ANALYSIS OF EFFICIENCY AND ELASTICITY OF LABOR ALLOCATION IN MANUFACTURING INDUSTRY IN INDONESIA

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Abstract

The purpose of this study is to analyse the level of efficiency and elasticity of the large and medium manufacturing industry sector during 2012 - 2020 in the Indonesian Standard Industrial Classification (ISIC) 2-digit level (major groups 10 to 33), consisting of 24 types of manufacturing sub-industries. In this study, the Cobb-Douglas production function model with linear logarithmic was used to analyse the manufacturing efficiency index. The results showed that: (1) during the period 2012-2020, the production efficiency of the 2-digit ISIC sub-sector (24 sub-sectors) increased on average by 445% or 4.45 times, (2) all the output elasticity values of the 2-digit ISIC subsector (24 subsectors) were less than one ($E_L < 1$), which showed that the marginal value added of labour was lower than the average value added of labour, so that the additional allocation of labour in large and medium-sized industries tended to reduce the average value added of labour, (3) the highest efficiency index in order were ISIC 26 (computer, electronic and optical products), ISIC 17 (paper and paperboard), ISIC 18 (electrical machinery and equipment), ISIC 19 (machinery and equipment) and ISIC 20 (machinery and equipment); ISIC 17 (paper and paper products); ISIC 31 (furniture) and ISIC 29 (motor vehicles, trailers and semi-trailers).

Keywords: efficiency, elasticity, ISIC, manufacturing industry, added value, employment

Article History: Received: 20 October 2023  Revised: 27 October 2023  Accepted: 29 October 2023
INTRODUCTION
The manufacturing industry has historically been a significant contributor to Indonesia's economy, but it has been impacted by the Covid-19 pandemic since the first quarter of 2020. From 2017 to 2022, the manufacturing industry's contribution to the Gross Domestic Product (GDP) peaked at 21.22% in 2017 and reached its lowest point at 20.17% in 2022. This sector has the highest contribution to GDP compared to other sectors. The growth rate of the number of manufacturing industries was negative in 2020 (-2.08%) but rebounded to 6.28% in 2022. However, overall, the growth rate remained positive with an average annual rate of 3.32% during the 2017-2022 period. The manufacturing industry also employs the largest portion of workers, accounting for an average of 14.25% of total employment. This indicates a transformation from the agrarian sector in Indonesia.

The Indonesian government has implemented 10 national priorities in 2018 to face the Industrial Revolution 4.0. One of the pillars is to improve human resources. This increase in human resources can be illustrated by an increase in labour productivity. However, the labour productivity of medium and large manufacturing industries in 2020 has decreased compared to previous years. The labour productivity in 2020 is IDR 485.42 million per worker. Productivity in large industry was IDR 483.97 million per worker and medium industry productivity was IDR 494.78 million per worker (BPS, 2022).

The development of the manufacturing industry is certainly an important thing to examine and analyse, so as to obtain a picture that can be used as a basis for policy making. One aspect of the manufacturing industry that can be analysed is the contribution in value-added output, efficiency, and labour elasticity. The relationship between value-added contribution and labour allocation in the manufacturing industry can be seen from the level of efficiency in the use of labour input. Langemeier (2015) stated that labour efficiency refers to labour productivity, which is the amount of output that can be produced per unit of labour input. In other words, labour efficiency measures how well a company utilises its workforce to achieve its goals.

Based on this phenomenon, understanding the efficiency of labour allocation in the manufacturing industry is interesting to study, because labour is the main input factor in producing value-added production. This study focuses on the large and medium manufacturing industry (LMM) sector according to the Indonesian Standard Industrial Classification (ISIC) 2 digits (major groups 10 to 33) consisting of 24 types of manufacturing sub-industries during 2012-2020. Thus, the research question raised is how is the level of efficiency and elasticity of the large and medium manufacturing industry sector in the 2-digit Indonesian Standard Industrial Classification (ISIC)?

THEORETICAL REVIEW
Productivity And Efficiency
Productivity and efficiency have distinct meanings. Productivity refers to the rate at which a company or country produces goods and services, which is typically assessed by the amount of output for each worker (Simplelearn, 2023; Kelton, 2022; Gordon et al., 2015; Kumar et al., 2016). It represents the measure of output per unit of input, such as labour, capital, or other resources (Kelton, 2022; Pachecho, 2014; Castelle, 2017). The level of productivity directly correlates to the performance and quality of products produced (Hanaysha, 2016). Conversely, efficiency is achieved with optimal performance at minimal input to yield maximum output (Banton, 2022). Efficiency demands the reduction of redundant resources to achieve a desired output, including personal time and energy (Nordmeyer, 2019). Efficiency can be quantified as the ratio of useful outputs to total inputs, as Banton (2022) and Rizwan et al (2021) suggest. Productivity gauges output per worker or input, whereas efficiency measures the amount of useful output compared to total input.

Labour Efficiency
To measure workforce efficiency, an organisation needs to gather data on multiple
aspects of its workforce, including employee attendance rates and productivity (Rizwan et al., 2021). