community Income, Workforce Skills, Productivity Efficiency*

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1. Introduction

Efficiency is fundamentally linked to the relationship between input and output. It refers to achieving the highest possible output with a given input or accomplishing a desired output using the least amount of input (Kao, 2023). In the context of rural development, efficiency in village productivity is crucial for improving the welfare of rural communities (Ritonga et al. 2021). Villages serve not only as administrative units but also as centers of economic and social activities. Therefore, they are expected to optimize both natural and human resources to produce tangible outputs through agriculture, livestock, household industries, and micro-enterprises (Husna & Annisha,

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2024). Efficient use of these resources can drive villages toward economic self-reliance and sustainable development (Asnidar et al. 2024).

Efficiency in rural productivity supports not only local community development but also contributes to broader national productivity. According to (Sembiring et al. 2022), increasing productivity at the village level can enhance national economic growth and achieve inclusive development targets. Productivity, as defined by Handoko (2012), is the ratio between output and input in a production system. In principle, this relationship can typically be quantified as the ratio of output to input (Noor et al. 2023). Productivity increases when a greater number of outputs is generated with an equivalent quantity of inputs. Likewise, a reduction in inputs while maintaining output levels leads to an increase in productivity (Widodo, 2024). Inputs may encompass production expenses and equipment expenditures. Output may encompass sales, earnings, and market share (Noor et al. 2023). Therefore, improving productivity is a strategic priority to achieve sustainable economic progress.

High national productivity contributes to international competitiveness and directly impacts economic growth and community welfare. This applies equally to rural areas, where villages act as foundational economic units. With the support of agriculture, household industries, and micro, small, and medium enterprises (MSMEs), villages are vital for sustaining the national economy. Enhancing productivity and efficiency at the village level, thus, becomes a pivotal effort toward achieving Indonesia's long-term development goals (Rofiah et al. 2024).

However, high productivity levels alone are not sufficient without efficiency. Productive efficiency refers to the ability of an economic unit to allocate and utilize resources optimally to produce maximum output. In village contexts, this translates into effective management of village funds, labor, and other resources to improve residents' welfare while minimizing inefficiencies (Shaban et al. 2017). Despite large allocations of village funds and human capital investments, many villages in Indonesia still struggle with inefficient resource use due to a lack of skilled labor, poor governance, and weak institutional capacity (Sopanah et al. 2023). These inefficiencies lead to slow progress in rural development and continued dependency on external financial support.

Indonesia's productivity level remains comparatively low relative to other nations in the Southeast Asian region. One indicator is Indonesia's total factor productivity (TFP) index, which assesses the impact of efficiency and innovation on economic growth and is lower than that of other Southeast Asian nations. According to the 2024 Asian Productivity Databook, Indonesia's Total Factor Productivity (TFP) index for 2022 is 1.05 percent. Within ASEAN, Indonesia ranks only above Myanmar. Indonesia's productivity significantly lags behind Singapore at 1.63 percent and Vietnam at 1.17 percent.

Based on *the Penn World Table* 10.0 which measures human resource capacity through the *Human Capital Index*, Indonesia is also the lowest in the ASEAN

environment and even the only one to experience a decline since 2010. Judging from the large rate of labor growth in Indonesia in 2012-2023, it can be seen in the following figure 1.

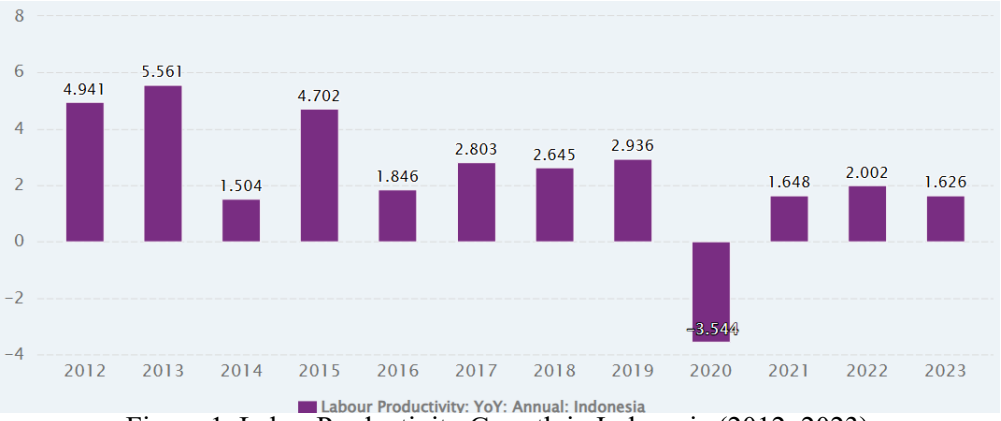

Figure 1. Labor Productivity Growth in Indonesia (2012–2023)
Source: CEIC Data, 2023

Based on figure 1. shows that the labor force growth rate in Indonesia in 2012-2023 fluctuates every year. The highest labor growth rate in 2012-2023 occurred in 2013 at 5,561, then decreased to 1,504 in 2014, in 2019 there was an increase of 2,935. However, it decreased again in 2023 to 1,626. The combination of declining human resource capabilities, low investment in technology and innovation leads to the contribution of negative TFP growth to economic growth.

Based on the explanation of *the Total Factor Productivity (TFP) index* data, Indonesia's productivity level is still relatively low when compared to other countries in the Asian region, this condition has implications for the level of productivity efficiency in rural areas. Including villages in Pamekasan Regency. According to Research (Zen & Budiasih, 2018) The efficiency of village productivity in Indonesia is still at a low level.

The urgency of this research lies in the fact that many villages in Indonesia have abundant natural resource potential, labor, and village funds, however, this potential has not been utilized optimally. Instead of a growth driver, these resources are often mismanaged due to limited institutional capacity and ineffective planning. Inefficiencies in the use of these resources have an impact on the low level of village economic independence, which hinders efforts to achieve sustainable village development.

In Indonesia, there are still areas with a low Human Development Index (HDI), including in East Java Province. Based on the Central Statistics Agency (BPS), East Java is ranked 21st and is low from the national average of 74.39. East Java itself faces HDI inequality between regions, where some regions have lower HDI values compared to the provincial average. One of the areas with HDI that is still laggard is

Pamekasan Regency. The district shows a lower HDI rate compared to the index value of East Java Province, reflecting significant challenges in human development. The development of HDI in Pamekasan Regency during the 2014-2023 period can be seen in the following Figure 2:

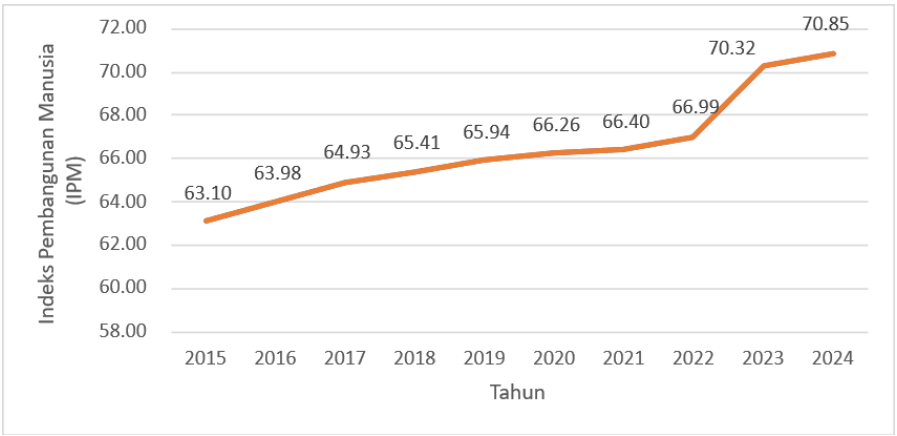

Figure 2. Human Development Index (HDI) Graph of Pamekasan Regency 2015-2024
Source: Central Statistics Agency of East Java, 2023

Figure 3. Graph of the amount of GDP per capita in Pamekasan Regency and East Java Province, 2015-2024
Source: Central Statistics Agency of East Java

Based on the graph in figure 1.2, it shows that the Human Development Index (HDI) in Pamekasan Regency shows a significant increase trend during the period 2015-2024. In 2024, the HDI value of Pamekasan Regency will reach a value of 70.85, which reflects progress in aspects of education, health, and people's living standards. However, this increase in HDI is not accompanied by optimal economic growth, as reflected by the low Gross Regional Domestic Product (GDP) per capita in this region.

Based on the data in Figure 1.3 which shows the development of GDP per capita in Pamekasan Regency and East Java Province during the period 2015–2024, it can be seen that Pamekasan Regency consistently has a GDP per capita value that is much lower than the provincial average. Throughout that period, the distance between the two did not show a significant narrowing. In 2024, the per capita GDP of Pamekasan Regency will be recorded at 14,971.5 thousand rupiah, while East Java Province will reach a much higher figure of 46,295.2, showing economic inequality between regions. Despite the upward trend from year to year, the economic growth rate in Pamekasan is still far behind the provincial average, which reflects the need for a strategy to accelerate economic development in this region.

The results of the survey show that the efficiency of village productivity in Pamekasan Regency also experienced the same thing. The phenomenon is that the village community in Pamekasan Regency mostly takes less than 7 hours to complete the main work. This is shown based on the results of a questionnaire from 82 respondents, 50 people stated that the time it takes to complete the main job every day is less than 7 hours. However, on the other hand, the results of the output of the village community in Pamekasan Regency show that it is dominantly less than the optimal output that should be produced. This is reflected in the results of the low district GDP per capita which is not in line with the high HDI level which can indicate a lack of optimal productivity efficiency (Foerster et al. 2020).

The inequality between the increase in HDI and the stagnation of economic growth indicates that there is a problem in productivity efficiency in Pamekasan Regency. This means that even though the quality of life of the community in the aspects of education and health has improved, and most of the village people in Pamekasan Regency complete their work every day with less than 7 hours. However, the results of the weekly output of the village community in Pamekasan Regency show that it is dominantly less than the optimal output that should be produced. This does not automatically improve the economic welfare of the community.

Village-Owned Enterprises (BUMDes) play a strategic role as a driving force for the local economy designed to increase the productivity efficiency of village communities through the use of local potential collectively and institutionally. BUMDes has great potential in encouraging the processing of superior village products, providing access to capital sources, expanding distribution and marketing networks, and involving the wider community, so that the village community in Pamekasan Regency can be an example for other villages in utilizing BUMDes as a driving force for local economic development (Annisa & Indah, 2024).

There are several internal and external factors that affect the level of village productivity efficiency. These internal and external factors include: 1). Very little product processing, 2). Limited capital, 3). Ineffective marketing 4). Institutional and production continuity development is inefficient, as well as 5). Lack of assistance for human resource development. 6). Economic Structure Dominated by Low

Productivity Sectors. 7). Lack of Investment and Technological Innovation. 8). Lack of Connectivity and Market Access which leads to low productivity efficiency.

The underdevelopment of these problems requires an increase in human and institutional resources through village communities to solve problems to increase productivity efficiency in Pamekasan Regency. Improvement efforts involve several steps, such as providing access to formal and non-formal education, health, skills training and income. With quality education, individuals can gain broader knowledge, improve critical thinking skills, and understand changes that occur in the social and economic environment (Borbalan & Claude, 2023).

According to research (Rokhmat et al. 2020), (Басовская et al. 2019) dan (Mayrica Efrianty & Putri Dhian Riskiana, 2022) The efficiency of community productivity can be influenced by, village assistance, income, and labor skills. Village assistance is a supply from the government as a means of support and also an impus for development in a village, where the assistance is used as a community facility in developing and advancing their productivity.

The factor that affects the next increase in productivity efficiency is Community Income. According to Shapiro & Stiglitz (1994) Higher wage rates will encourage increased productivity (Sari & Oktora, 2021). Income, as a result of work activities, is one of the important elements expected by every individual, especially those who work in local institutions such as Village-Owned Enterprises (BUMDes) or their own businesses affiliated with BUMDes.

The income obtained from this job is then used to meet their daily needs for clothing, food, and board to increase their work productivity (Rahman, 2013). BUMDes, as village economic institutions, plays an important role in the independent management of natural and human resources owned by villages. Through this processing, BUMDes increase community income (Enda, 2018).

According to Gomes (2003) Describe that productivity is also greatly influenced by the Skills factor (Anggapraja, 2016). Productivity can be achieved if the workforce has work skills that can be applied in doing their daily work (Nurhasanah, 2019). The skills of BUMDes workers play an important role in increasing productivity efficiency in villages. Without adequate skills, it is difficult for people to manage businesses, adopt new technologies, or even make good use of BUMDes.

Previous studies have limited to examining the impact of Village Assistance, Income, and Labor Skills on the Productivity Efficiency of Village Communities. Previous research has focused on one or two factors that affect village productivity, such as village funds or community income, without paying attention to village assistance and manpower skills, such as research from (Masita dan Idialis, 2024). The limitations of this study have not been found that specifically discuss productivity efficiency at the village level. Some studies, such as those conducted by Kasmita et al (2021) shows that budget allocation accompanied by institutional support of farmers is able to

increase village agricultural productivity. Meanwhile, Liani et al. (2024) found that the Village Fund was effective in improving the welfare of the community if accompanied by the active participation of residents.

However, these studies still tend to focus on one or two variables separately, such as the influence of the Village Fund on income or welfare, without thoroughly integrating other factors that also affect the productivity efficiency of rural communities, such as village assistance and labor skills. This shows that there is an important research gap to fill, considering that village productivity efficiency has a strategic role in encouraging economic independence in rural areas. This study offers a more holistic approach by integrating three main variables (village assistance, community income, and workforce skills) in a single study. This study uses a quantitative statistical test tool, namely using *Data Envelopment Analysis (DEA) of* quantitative data. Based on the research background, the purpose of this study is to analyze and test the efficiency of productivity at the village level which is indicated to be influenced by Village Assistance, Income, and Labor Skills in Pamekasan Regency.

2. Theoretical Background

Efficiency theory is closely related to consumption theory and production theory in microeconomics. Efficiency in consumption theory is where consumers have the ability to maximize the utility or satisfaction that will be fulfilled. Meanwhile, in production theory, which is where a company can produce the maximum pumpkin for the products carried out.

In conventional literature, production theory will describe the treatment of companies in buying and using inputs for production and selling outputs in the form of products produced. That way, in production theory, the company's ability to maximize profits and optimize its efficiency will be seen. Efficiency will be optimal if the company can maximize output by using fixed inputs or by minimizing the use of inputs to achieve the same level of output.

The concept of efficiency is an important part of the analysis of economic efficiency and productivity. According to Farrel (1957), Technical efficiency refers to the ability of a Decision Making Unit (DMU) to produce the maximum output from a certain number of inputs. If a unit is not in an efficiency position, then there is a waste in the use of inputs or output potential that has not been maximized.

According to Coelli (2005) Efficiency is something that is measured with two approaches, namely an output-oriented approach and an input-oriented approach. An output-oriented approach is where an entity will maximize its profits. The proportion of output to be produced is increased but still using the same level of input. While in the input-oriented approach, that is, where the entity will reduce the level of the proportion of inputs to produce output at the same level.

Sukartawi (1990) explained that efficiency occurs when a business is able to use the smallest possible inputs to obtain the maximum production results. In this case, the greater the ratio between outputs to inputs, the higher the efficiency level. Efficiency also reflects the level of effectiveness in the production process as well as the management of available resources.

Lovell (1993) states that efficiency is a component of productivity seen from the comparison between actual conditions and optimal conditions in the use of inputs. In this case, productivity is not only determined by the amount of output produced, but also by how the inputs are efficiently utilized to produce those outputs.

In simple terms, efficiency is a comparison between the output produced and the input used. A company or organization can be said to be efficient if the company or organization can produce a greater output by using a certain input, produce the same output with lower inputs than it should, produce a greater production from the use of its resources or the latter can achieve the result at the lowest possible cost. There are three variables to assess the efficiency of a job, namely input, output and efficiency standards.

In this study, efficiency theory is used to measure how optimal Village-Owned Enterprises (BUMDes) are in managing inputs such as village assistance, community income, and workforce skills to produce outputs in the form of productivity of village communities. Although this theory is widely used in the context of small industries or agriculture, its basic principles remain relevant because BUMDes are also productive economic institutions that carry out production functions (Hailudin. 2021)

The Effect of Village Assistance on Productivity Efficiency
Mukhlis (2024) stated that the use of village assistance funds, especially for infrastructure development, is the main strategy to increase community productivity more efficiently. Infrastructure such as village roads, irrigation canals, bridges, local markets, and other economic facilities are essential for creating an environment conducive to production and distribution activities in rural areas.
In addition, irrigation infrastructure financed through village assistance has been shown to increase the frequency of planting and crop yields, as stated by Mukhlis (2024). Proper irrigation increases water use and planting schedules, directly increasing agricultural yields.

Overall, development-focused village assistance makes a tangible contribution to improving productivity efficiency, especially when its implementation is targeted, participatory, and sustainable.

The Effect of Community Income on Productivity Efficiency
Haryanto (2021) In his research, it was shown that the increase in income in the village was positively correlated with the increase in productivity efficiency. A study published in "Dynamics of Rural Labor Productivity" found that land tenure and income from agricultural activities have a real and positive effect on agricultural labor

productivity in all types of villages. This shows that increasing community income can increase village productivity efficiency (Kamuli et al. 2023).

According to the theory of productivity efficiency, efficiency occurs when inputs (resources) are used to produce maximum output with minimal waste. Higher incomes give people access to productive inputs, such as modern agricultural equipment, quality raw materials, and additional training.

Research by Wang et al (2024) confirms that adequate income from agricultural products has a direct impact on the ability of rural communities to maintain and increase productivity efficiently.

The Effect of Labor Skills on Productivity Efficiency
Jie & Chindarkar (2017) proves that improving the skills of rural communities through training leads to a significant increase in job readiness and economic outcomes.

Pramono (2020) asserts that skill training in productive sectors such as agriculture, crafts, and resource processing significantly contributes to productivity improvements in Indonesian villages. A study published in *Labor Productivity Analysis* confirms that high labor productivity indicates efficient use of production factors in farming activities. This underscores the role of enhanced labor skills in supporting productivity efficiency.

3. Methodology

The location of this research is a village in Pamekasan Regency, East Java. The choice of the location is because villages in Pamekasan Regency have Bumdes that have active status and legal entities, as well as various levels of productivity that can be analyzed.

The population in this study consists of villages that have active Village-Owned Enterprises (BUMDes) located in Pamekasan Regency. The villages that are the focus of this research are Pademawu, Pamekasan, Proppo, Palengaan, Larangan, Galis, Pasean, Kadur, Waru, Pakong, Batu Marmar, Pegantenan, and Tlanakan which will be the object of research. To determine the research sample, *the purposive sampling technique is used* in this study, namely sampling techniques based on certain considerations that are relevant to the research objectives. In this case, the sample consists of individuals who are directly involved in the activities of Village-Owned Enterprises (BUMDes), including BUMDes managers, BUMDes members, and partners involved in the management or business cooperation with BUMDes. Using this approach, as many as 82 respondents were obtained who were considered to be able to provide relevant and in-depth information related to the productivity efficiency of village communities through the management of BUMDes.

The data collected in this study came from two types of sources, namely primary data and secondary data. Primary data were collected through surveys conducted with

structured questionnaires with likert scale measurements of 0-4. This questionnaire is given to village communities who receive village assistance programs and contribute to active Village-Owned Enterprises (BUMDes). Secondary data is taken from various official reports and related documents, such as the Village Community Empowerment Office (DPMD) and report by the Central Statistics Agency (BPS).

An operational definition is a guide to how a variable is measured, Village Assistance: Indicators of measuring village assistance for individuals are measured based on the recipient's perception and experience of the effectiveness of the use of village funds used to achieve the goals that have been set, and indicators of the allocation of village funds for various programs at the village level such as infrastructure development, as well as accessibility, relevance, transparency, fairness, and the impact of assistance on individual welfare and productivity.

Community Income: The indicators used to measure community income from BUMDes include the total income received by the community from various business units run by BUMDes, as well as the average per capita income calculated by dividing the total monthly income from BUMDes by the number of households involved.

Labor Skills: Labor skills are measured through skills training, post-training upskilling, participating in training programs in the village, as well as the types of skills possessed by those working in the productive sectors of the village.
Productivity Efficiency: Productivity efficiency is measured from the ratio of output to inputs in village economic activities, such as crop yield per hectare, SME production.

