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Evaluating the Efficiency and Productivity Effects of Cross-Border Acquisitions Using Data Envelopment Analysis (DEA)

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Abstract

Purpose – This research examines the impact of cross-border acquisitions on the efficiency and productivity of acquired companies, with a specific focus on MSA, an automotive firm.

Methodology – We employ Data Envelopment Analysis (DEA) to assess total factor productivity and compare MSA's performance before and after its acquisition by Michelin.

Findings – MSA's efficiency fluctuated over time, peaking in Q1 2021 with a score of 1 but declining in Q1 2022, indicating room for improvement. The Mann-Whitney test results show no significant change in MSA's efficiency following the acquisition, suggesting the merger did not notably enhance performance.

Practical implications – Managers should concentrate on optimizing material, labor, and capital management, while maintaining continuous operational monitoring. A proactive approach to the implications of strategic decisions, such as cross-border acquisitions, is essential for sustained high performance and long-term success.

Introduction

In today's landscape of economic globalization, businesses worldwide are increasingly pursuing cross-border acquisitions as a key growth strategy. This approach allows them to enhance their competitive edge and improve organizational performance by tapping into new markets, accessing diverse resources, and leveraging innovative technologies (Hanoum et al., 2025). By integrating their operations and expanding their international outreach, these companies aim to excel in an ever-evolving marketplace, thereby maximizing their potential for success and sustainability.

Cross-border acquisitions have become a popular mode of global expansion for firms because they provide a rapid means of establishing an international presence in specific markets. According to the United Nations Conference on Trade and Development (2000), there

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were approximately 60,000 acquisitions at the beginning of the twenty-first century that could be classified as transnational (Teperek, 2024). Cross-border acquisition activities have become a popular trend in many regions worldwide, including North America, Asia, and Latin America.

Over the past two decades, cross-border acquisitions in transitional economies have surged due to technological, economic, and political changes, as well as market globalization. The World Investment Report 2021 notes a 58% increase in the value of cross-border acquisitions in developed countries from the previous year (ESCAP, 2021). The primary reason for pursuing cross-border acquisitions in transitional economies is to enhance the performance of the companies (Azizi et al., 2025). Foreign companies expand into transitional economies to achieve geographical diversification, accelerate growth, utilize natural resources, and reduce labor costs (Lee et al., 2021). Cross-border acquisitions offer strategic advantages and promote global economic integration by granting access to new technologies, talent, and knowledge (Brooks & Jongwanich, 2011).

However, cross-border acquisitions carry risks, including regulatory, political, and cultural differences, which complicate government approval compared to domestic deals. In Indonesia, cross-border mergers and acquisitions (M&A) have grown significantly, with the value doubling from $ 1.3 billion in 1998 to $2.7 billion in 1999 (Yehezkiel, 2021). In 2020, there were 40 cross-border M&A transactions—32 inbound and 8 outbound—as well as 22 domestic transactions, with a total value of $9.7 billion, up from $7.2 billion in 2019. Acquisitions typically involve the purchase of company shares and often reference foreign jurisdictions; however, the transfer deed is governed by Indonesian law (Yehezkiel, 2021).

In 2019, Michelin acquired an 88% stake in Indonesian tire manufacturer MSA for $439 million as part of its strategy to expand in the Asia-Pacific region. The acquisition received regulatory approval and was completed the same year. Initially, Michelin obtained 87.59% in June 2019 and later increased its stake to 98.64% by acquiring an additional 11.05%. By 2021, Michelin had purchased the remaining 1.36%, raising its total stake to 99.64% (Michelin, 2019). This acquisition demonstrates how cross-border mergers and acquisitions can facilitate company growth and benefit local economies by attracting foreign investment and generating employment opportunities.

