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The Role of Workforce Quality, Village Assistance, and Village-Owned Enterprises on Economic Efficiency

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Abstract

Economic inefficiency in Pamekasan Regency is reflected in its low GRDP per capita, indicating suboptimal community welfare, particularly in villages. This study aims to analyze and identify village-level economic efficiency influenced workforce quality, village assistance, and the role of village-owned enterprises. Using a quantitative approach, this research applies an output-oriented Data Envelopment Analysis (DEA) method. The findings reveal that 71% of the villages have Constant Return to Scale (CRS), 7% are in Increasing Returns to Scale (IRS), and 22% in Decreasing Returns to Scale (DRS). The average efficiency score is 0.94, indicating that economic efficiency has reached 94%. This suggests that the combination of workforce quality, assistance, and village-owned enterprises involvement contributes significantly to achieving efficient village economies. The study concludes that while the economic efficiency level is high, a 6% improvement remains possible through increased output or reduced input, following the benchmark of optimally efficient Decision-Making Units (DMUs). The novelty of this research lies in its integration of qualitative elements quantified through efficiency measurement tools, providing a focused analysis of how workforce quality, village assistance, and village-owned enterprises institutions influence village-level economic efficiency.

Keywords

Economic Efficiency, Income, Village Assistance, Village Economy, Workforce Quality.

1. Introduction

Village economic efficiency is a key priority in improving rural economies (Zahruddin et al., 2023). Villages play a strategic role in national economic growth Bahruddin et al. (2022), where strong rural economies contribute to regional progress and community welfare (Tomisa & Syafitri, 2020). According to Luenberger (1992) and Mankiw (2020), economic efficiency means utilizing limited resources effectively to maximize community welfare. Higher efficiency is achieved by minimizing costs and increasing revenue (Priyanti et al., 2023). This leads to improved welfare, poverty reduction, and sustainable growth. In this study, income represents economic efficiency, supported by Bojnec & Papler (2011) who highlight income and technology investment as key factors in sustainable development. Sari & Setypwati (2022) states that the indicator for measuring the level of economic efficiency in a region is the level of income per capita. Islam et al. (2003) adds that optimal income increases output and supports long-term growth. In Pamekasan Regency, economic efficiency remains low. Data on BPS (2024) show Pamekasan has the second-lowest GRDP per capita on Madura Island. Gross Regional Domestic Product (GRDP) per capita is a key indicator of economic efficiency (Prassetyo, 2022; Maulana et al., 2025). This phenomenon is reflected in the low GRDP per capita figure which shows that inequality in the distribution of income directly contributes to the low level of economic efficiency (Ezkirianto & Alexandi, 2018). This condition is supported by GRDP data from 2019–2024 across four districts in Madura, as shown in Figures 1 and 2.

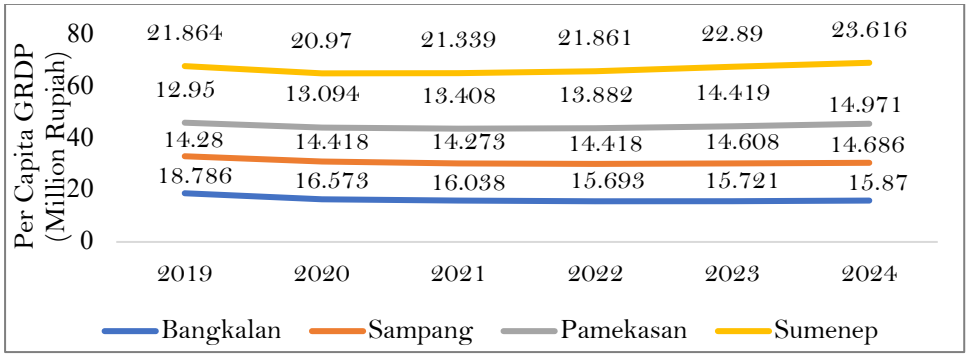

Figure 1. Per Capita GRDP at Constant Prices for 4 Regencies in Madura 2019-2024

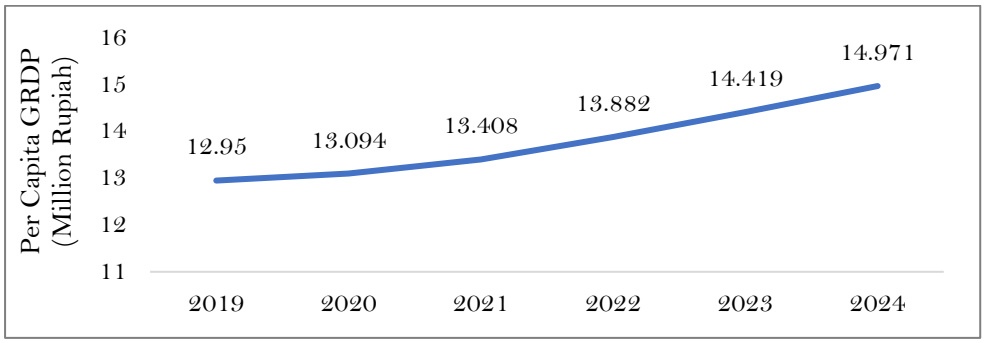

Figure 2. Per Capita GRDP at Constant Prices in Pamekasan Regency 2019-2024

Based on the analysis in Figures 1 and 2, the Gross Regional Domestic Product (GRDP) per capita at constant prices in Pamekasan Regency showed a consistent upward trend from 2019 to 2024, increasing from IDR 12.95 million to IDR 14.971 million. However, this figure remains the second lowest on Madura Island and far

below the East Java Province average of IDR 46.295 million in 2024. This indicates that the income level in Pamekasan is still relatively low, signaling economic inefficiency, particularly in rural areas. Survey data from 82 respondents involved in village-owned enterprises show that average incomes range between IDR 1,000,000 and IDR 1,500,000 per month, or IDR 12,000,000 to IDR 18,000,000 The low average income of rural communities is one indicator that supports the assumption of economic inefficiency in rural areas in Pamekasan Regency.

This study focuses on improving the economic efficiency of villages, which lies in the challenges of utilizing existing resources. It is hoped that this research identifies the optimal ways to improve the role of worker quality, village assistance, and village-owned enterprises institutions. The economic efficiency formed from these three input variables has a direct impact on increasing the income and welfare of rural communities. According to Kulsum & Bratamanggala (2024), internal factors such as human resource quality, transparency, accountability, and management capacity, as well as external factors like government policy and infrastructure, significantly affect economic efficiency. Phoek et al. (2024) also emphasize the importance of financial support and socio-cultural factors. Meanwhile, in this study, the economic efficiency of villages is measured based on the factors of workforce quality, village assistance, and village-owned enterprises institutions. In addition, worker quality plays a central role in achieving economic efficiency. According to research by Huselid (1995), the main indicator of economic efficiency is improving worker quality, which includes aspects of increasing labor productivity and managing working time. Turekulova et al. (2024) found in Kazakhstan that training and skills programs significantly improve economic efficiency. Additionally, effective labor considers worker quality, including education, training, and skills (Jajri & Ismail, 2014). Meanwhile, Indarti et al. (2022) support the idea that more workers will enhance economic efficiency.

In addition to human resources, economic efficiency can also be influenced by financial support, such as village assistance (Phoek et al., 2024). Village assistance, especially in the form of village funds, also contributes significantly to development. According to Law No. 6/2014, village funds aim to improve the village economy. Effective management of village funds can improve public services and infrastructure (Mamuaja et al., 2021). Research by Suhono et al. (2021) and Priyanti et al. (2023) shows that village funds have a positive impact on community welfare and village economic development (Pratiwi & Novianty, 2020). Additionally, the optimal utilization of village funds has made a significant contribution to the progress and development of village-owned enterprises (Zamzami & Maulina, 2023).

The existence of village-owned enterprises serves as a driver of rural economic progress (Slihin, 2021). However, only 70% of the 130 village-owned enterprises in Pamekasan are active, indicating a lack of utilization. Mamahit et al. (2024) state that well-managed village-owned enterprises can create jobs and increase income. Training and innovation are key to improving village-owned enterprises performance (Pradani, 2020; Zahruddin et al., 2023). This study addresses the gap in previous research, which focused on only one village-owned enterprises, whereas this study analyzes several village-owned enterprisess in Pamekasan district with different business units and examines these variables separately with a focus on local village conditions. This study explores by combining variables related to worker quality, village assistance, and village-owned enterprises, including training or work skills, income generated from Village-owned enterprises, and the contribution of village assistance to infrastructure or facilities available, to provide a holistic view of the economic efficiency of villages in Pamekasan District. The use of Data Envelopment Analysis (DEA) as a new methodological approach enables more accurate evaluation by combining quantitative and qualitative data to assess efficiency. This research aims to analyze and identify village-level economic

efficiency influenced by worker quality, village assistance, and the role of village-owned enterprises institutions.

2. Literature Review and Hypothesis Development

2.1 Economic Efficiency Theory

Economic efficiency is a foundational concept in development economics. Pareto efficiency refers to a situation where the allocation of resources cannot be changed to make one person better off without making someone else worse off. This concept was introduced by Italian economist Vilfredo Pareto in 1906 in the context of economic efficiency and income distribution, stating that Pareto efficiency in income distribution occurs when there is no way to change the distribution of income that would improve the well-being of one individual without reducing the well-being of another. In the context of village economies, efficiency implies using limited resources to maximize collective welfare without waste (Mankiw, 2020). This principle guides public policy aimed at improving welfare and reducing poverty (Pokhrel, 2024).

At the macroeconomic level, efficiency is reflected in the optimal utilization of inputs such as labor, capital, and technology to produce maximum output (Priyanti et al., 2023). The theory distinguishes between technical efficiency maximizing output from given inputs and allocative efficiency optimal input allocation based on their relative productivity and costs. Efficiency is seen as the ratio of efforts to optimize the use of inputs to produce a certain level of output with minimum expenditure or to produce maximum output from a certain number of inputs (Samuelson & Nordhaus, 2004). In addition, Camanho et al. (2024) state that economic efficiency can be analyzed based on the aspects of costs, income, and profits. Therefore, economic efficiency is the ability of an economic entity to optimally utilize available resources to produce output with maximum income at minimum cost.

In this study, the main input variables are worker quality, village assistance, and village-owned enterprises institutions, all of which aim to produce maximum output in the form of economic efficiency, namely village community income. Worker quality is related to maximizing the productivity of each worker (Nisa & Rafikasari, 2022), while the strategic allocation of village funds is crucial for supporting productive economic activities (Suhono et al., 2021). Meanwhile, village-owned enterprises play a central role in managing and utilizing village assets to generate income (Salihin, 2021). When these inputs are effectively coordinated, economic efficiency will be achieved, thereby supporting sustainable village development (Nuak et al., 2020; Qadarisman et al., 2021).

2.2 Workforce Quality, Village-Owned Enterprises and Village Assistance

The quality of the workforce is also very important for economic performance. The workforce consists of individuals who are able and willing to produce goods and services (Dumais et al., 2022). Workforce quality is shaped by the presence of human capital as its primary element, which can be enhanced through sustainable investments such as education and vocational training, as higher workforce quality leads to higher worker productivity (Makovskaya, 2018). According to the Solow Growth Model, labor is the center of long-term growth, and increased labor participation correlates with greater output (Indarti et al., 2022). In line with Rodriguez-Clare (1996), labor force growth contributes to development through increased income and consumption, which ultimately enhances overall economic efficiency. Thus, the interaction between institutional strength (village-owned enterprises), productive labor force, and fund allocation (village funds) forms a relationship among the three variables that efficiently determines the level of economic efficiency at the village level.

According to Arifin et al. (2020), village funds provide a significant opportunity to improve basic public services such as education, health, and infrastructure by fully maximizing the village's potential. According to Diatmika (2021), the success and effectiveness of these funds largely depend on how well they are managed by the village government. Efficient and effective management is essential to ensure that village funds are utilized in a way that supports sustainable development goals and meets the needs of the local community (Han et al., 2021). Proper allocation and monitoring of these funds allow for the optimal use of resources, preventing waste and ensuring that every expenditure contributes to the overall progress of the village (Olivia & Mahi, 2023).