The analysis method used in this study is a deterministic non-parametric frontier with DEA aimed at measuring the productivity efficiency of village communities in Pamekasan Regency. The efficiency value with the Data Envelopment Analysis method was calculated using the DEA STATA 14.0 application.

This research is a type of qualitative research whose results are transformed into a quantitative approach with a nonparametric approach of Data Envelopment Analysis (DEA).

Efficiency measurement method with DEA, DEA is a mathematical programming technique based on linear programming that is used to evaluate the efficiency of a decision-making unit (work unit) that is responsible for using a number of inputs to obtain a targeted output (Savira & Abdullah, 2019). DEA was first introduced by Charnes, Cooper, and Rhodes in 1978. The DEA method was created as a tool to evaluate the performance of an activity in an entity unit (organization) hereinafter referred to as a Decision Making Unit (DMU) (Savira & Abdullah, 2019).

DEA is a non-parametic approach chosen in this study. Non-parametric was chosen for several reasons, because the model did not specify certain conditions, namely the population parameters that were the parent of the research sample (Wijayanti et al.

2021). In DEA, the relative efficiency of the DMU is defined as the ratio of the total weighted output divided by the total weighted output (total weighted output/total weighted input) (Kreuta et al. 2016).

The essence of DEA is to determine weights or scales for each input and output of the DMU. The weights have the following properties: (1) not negative, and (2) universal, meaning that each DMU in the sample must be able to use the same set of weights to evaluate its ratio (total weighted output/total weighted input) and the ratio must not exceed 1 (total weighted output/total weighted input <1) (Lumban, 2017). There are various different typologies of DEA approaches based on constant return to scale analysis or variable ratio to scale analysis, as well as based on input oriented or output oriented analysis.

The stages in measuring the efficiency value in the DEA method are as follows: 1. Selecting a DMU (decision making unit). 2. Identify the Variables used 3. Decision Making Unit (DMU) Classification 4. Grouping and Recapitulation of Inputs and Outputs 5. After determining the DMU and knowing the inputs to determine the efficiency value, input these numbers into the STATA 14 6. application the determination of DMU is efficient and inefficient.

The stages of testing and processing the input-output data are as follows: 1. Calculation of the relative efficiency of the DMU, the calculation of the relative efficiency is calculated with the mathematical DEA model based on the variable return to scale output-oriented. 2. Efficient and inefficient calculation of DMU efficiency scale, it is a measurement of the efficiency index that is a reference considering that if the DMU unit does not run optimally on a production scale and can reduce or minimize errors in the calculation of technical efficiency from the constant calculation of return to scale and variable return to scale due to DMU running in optimal conditions. 3. The result of the efficiency value distribution, the approach with DEA variable return to scale assumes that when the ratio is added to the input and the output is not always the same.

According to research Rusydiana & Hasib (2020) DEA has the following advantages: There is no need to look for the assumption of the form of relationship between input and output variables of the same DMU whose efficiency will be measured. According to research (Rustyani & Rosyidi (2019) Shortcomings to be noted of the DEA method include: DEA is a non-parametric technique, so systemic hypothesis testing is not easy to do.

This study uses the DEA VRS model with an output-oriented approach, where the output-oriented model aims to ensure that the input remains constant while the output increases (Ibrahim et al. 2019). This method uses the Variable Returns to Scale (VRS) approach, which allows for a more flexible analysis because it takes into account conditions where the relationship between input and output is not always fixed or proportional. In this study, the method used to measure technical efficiency is Data Envelopment Analysis (DEA) with an output-oriented Variable Returns to Scale

(VRS) approach. This model is known as the BCC (Banker, Charnes, and Cooper) model, which allows for a change in scale in the production process (Pamungkas et al. 2016). DEA is a non-parametric method used to evaluate the relative efficiency of the Decision Making Unit (DMU), in this case the individual who is the research respondent (Widiyana & Indiyanto, 2017).

The DEA BCC (VRS) model was chosen because it accommodates the variation in the scale of effort that may occur in each individual. In the context of this study, individuals have different levels of income, labor skills, and utilization of village assistance, so the assumption of Constant Returns to Scale (CRS) is not appropriate. Therefore, the BCC (VRS) model is more appropriate to measure technical efficiency, because it can capture increasing, constant, or decreasing returns to scale in individual productivity. Mathematically, the output-oriented DEA BCC model aims to determine the level of technical efficiency by maximizing output without increasing the number of inputs used (Ibrahim et al. 2019). The model is formulated as follows:

$$\max \theta$$

subject to:

$$\sum_{j=1}^{n} \lambda_j \, Xij \leq x_{io}, \qquad \forall i \quad \ldots\ldots\ldots\ldots\ldots 1)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq \theta Y_{ro}, \qquad \forall r \ldots\ldots\ldots\ldots\ldots 2)$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0, \quad \forall j$$

In the model, θ is an individual's technical efficiency score, where the θ = 1 indicates that the individual has reached the optimal level of efficiency (no longer an increase in output is possible with the same input), while the value of the θ > 1 indicates that individuals still have inefficiencies and can still increase their output in proportion to the available inputs. Variabel Xij represents the inputs used by individuals to-j, namely village assistance, community income, and workforce skills, while Yr_j is the output produced, namely the efficiency of village productivity. Parameter λ_j shows the weight given to each individual in the formation of the frontier of efficiency, while the constraints of $\sum \lambda j = 1$ ensure that the model follows the assumption of Variable Returns to Scale (VRS).