Cross-border acquisitions significantly impact the efficiency and productivity of involved companies, though not always positively. To assess performance, two main approaches are used: stock-market-based measures, which analyze changes in share prices before and after the acquisition, and accounting-based measures, which evaluate profitability indicators over time (Savović & Mimović, 2020). However, both approaches have limitations. For instance, stock-market-based measures are inapplicable to unlisted companies, while accounting-based measures may be influenced by differences in accounting practices or short-term fluctuations (Savović & Mimović, 2020).

Therefore, some authors suggest that a more desirable methodological approach in assessing acquisition performance is the assessment of total factor productivity (TFP) (Hanoum, 2021; Rachmad et al., 2024). Data envelopment analysis (DEA) is a method that can be used to estimate total factor productivity and is a useful tool for analyzing company efficiency and productivity (Hanoum & Islam, 2021). DEA is well-suited for evaluating acquisition performance, focusing on efficiency rather than average performance. While some studies have applied DEA in the financial and construction sectors, research in the automotive sector is limited.

Previous studies have investigated the performance of cross-border acquisitions using DEA, but they mainly analyzed acquisitions in the financial sector (Li et al., 2021) (Kiliç, 2011). Another study examined the impact of cross-border acquisitions on the efficiency and productivity of acquired companies in the cement industry within a transitional economy (Savović & Mimović, 2020). Therefore, a study conducted a DEA analysis of the automotive industry in Indonesia, examining the cross-border acquisition activities, to explore the effects of such acquisitions on the productivity of acquired companies. The study assessed the efficiency and productivity of individual inputs, as well as the total efficiency and productivity of acquired companies during the period 2018–2022.

The study on cross-border acquisitions in MSA offers key contributions. First, it highlights the importance of interdisciplinary research, using DEA to measure acquisition performance in the fields of acquisitions, performance measurement, and operations management. Second, it broadens knowledge on the effects of cross-border acquisitions, particularly in the automotive industry, an area often overlooked in previous research. Lastly, the findings have practical implications for managers and policy-makers, helping them assess whether to promote or discourage such acquisitions based on their impact on the efficiency and productivity of acquired companies and overall national productivity.

Literature Review

Effects of Acquisitions on Efficiency and Productivity

The effects of acquisitions on efficiency and productivity have been extensively researched in the field of performance management studies. Acquisitions, which involve one company purchasing another, are often motivated by the expectation of realizing synergies, cost savings, and improved operational performance. However, there is no consensus on the most effective method for measuring acquisition performance or on the optimal timing of these measurements during the process (Cartwright & Schoenberg, 2006).

This topic presents a complex picture. Some studies indicate that acquisitions can lead to increased efficiency and productivity (Savović & Mimović, 2020). Additionally, institutional factors may influence the relationship between the speed of human and functional resource integration and acquisition performance (King et al., 2020; Schriber et al., 2018). The more information the acquiring company has about the target company, the better the acquisition performance tends to be (Ahammad & Glaister, 2013).

However, a substantial body of research highlights the potential negative consequences of acquisitions, including cultural clashes, integration challenges, and disruptions to existing operations, which can hinder improvements in efficiency and productivity. The outcomes of an acquisition often depend on factors such as the compatibility of the two companies, the post-acquisition integration process, and the industry in which they operate.

The literature emphasizes the importance of considering both the short-term and long-term effects of acquisitions on efficiency and productivity. While immediate post-acquisition performance may be volatile, companies can adapt and improve over time. Understanding these long-term dynamics is essential for practitioners and policymakers, as it informs merger strategies and their economic implications. The multifaceted effects of acquisitions reveal both positive and negative outcomes, underscoring the importance of a long-term perspective in assessing their impact on firms and industries.

Improving Efficiency and Productivity Through Cross-Border Acquisitions

One of the driving forces behind cross-border acquisitions by MSA, a company that produces car and motorbike tires, is the desire to enhance the operating efficiency of local companies. Acquired companies benefit from improved efficiency and productivity through various means, including the adoption of advanced technologies, knowledge transfers, and strategic restructuring measures (Pitkethly et al., 2003). These strategies often involve modernizing outdated production facilities and factories, which require significant investment.

Foreign acquirers, such as MSA, play a crucial role in enhancing the technological capabilities of local firms. Even if this strategy does not yield immediate profits, it is expected to result in significant long-term savings. By investing in advanced technology, new equipment, and modern production facilities, MSA can markedly increase its production capacity. Acquired companies can spread their fixed costs over larger production volumes, resulting in lower average costs and increased operating efficiency (Capron, 1999).

Cross-border acquisitions also provide various benefits, encompassing raw materials, components, energy, and all inputs needed in the production process(Rosenbloom, 2010). Such acquisitions strengthen the bargaining power of the acquired company with suppliers, potentially reducing raw material prices and procurement costs. Additionally, cross-border acquisitions grant access to modern technologies, which can further improve efficiency and productivity.

Research Questions

The objective of this study is to compare the efficiency and productivity of MSA before and after its cross-border acquisition by Michelin. The research aims to address the following questions:

RQ1. How does MSA's efficiency compare before and after the acquisition?
RQ2. Do cross-border acquisitions improve the performance efficiency of acquired companies?
RQ3. How does MSA's productivity compare before and after the acquisition?

Research Methods

The data analysis was conducted in three steps. The first step involves applying Data Envelopment Analysis (DEA) to obtain efficiency scores. The second step involves calculating the Malmquist productivity index (MPI) and its components. The second step involves calculating the effect of a two-company cross-border acquisition on the productivity of materials in acquired companies, the productivity of capital in acquired companies, and the productivity of labor in acquired companies using regression analysis.

DEA window analysis

In this study, the efficiency of acquired companies is assessed using DEA, a mathematical, non-parametric approach that calculates efficiency without requiring a specific functional form. The ratio DEA model, also known as the CCR model (Charnes, Cooper, and Rhodes' model), measures the efficiency of Decision-making Units (DMUs) by comparing the weighted sum of outputs to the weighted sum of inputs. This model calculates total technical efficiency, which

includes both pure technical efficiency and efficiency resulting from different business volumes. Depending on the analysis's purpose, the choice of model orientation can be input or output, and it should align with the study's goals.

Important assumptions for the valid application of the DEA model include:

- Principle of Homogeneity: Decision-making units should be similar in nature.
- Positivity of Input and Output Variables: All input and output variables should be positive.
- Isotonicity: An increase in some input should result in a proportional increase in output without decreasing any other input.
- Optimal Number of Input and Output Variables: The chosen variables should effectively measure the decision-making unit's effect and be common for all units.

To monitor the performance of decision-making units over time, an extended DEA method known as the Window DEA can be used. This method involves observing DMUs at different time periods as separate units, allowing performance comparison between the observed DMU and its performance over different time periods and with other units within the same window. This approach can be particularly useful when there is a small number of DMUs, as it increases the discriminatory power of the analysis.

Mann Whitney T-Test Analysis

The Mann-Whitney test is a non-parametric test that is commonly used to determine whether there is a significant difference between two independent data populations. Santoso (2012) suggests that the Mann-Whitney test is a viable alternative to the t-test and z-test for independent variables, which involve two samples that are not related to each other. In other words, the Mann-Whitney test can be used when the assumptions of the t-test and z-test are not met. According to Sugiyono (2012), the formula for the Mann-Whitney test is as follows.

$U1 = n1n2 + (n1(n1 + 1))/2 + R1$

Description :

U1 : number of rank 1 U2 : number of rank 2 n1 : sample size 1

n2 : sample size 2

Or

$U2 = n1n2 + (n2(n2 + 1))/2 + R2$

R1 : number of rank in the sample n1 R2 : number of rank in the sample n2

The hypothesis used in the study is

H0: There is no difference between the efficiency of MSA after and before the cross-border acquisition by Michelin.

H1 : There are differences between the efficiency of MSA before and after the cross-border acquisition by Michelin.