Supporting this view, Priyanti et al. (2023) found that village funds have had a very efficient impact on achieving economic development targets. Their research demonstrated that the inputs or costs needed to generate income were lower than the actual income realized, which is a clear indication of optimal efficiency in the use of village funds. This suggests that when village funds are properly managed, they not only enhance the infrastructure and public services but also contribute to improving the economic welfare of the village population. Thus, effective governance and transparency in managing village funds are critical factors for maximizing their potential benefits in rural development.

Douglass (1990) emphasized the importance of institutions as formal and informal rules that shape economic behavior. Institutions such as village-owned enterprises act as key drivers in maintaining economic stability and fostering efficiency. Village-owned enterprises not only manage assets but also facilitates community empowerment, as highlighted by Salihin (2021), Lumintang and Waani (2020), and Zahruddin et al. (2023). According to Government Regulation No. 72 of 2005 and Law No. 32 of 2004, the establishment of village-owned enterprises must align with village needs and potentials, reinforcing their role in promoting rural economic growth (Riyanti et al., 2021).

H1. Workforce quality affects financial performance
H2. Village-owned enterprises affect financial performance
H3. Village assistance affects financial performance

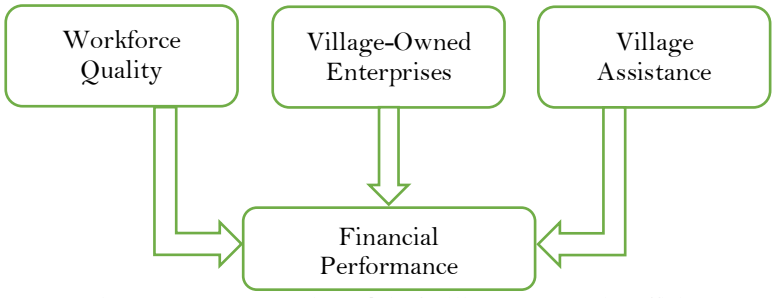

Figure 3. Conceptual Model of Village Economic Efficiency

Figure 3 illustrates that within this framework, workforce quality serves as human capital that acts as the primary driver of labor productivity. Improving workforce quality through education and training contributes to increasing the economic output of the village. Village-owned enterprises function as economic institutions that manage village assets and potential. These enterprises support local economic stability, community empowerment, and the management of village businesses oriented toward profit and community welfare. Village assistance or village funds act as a source of financing that supports infrastructure development, public services, and community empowerment programs. Efficient management of village funds can maximize the potential for economic and social development.

These three variables are linked to financial performance, which indicates the extent to which these inputs generate optimal economic output. This optimization is measured using the Data Envelopment Analysis (DEA) approach. A DEA score of 1 indicates full technical efficiency, while Increasing Returns to Scale (IRS) suggests there is potential to increase output through further input development. Conversely, Decreasing Returns to Scale (DRS) indicates the need for input structure adjustments to achieve greater efficiency.

3. Methods

This research is classified as qualitative research transformed into a quantitative approach. According to Ahmad et al. (2019), quantitative research emphasizes the analysis of numerical data processed through statistical methods. The data used in this study are cross-sectional, collected at a single point in time from several villages with village-owned enterprises (BUMDes) in Pamekasan Regency. Wang and Cheng (2020) define cross-sectional data as data collected from multiple regions at a specific moment. The choice of this method aligns with the use of questionnaires distributed simultaneously to villages having village-owned enterprises, aiming to analyze the relationship and efficiency between independent variables and the dependent variable.