Using the output-oriented DEA BCC model, this study can identify individuals who have achieved technical efficiency in producing output optimally with the inputs

available, as well as provide recommendations for individuals who still have the potential to increase their productivity.

4. Empirical Findings/Result

In this study, uses the Data Envelopment Analysis (DEA) method with the Variable Returns to Scale (VRS) approach to calculate the relative efficiency of each Decision Making Unit (DMU). This approach was chosen because it is able to capture pure technical efficiency without requiring a fixed scale of results, so that it is in accordance with the conditions of the village community in Pamekasan Regency.

This research is focused on output orientation, which aims to maximize the productivity produced by rural communities. This approach is considered more relevant because the research aims to improve productivity outcomes without reducing inputs such as village assistance, community income, or workforce skills that have already been allocated. On the other hand, the orientation of inputs that reduce resources is considered inappropriate, because the inputs in this study are the main factors that support the empowerment of rural communities.

Thus, the output orientation is chosen to identify the potential for optimizing results that can be achieved by the village community, especially in terms of productivity efficiency. Through this calculation, the results will show efficient Decision Making Units (DMUs) (with an efficiency score of 1) and provide an overview of inefficient Decision Making Units (DMUs), so that improvement measures can be found to increase their productivity. Based on the results of data processing using DEA STATA 14.0 software with the VRS (Variable Return to Scale) model, the following values were produced:

Table 1
Efficiency Calculation Results Based on the DEA Method

Skala	Decision Making Unit (DMU)	Total DMU	Persentase (%)
Nilai Efisiensi (1,00)	DMU 1, DMU 2, DMU 3, DMU 5, DMU 6, DMU 7, DMU 11, DMU 12, DMU 13, DMU 14, DMU 15, DMU 19, DMU 20, DMU 21, DMU 23, DMU 24, DMU 25, DMU 30, DMU 31, DMU 32, DMU 33, DMU 34, DMU 35, DMU 36, DMU 37, DMU 38, DMU 39, DMU 40, DMU 41, DMU 42, DMU 43, DMU 44, DMU, DMU 46, DMU 47, DMU 48, DMU 49, DMU 51, DMU 52, DMU 53, DMU 54, DMU 55, DMU 56, DMU 57, DMU 58, DMU 59, DMU 60, DMU 61, DMU 62, DMU 63, DMU 64, DMU 65, DMU 66, DMU 67, DMU 68, DMU 69,	64 DMU	78%

Skala	Decision Making Unit (DMU)	Total DMU	Persentase (%)
	DMU 70, DNU 71, DMU 72, DMU 73. DMU 74, DMU 75, DMU 76, DMU 77, DMU 82		
Nilai Efisiensi (< 1,00)	DMU 4, DMU 8, DMU 9, DMU 10, DMU 16, DMU 17, DMU 18, DMU 22, DMU 26, DMU 27, DMU 28, DMU 29, DMU 50, DMU 78, DMU 79, DMU 80, DMU 81	18 DMU	22%
Total	82 DMU		100%

Source: Primary Data, 2024 (processed)

It can be seen in table 1. that the relative efficiency results calculated through the Data Envelopment Analysis (DEA) approach, obtained a total of 64 DMUs, some Decision Making Units (DMUs) show a maximum efficiency level, which is 1.00, which means that the units have operated efficiently compared to other units in the sample.

The results of Return to Scale (RTS) in this study are divided into two main categories, namely Decreasing Return to Scale (DRS) with a value of (-1) and Constant Return to Scale (CRS) with a value of (0). The DRS category indicates that the increase in inputs does not result in comparable outputs, whereas CRS indicates a balance between input and output. The Decision Making Unit (DMU) which has a relative efficiency value of 1.00 is as follows:

DMU 1, DMU 2, DMU 3, DMU 5, DMU 6, DMU 7, DMU 11, DMU 12, DMU 13, DMU 14, DMU 15, DMU 19, DMU 20, DMU 21, DMU 23, DMU 24, DMU 25, DMU 30, DMU 31, DMU 32, DMU 33, DMU 34, DMU 35, DMU 36, DMU 37, DMU 38, DMU 39, DMU 40, DMU 41, DMU 42, DMU 43, DMU 44, DMU, DMU 46, DMU 47, DMU 48, DMU 49, DMU 51, DMU 52, DMU 53, DMU 54, DMU 55, DMU 56, DMU 57, DMU 58, DMU 59, DMU 60, DMU 61, DMU 62, DMU 63, DMU 64, DMU 65, DMU 66, DMU 67, DMU 68, DMU 69, DMU 70, DMU 71, DMU 72, DMU 73, DMU 74, DMU 75, DMU 76, DMU 77, and DMU 82 the relative efficiency value is 1.00.