The criterion for the test is based on the significance value (Asym Sig 2-tailed) being compared to the predetermined level of significance, $\alpha = 0.05$. If the significance value is less than $\alpha = 0.05$, the null hypothesis (H0) is rejected, leading to the conclusion that there is a difference in efficiency between conventional banking and Islamic banking. Conversely, if the

significance value is greater than $\alpha = 0.05$, the null hypothesis is accepted, indicating that there is no difference in the level of efficiency between conventional banking and Islamic banking. This decision-making process is crucial in determining whether a significant difference exists between the two types of banking systems, thereby contributing to an understanding of their comparative performance and implications for financial stability.

Data and model structuring

When applying the Data Envelopment Analysis (DEA) method, it is crucial to carefully select input and output variables. This selection should consider the optimal ratio relative to the number of Decision-Making Units (DMUs) and ensure that these variables accurately represent the DMUs involved. In this analysis, each acquired company, such as MSA within the context of Michelin, is treated as a distinct DMU. We evaluate MSA's performance across two-time frames: the period before the cross-border acquisition (Pre Cross-border Acquisition, 2018) and the years following the acquisition (Post Cross-border Acquisition, 2019, 2020, 2021, and 2022). The data used for this analysis is derived from each company's quarterly reports from 2018 to 2022.

To effectively apply the DEA method, it is essential to select input and output variables carefully. This selection must consider the optimal ratio relevant to the number of DMUs and ensure that the chosen variables accurately reflect the DMUs. Typically, inputs for measuring efficiency and productivity are classified into five categories: capital (C), labor (L), energy (E), materials (M), and services (S). This classification is commonly known as the KLEMS approach, where the last three categories, energy, materials, and services, are often grouped as a single input. In companies producing a single product, output generally includes annual production figures or their monetary values, along with realized operating revenues.

In our analysis of MSA, we consider three input variables: materials, capital, and labor, alongside one output variable, operating revenues. Material input is estimated by accounting for material costs and fuel and energy costs. The capital input is based on the book value of fixed assets, while the labor input includes all employee wages, benefits, and payroll taxes. The output is defined as operating revenue, which covers total sales and other operating revenues.

The data for material costs, fuel, and energy expenses is sourced from the companies' balance sheet statements, while the book value of fixed assets is obtained from the companies' income statements. This careful selection of input and output variables allows us to conduct a thorough analysis of MSA's efficiency and productivity following its acquisition by Michelin.

To evaluate the productivity of the acquired companies, we construct an input-oriented CCR DEA Window model. This orientation is consistent with the objectives of the analysis, focusing on reducing input variable values while theoretically ensuring that this reduction does not compromise the outputs. This approach helps maintain the relative technical efficiency of the observed DMUs.

Results and Discussion

Result of DEA Window Analysis

Figure 1 illustrates the efficiency scores of MSA over various quarters. It indicates that the company experienced fluctuations in performance across various periods. In Q1 2019, MSA reported a low efficiency score of 0.025244, indicating inadequate resource allocation or operational processes during that time. Conversely, in Q1 2021, the company achieved a

maximum efficiency score of 1, reflecting successful operational efficiency and optimal resource management. In Q1 2022, however, the efficiency score fell to 0.552074, suggesting opportunities for improvement in the company's efficiency during that quarter. Despite this decline from its peak, MSA regained maximum efficiency in Q2 2022, signifying a strong operational performance. Overall, the quarters in which the company demonstrated efficiency, characterized by a maximum efficiency score of 1, include Q1 2021, Q2 2022, Q3 2019, Q3 2021, and Q4 2022. Conversely, the quarters deemed inefficient, with scores below 1, are Q1 2019 and Q1 2022.

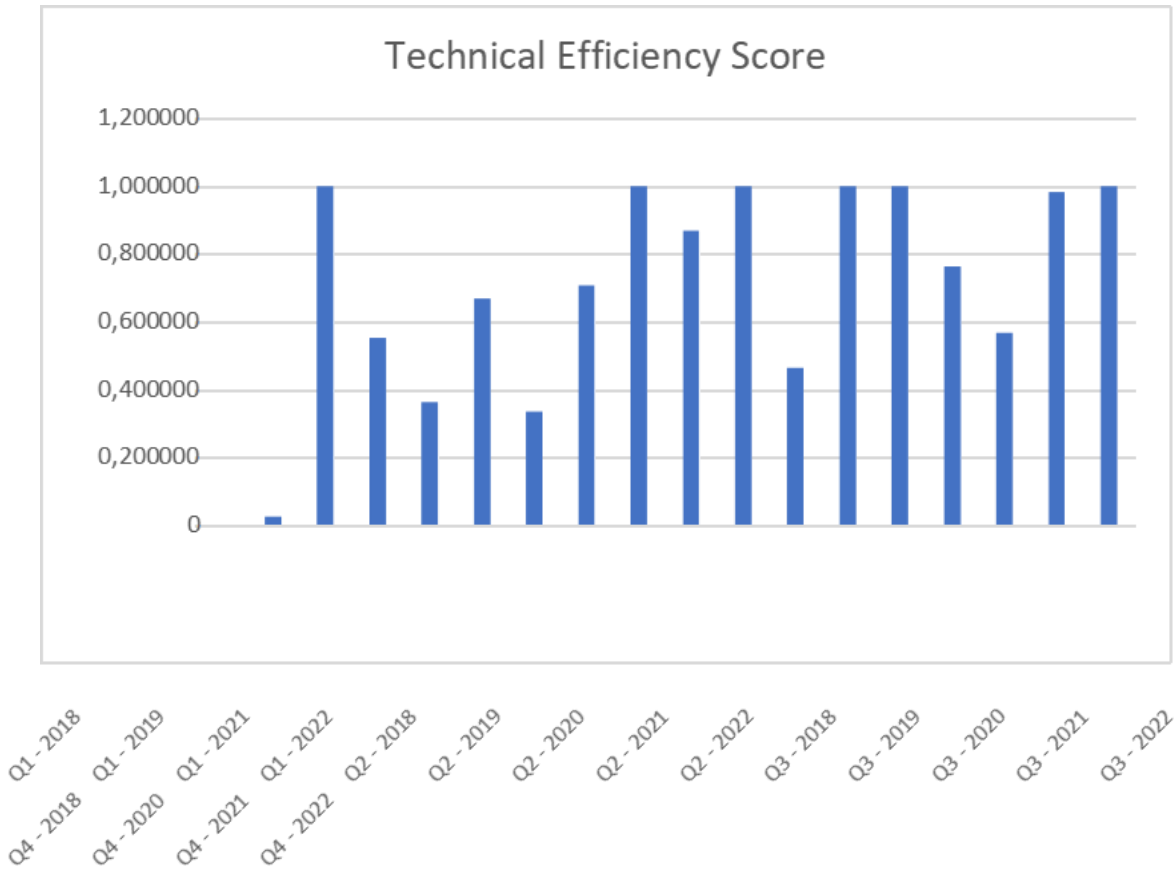

Figure 1. MSA's Technical Efficiency Scores (2018-2022)
Source: Data processing

The Data Envelopment Analysis (DEA) method enables inefficient decision-making units (DMUs) to evaluate and compare their performance with that of DMUs that are operating efficiently. This comparative analysis serves as a valuable tool for identifying potential areas for improvement and enhancing overall efficiency. In Table 1, we illustrate the specific quarters that are classified as efficient. These quarters include the first quarter of 2021, the second quarter of 2022, the third quarter of 2019, the third quarter of 2021, and the fourth quarter of 2022. By using these efficient quarters as benchmarks, DMUs that struggle with inefficiency can strategically assess their performance and implement changes to enhance their operational effectiveness.

In Q1 2019, the company recorded an exceptionally low efficiency score of 0.025244. The performance in Q3 2019 and Q4 2022 serves as relevant benchmarks for improving efficiency during this period, given their comparatively lower scores. In Q1 2022, the company again exhibited suboptimal efficiency, achieving a score of 0.552074.

Table 1. Peer-Group (Benchmarking Reference)

No.	DMU	Score	Benchmark (Lambda)
1	Q1 - 2019	0,025244	Q3 - 2019(0,006063); Q4 - 2022(0,003321)
2	Q1 - 2022	0,552074	Q1 - 2021(0,212115); Q2 - 2022(0,215429)
3	Q2 - 2018	0,363802	Q3 - 2019(0,171270); Q4 - 2022(0,101680)
4	Q2 - 2019	0,669439	Q3 - 2019(0,395085); Q4 - 2022(0,037097)
5	Q2 - 2020	0,335554	Q1 - 2021(0,017183); Q3 - 2021(0,297327)
6	Q2 - 2021	0,707401	Q3 - 2019(0,026025); Q4 - 2022(0,227239)
7	Q3 - 2018	0,870380	Q3 - 2019(0,212255); Q4 - 2022(0,241401)
8	Q3 - 2020	0,464241	Q3 - 2019(0,115910); Q4 - 2022(0,208039)
9	Q4 - 2018	0,762994	Q3 - 2019(0,636997); Q4 - 2022(0,253117)
10	Q4 - 2020	0,566951	Q3 - 2019(0,149469); Q3 - 2022(0,546428)
11	Q4 - 2021	0,983617	Q3 - 2019(0,140369); Q3 - 2022(1,014908)

Source: Data processing

For potential efficiency improvements, Q1 2021 and Q2 2022 can be referenced, as they demonstrate higher efficiency scores. Additionally, the periods of Q2 2018, Q2 2019, Q2 2020, Q2 2021, Q3 2018, Q3 2020, Q4 2020, and Q4 2021 consistently reported efficiency scores below 1, indicating operational inefficiency. For these instances, other quarters and years with similarly low efficiency scores can provide valuable reference points for enhancing efficiency.

Result of Mann-Whitney T-Test Analysis

The Mann-Whitney test is a non-parametric statistical method used to compare two independent groups. It is particularly useful when the data do not follow a normal distribution and when sample sizes are small. This test is appropriate for analyzing the efficiency values of MSA before and after the cross-border acquisition by Michelin. In this research, the Mann-Whitney test was conducted using the SPSS 25 software to assess the differences in the efficiency values of MSA during the specified research period.

Table 2 presents the results of the Mann-Whitney test, showing that the efficiency of MSA before the acquisition had a Mann-Whitney value of 23.5 and a significance value of 0.181. Since the significance value (p-value) of 0.181 is greater than 0.05, we accept the null hypothesis (H0). This indicates that the two populations being studied are identical, meaning there are no significant differences between them. Therefore, we conclude that there is no difference in the efficiency level of MSA before and after Michelin's cross-border acquisition.

Table 2. Mann-Whitney T-Test Result

DMU	Mann Whitney Value	Sinificance Value
Before Cross Border Acquisition by Michelin	23.5	0.181
After Cross Border Acquisition by Michelin		

Source: Data processing

Overall, there was no significant change in the efficiency and productivity of MSA before and after Michelin's acquisition. The main reason for the acquisition was to strengthen and expand in the rapidly growing Indonesian market. Michelin recognized MSA, a local tire manufacturer with a production capacity of over 180,000 tons, as a promising opportunity. This includes the production of 11 million units of tires for four-wheeled passenger vehicles, 9 million units for two-wheeled vehicles, and 250,000 truck tires. In 2017, prior to the acquisition, MSA recorded net sales of US$281 million.

Discussion and Implication

The combined insights from the Data Envelopment Analysis (DEA) and Mann–Whitney U test provide a comprehensive view of MSA's operational efficiency and productivity. The DEA results reveal notable fluctuations across quarters and years, with efficiency scores ranging from very low to optimal levels.

In Q1-2019, MSA recorded a markedly low efficiency score of 0.025, reflecting operational challenges and suboptimal resource allocation. Conversely, Q1-2021 achieved a perfect score of 1, signaling substantial improvements in operational processes and resource utilization. These shifts highlight the intermittent nature of the company's efficiency, characterized by periods of strong performance followed by downturn. Benchmarking against high-performing quarters, such as Q1-2021 and Q2-2022, can guide corrective measures during weaker periods, including Q1-2019 and Q1-2022. Persistently low scores across several other quarters, such as Q2-2018, Q2-2019, Q2-2020, Q2-2021, Q3-2018, Q3-2020, Q4-2020, and Q4-2021 indicate a need for sustained, long-term efficiency initiatives rather than short-term interventions.

Improving performance in low-scoring periods requires targeted strategies. For Q1-2019, the focus should be on optimizing material and capital management, reviewing supply chain structures, and refining capital allocation strategies. Even in relatively strong quarters like Q1-2022, there is still scope for enhancing labor productivity and capital utilization. Continuous monitoring, coupled with a commitment to innovation in resource management, will be crucial to sustaining high efficiency levels.

The results of the Mann–Whitney U test indicate that there is no statistically significant difference in efficiency when comparing the periods before and after Michelin's cross-border acquisition, with a p-value of 0.181, which is greater than the conventional threshold of 0.05. This finding implies that the acquisition did not have a significant impact on MSA's efficiency performance, suggesting that the company's operational effectiveness remained stable despite the changes brought about by the acquisition.

From a managerial perspective, these findings emphasize the importance of optimizing material and capital through streamlined processes, waste reduction, and improved capital allocation. Enhancing labor productivity is equally critical and can be achieved through targeted training and development programs designed to strengthen workforce efficiency. Continuous performance monitoring is crucial for ensuring the timely identification and resolution of operational inefficiencies, thereby preventing performance declines. Finally, adopting a long-term strategic approach that embeds sustainable operational practices aligned with industry's best practices will help secure consistent efficiency gains and support sustainable business growth.

Conclusion

This study evaluated MSA's efficiency and productivity through DEA Window Analysis and the Mann–Whitney U test, revealing significant variations in operational performance over time. While Q1-2019 marked a low point in efficiency, Q1-2021 represented an operational peak. Benchmarking high-performing quarters offers actionable guidance for improving weaker periods. The acquisition by Michelin did not yield a statistically significant change in efficiency levels, indicating that operational improvements or inefficiencies were likely driven by internal factors rather than ownership changes. To address efficiency challenges, MSA should focus on material and capital optimization, supply chain evaluation, and labor productivity enhancement, supported by continuous monitoring and innovation-driven resource management.

This study examines the efficiency and productivity of MSA, a single company in the automotive tire manufacturing sector. While it is limited by focusing on just one company, it offers valuable insights into MSA's performance and the factors affecting efficiency in the industry. Some researchers argue that analyzing fewer companies allows for a more in-depth comparison (Bengtsson & Larsson, 2012). Future research could investigate how acquisitions affect other firms in the sector and examine the benefits and challenges of consolidation strategies in Indonesia's automotive tire market.

Another limitation of this study is the reliance on secondary data, which may not provide a comprehensive understanding of the company's performance. Primary data collection through interviews or other direct methods could have provided more in-depth information on the factors influencing the efficiency and productivity of MSA. However, due to time and resource constraints, this study relies on secondary data sources. Despite this limitation, the study can still contribute to the understanding of the automotive tire manufacturing industry by identifying potential areas for improvement and developing strategies to enhance efficiency and productivity.

Future research could therefore expand the sample by examining multiple companies within the industry to evaluate whether acquisition effects are consistent across different contexts. It could also integrate primary data through interviews, surveys, or direct observations to uncover underlying efficiency drivers that may not be evident from secondary data alone. Additionally, assessing consolidation strategies would provide insights into both the benefits and challenges of mergers and acquisitions in the Indonesian automotive tire manufacturing market. By addressing these limitations, subsequent research could develop more targeted interventions and industry-wide strategies to enhance operational efficiency and support sustainable performance.

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