The study population comprises the village community involved in Village-owned enterprises in Pamekasan Regency. The research population consists of rural communities involved in village-owned enterprises in Pamekasan Regency. Meanwhile, the sample in this study uses purposive sampling. According to Creswell and Creswel (2017), purposive sampling is a non-probability sampling method deliberately used by researchers to select individuals, groups, or cases considered relevant to the research. The selection of villages in this study focused on several villages that have village-owned enterprises business units based on the criteria of active village-owned enterprises, whether they are already developed or still developing, including Laden Village, Montok Village, Pademawu Village, Sumedangan Village, Prekbun Village, Gagah Village, Murtajih Village, and Padelegan Village, with a total of 82 respondents consisting of Village-owned enterprises managers, village officials, or community members involved in Village-owned enterprises activities. Primary data collection involved direct observation, interviews, and distributing questionnaires to the village communities engaged in Village-owned enterprises. The questionnaire employed a Likert scale ranging from 0 to 4 to measure variables.

The analytical tool used is Data Envelopment Analysis (DEA) with STATA 14.0 software, employing the Variable Return to Scale (VRS) model. The DEA method is categorized as a non-parametric approach that refers to linear programming techniques designed to measure the relative efficiency of Decision-Making Units (DMUs). DEA compares input utilization (workforce quality, village assistance, and village-owned enterprises institutions) against output production (economic efficiency) without requiring assumptions about the functional form between inputs and outputs. This concept is based on Farrel's definition of technical efficiency, which emphasizes optimizing output by minimizing input. It was further developed in 1978 by Charner, Cooper, and Rhodes, and subsequently underwent several developments, namely DEA BBC, often referred to as variable return to scale (VRS). The efficiency score of a unit is determined based on the efficiency frontier. A unit on the efficiency frontier 1 (100%) is considered efficient. Units below the frontier with a score <1 (less than 100%) indicate suboptimal efficiency and thus have potential for improvement. Units on the frontier serve as a benchmark for units that are not yet efficient.

The DEA VRS model assumes that increases in inputs do not necessarily result in proportional output increases. This allows for identifying increasing returns to

scale (IRS) when output increases more than input, and decreasing returns to scale (DRS) when output increases less than input. Technical efficiency is calculated using the VRS approach, which adds convexity constraints to weight values, allowing for a more flexible measurement compared to the constant return to scale (CRS) model. This approach is considered most appropriate when not operating at optimal scale. The following is the output-oriented DEA BBC model:

$$Min \sum_{j=1}^{n} v_j \, x_{j0} - w$$

Subject to:

$$\sum_{i=1}^{m} u_j \;\; y_{i0} = 1$$

$$\sum_{i=1}^{m} u_i \;\; y_{ik} - \sum_{j=1}^{n} v_j \;\; x_{jk} + w \;\leq 0, \;\; for\, k \;= 1, 2, \ldots, h$$

In this model, vj represents the weight of input j for the analyzed DMU, ui represents the weight of input i for the analyzed DMU, xjk represents the amount of input j from DMU k, Yik represents the amount of output i from DMU k, and xj0 represents the amount of input j from the DMU being analyzed. w represents the scale factor. The variables m, n, and h represent the number of outputs, inputs, and DMUs analyzed, respectively (Santana et al., 2014).

4. Results

According to Sari & Setyowati (2022), the process of measuring efficiency begins with defining the Decision-Making Units (DMUs), where each village community participating in Village-owned enterprises is treated as a DMU assessed by its inputs such as workforce quality, village assistance, and the role of Village-owned enterprises and its output in the form of economic efficiency. Relevant data on these inputs and outputs are gathered through questionnaires and interviews. This study employs a Variable Returns to Scale (VRS) DEA model, which is appropriate for its output-oriented objective of maximizing economic efficiency given existing inputs. The relative efficiency of each DMU is then calculated, producing scores from 0 to 1, with a score of 1 indicating full efficiency. Finally, scale efficiency is measured by comparing technical efficiency scores under both VRS and Constant Returns to Scale (CRS) assumptions to determine whether each DMU is operating at its optimal scale.

Optimizing the use of workforce quality, village assistance, and the institutional role of village-owned enterprises enables villages to achieve full technical efficiency, which is reflected by a DEA score of 1. When the scale efficiency shows an Increasing Returns to Scale (IRS) condition, it indicates that there is still potential to further develop and expand inputs to boost economic output. Conversely, if the condition is Decreasing Returns to Scale (DRS), it means that efficiency can be improved by making optimal adjustments to the input structure. Villages or DMUs that have not yet reached technical efficiency can use the best-performing DMUs those with a DEA score of 1 as benchmarks to identify gaps and adopt best practices, thereby improving their efficiency towards an optimal level.