Meanwhile, a total of 18 DMUs had a relative efficiency score of less than 1.00 (<1.00), indicating that these units are still inefficient and have the potential to improve performance by maximizing output or minimizing input. The DMUs in this category are:
DMU 4, DMU 8, DMU 9, DMU 10, DMU 16, DMU 17, DMU 18, DMU 22, DMU 26, DMU 27, DMU 28, DMU 29, DMU 50, DMU 78, DMU 79, DMU 80, and DMU 81.

Scale Efficiency

Scale Efficiency (SE) is an efficiency index used to reduce errors in the calculation of technical efficiency from constant and variable return to scale caused by DMUs not operating under optimal conditions. SE accounts for whether a DMU is operating at an optimal production scale. The ratio of constant returns to scale technical efficiency to variable returns to scale technical efficiency is known as scale efficiency.

Based on data processing shown in Table 1, it is known that 64 out of 82 DMUs (78.05%) are scale efficient. This means that the majority of DMUs in this study are operating at an optimal production scale. Technically, 56 DMUs or 68.29% are already efficient. The remaining 26 DMUs have efficiency scores above 60%, which, although not fully efficient, indicate relatively high potential for improvement.

These findings indicate that most DMUs are not only technically efficient but are also operating at the correct scale. This is important because low scale efficiency can mask good technical performance, and vice versa. Therefore, analyzing scale efficiency provides a more comprehensive picture of the sources of inefficiency and the potential for productivity improvement.

Table 2. DMU Efficiency Distribution

Asumption	100%	80% - 99,9%	60% - 79,9%	40% - 59,9%	0 – 39,9%
CRS	39	-	43	-	-
VRS	56	-	26	-	-
SKALA	64	-	18	-	-

Source: Primary Data, 2024 (processed)

Based on Table 2, the results of the DMU efficiency distribution using the DEA approach with the Variable Return to Scale (VRS) assumption show that 56 DMUs or 68% are fully efficient (score = 1.000000). This indicates that most decision-making units have optimally managed the available inputs to produce maximum output.

At the moderate efficiency level or below 1.000000, there are 26 DMUs or 32%. DMUs in this category show inefficiency in the use of inputs such as village assistance, community income, and labor skills, resulting in suboptimal output. This suggests that resource management in these DMUs still requires improvement to enhance efficiency.

This distribution also shows that although the majority of DMUs are technically efficient, there remains a significant proportion that is not. Thus, there is substantial opportunity to improve productivity and efficiency by optimizing input use and increasing output capacity. Inefficient DMUs can use the fully efficient ones as benchmarks in formulating performance improvement strategies.

The DEA method is also capable of measuring whether a DMU has optimized its production capacity, i.e., how effectively input is used to generate output. In this context, a DMU may fall under one of three Returns to Scale

(RTS) conditions: Increasing Returns to Scale (IRS), Constant Returns to Scale (CRS), and Decreasing Returns to Scale (DRS). The scale distribution calculations are shown in the following table 3.

Table 3. DMU Scale Distribution

Scale	Number of DMU	Percentage (%)
Decreasing Return to Scale (DRS)	18	22%
Constant Returns to Scale (CRS)	64	78%
Increasing Return to Scale (IRS)	-	-
Total Sample	82	100

Source: Primary Data, 2024 (processed)

According to Table 3, the majority of DMUs, i.e., 64 DMUs or 78%, operate under the Constant Return to Scale (CRS)condition. This shows that these DMUs have reached an optimal scale where input increases are proportionally matched by output increases. In other words, resources such as village assistance, community income, and labor skills are being used efficiently in the production process.

Meanwhile, 18 DMUs or 22% are under Decreasing Return to Scale (DRS). This indicates that increasing input does not yield proportional output or may even reduce it. This means scale efficiency has not been achieved, and there may be resource waste. This suggests that several DMUs are still facing challenges in optimizing their available inputs to improve productivity efficiency.

5. Discussion

The results of this study provide a comprehensive overview of the relative efficiency of villages (DMUs) in Pamekasan Regency in managing their resources to improve community productivity. Using the Data Envelopment Analysis (DEA)method with a Variable Return to Scale (VRS) approach, it was found that the majority of DMUs have achieved a good level of efficiency.

A total of 68% of of the total DMU showed full efficiency with an efficiency value of 1.00. This indicates that the village community has been able to optimize inputs such as village assistance, community income, and labor skills in producing maximum output. This supports the theory of technical efficiency according to Farrel (1957) which states that a unit is said to be efficient if it is able to produce the maximum output of a given input without waste. This condition shows that the management practices applied in the village can be used as a model or benchmark for other villages that have not achieved maximum efficiency.

However, 32% of DMUs were found to be inefficient. This shows that there is room for improvement in the utilization of the resources owned. This inefficiency can be caused by various factors such as low quality of human resources, ineffective management of village assistance, or limited access to training and technology. According to Coelli (2005), Input-oriented and output-oriented approaches can be

used to evaluate inefficient entities in order to increase productivity without adding excessive inputs. Therefore, there is a need for more specific and targeted empowerment policy interventions or programs for these villages.