Based on the results of data processing envelopment analysis (DEA) using the assumption of variable return to scale (VRS) The results measured from the income of the community generated as output (Y) are indicators of economic efficiency in this study, where the output is influenced by several input variables, namely workforce quality (X1), village assistance (X2), and the role of village-owned enterprises (X3). The results of the analysis and discussion in this study will be

explained based on the results of the DEA method VRS or BBC model using STATA software version 14.0 in Table 1.

Table 1. Distribution of Efficiency Scale

Efficiency Scale	Total DMU	Percentage (%)
Decreasing Return to Scale (DRS)	18	22
Constan Return to Scale (CRS)	58	71
Increasing Return to Scale (IRS)	6	7
Total Sample	82	100

Based on the calculation results in Table 1, from data processing with the DEA method, the Constant return to scale (CRS) model oriented to output shows that there are 58 people or 71% who show CRS efficiency. While the IRS level is 6 people or 7% of the total number of respondents. DMU which is on the IRS scale shows that the increase in output produced is greater than the increase in input used, namely workforce quality, village assistance, and village-owned enterprises institutions (BUMDes), in addition there are 18 people or 22% of the total number of respondents who are on the DRS scale. This shows that the increase in economic efficiency output in the form of community income is smaller than the increase in input. Based on this analysis, it shows that there is a difference in technical efficiency values with the CRS and VRS models that can be used to determine scale efficiency and are referred to as constant return to scale (CRS), increasing return to scale (IRS) or decreasing return to scale (DRS). At the IRS level, the increase in the amount of output produced is greater than the addition of input given. At the decreasing return to scale (DRS) level, the increase in the amount of output that has been produced is smaller than the addition of input given. Meanwhile, at the CRS level, where each additional input will add to the output result by the input that has been given constantly based on the results of data processing using STATA software version 14.0 with the VRS model (variable return to scale) produces the value of the economic efficiency level in the following Table 2.

Table 2. Distribution of technical efficiency values using scale efficiency (SE)

Efficiency Level	Efficiency Value	Total DMU	Percentage (%)
Too Low	0.278 – 0.459	0	0
Low	0.460 – 0.641	0	0
Medium	0.642 – 0.823	11	13
Hight	0.824 – 0.999	13	16
Full Efisien	1	58	71
Total		82	100
Average TE: 0.94			
Full Efisien TE: 1.00			
Minimum TE: 0.77			

Based on Table 2, through the DEA approach, there are 58 respondents or 71% who have reached the optimal efficiency level (full efficiency) which means that the DMU has reached an efficiency value of 1.00 or 100%. This shows that the DMU has been on the efficient frontier and no other DMU can produce more output with the same or less input. Where individuals have utilized all inputs optimally to produce maximum output in their use. At a very low efficiency level with a value of 0.278-0.459 there are none or amounting to 0, at low efficiency with a value of 0.460-461 there are none or amounting to 0 and medium efficiency with a value of 0.642-0.823 as many as 11 DMUs (13%) of the total number of DMUs, while at a high efficiency level as many as 13 people (16%) these results indicate that the entity has utilized most of the resources well, but there is still room for improvement such as opportunities to increase productivity or reduce the use of input without reducing

the value of its output. while the average value of economic efficiency in Village-owned enterprises in Pamekasan Regency villages is 0.94, which means that on average it has achieved a technical efficiency level of 94%, which indicates that the entity has almost achieved maximum efficiency. Where technical efficiency is calculated based on the ratio of output produced to input used so that to achieve the maximum efficiency value (1) there is still an opportunity by increasing by 6%. Therefore, DMUs that are not yet technically efficient can refer to DMUs that are already technically efficient, as in Table 3.

Table 3. Distribution of Technical Efficiency with CRS and VRS Assumptions

Efficiency CRSTE			**Efficiency VRSTE**		
Efficiency Value	**Total**	**Percentage**	**Efficiency Value**	**Total**	**Percentage**
0.278 – 0.459	8	10	0.278 – 0.459	6	7
0.460 – 0.641	1	1	0.460 – 0.641	2	3
0.642 – 0.823	31	38	0.642 – 0.823	23	28
0.824 – 0.999	5	6	0.824 – 0.999	8	10
1,000	37	45	1,000	43	52
Total	82	100	Total	82	100
Average	0.796		Total	0.834	
Minimum	0.285		Average	0.333	
Maximum	0.888		Minimum	0.857	

In the context of the DEA method, the VRS model above shows the difference in technical efficiency between CRS and VRS frontier. In contrast to the CRS model, the current VRS model shows 43 that are efficient or have a value of (1), namely DMU 3, 4, 9, 10, 12, 13, 15, 16, 21, 23, 28, 30, 33, 35, 39, 40, 42, 45, 46, 48, 50, 51, 52, 53, 54, 55, 56, 57, 60, 62, 63, 64, 65, 69, 70, 71, 72, 73, 76, 78, 79, 80, 82 which have a full efficiency value or 1.00 while the minimum VRS TE value is 0.333 while the average VRS TE is 0.834 where there are still units that are not optimally efficient so that in order to achieve optimal efficiency value needs to increase its efficiency level by 17%. While CRS TE in this study only shows 37 which are optimally efficient including DMU 3,4, 10 12, 15, 16, 21, 23, 30, 33, 35, 39,40, 42, 45, 46, 48, 50, 51, 52, 53, 54, 55, 55, 56, 57, 60, 62, 63, 64, 65, 70, 71, 72, 76, 78, 79, which has a full efficiency value or 1.00 and a minimum CRS TE value of 0.285 while the average CRS TE is 0.79 this shows that to achieve efficient CRS TE units can increase their efficiency by 21% to achieve optimal efficiency. Based on the average value of VRS TE and CRS TE, it shows that the average VRS TE is greater than the average CRS TE, indicating that most units' experience scale inefficiency. VRS TE shows that units operate on different scales and units can operate below Increasing Returns to Scale (IRS) or Decreasing Returns to Scale (DRS), while CRS TE shows that all units operate on an optimal scale which assumes that increasing input will result in an increase in output in the same proportion (fixed scale). So, the VRS TE value is greater to achieve optimal efficiency value, it must evaluate its production scale, namely by IRS or reducing DRS. If there is an IRS, increasing its input to produce greater output operationally such as increasing workforce quality input, village assistance, and the role of village-owned enterprises has resulted in an increase in economic output, namely community income that is greater than the increase in input. Meanwhile, if DRS efficiency can increase if the unit reduces its production scale because increasing input no longer produces greater output. This shows that the increase in economic efficiency output, namely income, is smaller than the increase in input, including workforce quality, village assistance, and village-owned enterprises, where when a unit shows DRS in the BBC model, then the unit has not operated at an optimal level, even though it has increased its input, it will not provide a comparable increase in output, so with this DMU that has experienced DRS needs to reduce operational measures such as workforce quality, village

assistance, and village-owned enterprises management by managing resources more efficiently such as reducing the amount of village fund allocation by diverting it to other financing. Constant Returns to Scale (CRS), units have worked on an optimal scale, their input and output operate on the same scale by focusing on operational strategies such as maintaining efficient business units and focusing on increasing their operational efficiency.

5. Discussion

The results of the DEA analysis indicate that the average economic efficiency of village-owned enterprises in Pamekasan Regency is 0.94, meaning they have achieved 94% of technical efficiency, with a 6% potential for improvement. This suggests that most village-owned enterprises have managed their inputs effectively but still have room for optimization. The quality of workers plays an important role in promoting economic efficiency at the village level. Optimal utilization of labor, including job training, increased productivity, and appropriate working hours, has a positive impact on the income and welfare of rural communities. The income generated is used to meet basic needs, thereby improving the overall quality of life and economic efficiency in rural areas. This finding is supported by Bahtiar & Karim (2021), who show that improvements in human resource quality integrated with village-owned enterprises management significantly contribute to increased income and the well-being of rural communities. These findings are supported by Dumais et al. (2022), who found a positive impact of labor on economic efficiency in North Minahasa Regency. Additionally, Zahruddin et al. (2023) emphasized the importance of village-owned enterprises training in improving managerial capacity, efficiency, and productivity, contributing to village autonomy and sustainable growth. These studies reinforce the conclusion that labor, when managed effectively, significantly influences village prosperity.