These results show that village assistance, income and labor skills have a positive impact on village productivity efficiency in Pamekasan Regency. The results of this study are also supported by several studies, namely research by Nainggolan (2022) Given that village assistance significantly increases crop production (chili and tomatoes), lowers production costs, and encourages increased farmers' incomes, a clear mechanistic pathway linking village assistance with improved engineering efficiency and agricultural output. Furthermore, research from Xie et al. (2024) stated that the impact of the adoption of digital agro-technology services on farmers' efficiency and income is also evident through research in Hainan, China: farmers' income increased by 15.6% and technical efficiency increased by 7.3%, indicating that increasing income through technological modernization also lifts production efficiency

Research Hu et al. (2023) also showed that applying the DEA-SBM model and Tobit panel to show that human capital including education, health, and mobility has a significant positive effect on the ecological efficiency of agriculture in the provinces of China, emphasizing that improving the skills of human resources is useful in improving the efficiency of village-based productivity. These findings comprehensively confirm that village assistance, income, and workforce skills are important determinants in improving the productivity efficiency of rural communities.

In terms of efficiency scale, as many as 78% of DMUs are in the Constant Return to Scale (CRS) condition, which means that the increase in input is proportional to the increase in output. This shows that the majority of the village community has been operating at an optimal scale. So there is no significant potential to increase efficiency through addition or reduction of inputs. This indicates that the productivity of the village community in Pamekasan Regency at the DMU is already on the optimal track.

Meanwhile, 21% of DMUs were in the Decreasing Return to Scale (DRS) condition, which indicates that the increase in input is not followed by a commensurate increase in output or it shows that the increase in the productivity efficiency output of the village community in Pamekasan Regency is smaller than the increase in the input of village assistance, income, and labor skills (Gumilar, 2021; Nurhasanah, 2019). This reflects the waste of resources or ineffectiveness in the production process, which needs to be addressed immediately through strengthening village management and increasing the capacity of human resources Handoko, 2012; Anggapraja, 2016).

These results are also consistent with previous research by (Hailudin, 2021) which shows that BUMDes can be used as an efficient production unit if input management is carried out optimally. In addition, the research Purwaningsih & Asriati (2024) About the efficiency of village government also found that inefficiencies are often caused by the lack of technical skills of managers and weak accountability systems.

Study Astuti et al (2024) emphasizing the importance of benchmarking between villages as a way to increase efficiency and reduce inequality in resource management.

Overall, these results show the importance of a data-driven approach in evaluating and designing village development policies. The use of DEA not only helps identify efficient and inefficient villages, but also opens up opportunities to direct interventions in a more targeted manner (Foerster et al. 2020; (Borbalan & Claude, 2023). Villages that are not yet efficient can learn from efficient village best practices, both in budget management, community involvement, and workforce skills improvement strategies (Sari & Oktora, 2021). (Borbalan & Claude, 2023). (Foerster et al. 2020).

In addition, the scale efficiency value shows that 78.05% of DMUs have operated efficiently in production scale. This means that the majority of villages have managed their production capacity well. However, the existence of rural communities that are not yet efficient at scale is also an important warning that technical efficiency alone is not enough without being balanced with the right scale of production (Masita dan Idialis, 2024; Rofiah et al. 2024). Local governments and stakeholders need to make efficient villages as a benchmarking model. Good practices from efficient villages can be used as learning and adaptation materials by other villages through mentoring programs, inter-village collaboration, or cross-regional training.

DEA also opens up benchmarking opportunities, where inefficient villages can be used as a model for improvement. For example, best practices in village aid management, local economic empowerment, or job skills training can be replicated or adapted in villages that are still lagging behind in terms of efficiency. Thus, the results of this study make an important contribution to the formulation of data-based policies to encourage village efficiency and productivity in a sustainable manner (Rahman, 2013; Sembiring et al. 2022; Husna & Annisha, 2024).

6. Conclusions

Based on the results of the study, it was concluded that Village Assistance, Community Income, and Labor Skills have an effect on the Productivity Efficiency of Village Communities in Pamekasan Regency. Using the Data Envelopment Analysis (DEA) approach and the assumption of Variable Returns to Scale (VRS). This research shows that most of the village communities in Pamekasan Regency who are members of BUMDES have been able to manage their resources efficiently to produce community productivity. This is demonstrated through the achievement of technical efficiency and scale efficiency by the majority of the decision-making units (DMUs) analyzed. While some others are still at varying levels of efficiency. This shows that although in general the productivity of the village community has run efficiently, there is still room for further improvement to achieve maximum technical efficiency.

The productivity efficiency that has been achieved shows that the utilization of available resources is quite optimal, but several factors still need to be improved so

that all village communities can achieve full efficiency. One of the main factors that can be improved is the use of village assistance more effectively and on target in order to support the wider economic development of the community. In addition, improving the skills of the workforce is also a crucial aspect in encouraging productivity, because a more skilled workforce will be better able to manage resources more efficiently.

In addition, increasing people's income can also contribute to better productivity efficiency, given that higher incomes can encourage investment in education, skills training, and technology that can increase productivity. Therefore, continuous efforts are needed from various parties, both the government and the community, in optimizing existing resources so that the efficiency of village productivity can continue to increase and provide greater benefits for the welfare of the community as a whole. In general, the results of this study indicate that although efficiency has been achieved in many rural communities, there is still significant room for improvement for other rural communities. Overall efficiency improvement will support the achievement of sustainable and equitable village development in the Pamekasan Regency area.

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