Assistance from village funds provided by the government-provided village funds also contribute efficiently to community income generation (Murthi et al., 2022; Hilmawan et al., 2023). The results show that most village funds have been targeted effectively and allocated according to village-specific needs. This has led to the development of infrastructure such as local markets managed by Village-owned enterprises, which facilitate trade in local products and enhance villagers' access to economic opportunities. Khadlirin (2021) found similar results in Tegalarum Village, where fund management efficiency reached 95.57%. Likewise, Priyanti et al. (2023), observed high effectiveness in Seteluk Village, where village fund usage in economic development consistently yielded efficient outcomes, with realized development outputs contributing significantly to community income.

The role of village-owned enterprises is another key driver of rural economic efficiency. DEA results show that 94% of respondents perceive Village-owned enterprises as having a positive and efficient impact on income levels. Through the effective management of business units, village-owned enterprises contribute to increased welfare and economic independence. This finding is supported by Pradani (2020), who noted that Village-owned enterprises development significantly enhances village economies and public welfare. However, contrasting evidence is provided by Bahruddin et al. (2022), who reported that in Padaidi Sipodeceng Village, the impact of Village-owned enterprises was limited mainly to its members and contributed only 7% to the village's original income in 2018. This highlights the need for more inclusive and scalable village-owned enterprises operations to ensure broader community benefits.

6. Conclusion

Based on the results and discussion, this study concludes that workforce quality, village assistance, and the role of village-owned enterprises institutions have an efficient influence on economic efficiency in villages of Pamekasan Regency. The optimal utilization of workforce quality through job training, productivity improvement, and adequate working hours has proven effective in increasing community income and welfare. Likewise, village funds allocated by the government have shown efficiency in enhancing economic outcomes, as most of the funds were distributed appropriately and in accordance with local needs. Furthermore, Village-owned enterprises have contributed significantly to the village economy by managing and developing business units that enhance community income.

This study provides a real contribution to strategic policy directions to support economic efficiency improvements in villages, particularly in Pamekasan Regency. First, strengthening human capital through job training tailored to the characteristics and economic potential of villages should be prioritized to enhance labor productivity. Second, mechanisms for village fund assistance should be based on efficiency analysis, particularly considering the characteristics of output scale, where villages with Increasing Returns to Scale (IRS) are eligible for expansion interventions, while villages in Decreasing Returns to Scale (DRS) require restructuring of input structures. Third, institutional strengthening of village-owned enterprises should be carried out through the development of a regulatory framework that promotes managerial capacity building, business innovation, and business sustainability. Finally, the Data Envelopment Analysis (DEA) approach can be integrated as a quantitative evaluative tool to assess the effectiveness of development interventions and support the formulation of more targeted and efficient policies based on actual achievements.

Theoretically, this research strengthens the understanding that human capital and institutional effectiveness are critical factors in achieving economic efficiency in rural areas. It also highlights the importance of input-output alignment in optimizing development outcomes. From a practical standpoint, these findings suggest that continuous investment in workforce quality, careful allocation of village funds, and strategic empowerment of village-owned enterprises are essential for sustaining village economic growth.

Nevertheless, this study has limitations. The DEA method with a Variable Return to Scale (VRS) output-oriented model showed that not all Decision-Making Units (DMUs) reached optimal efficiency. With an average efficiency score of 0.94, there remains a 6% gap for improvement. Around 7% of DMUs were in the IRS condition, indicating opportunities to scale up inputs for greater output, while 22% of DMUs experienced DRS, where increased input did not result in proportional output growth. This suggests the need for better resource management and scaling strategies. Future research should explore additional variables such as digital infrastructure or market access, and use longitudinal methods to observe changes in efficiency over time. Comparative studies across different regions could also offer broader insights into best practices for achieving rural economic efficiency.

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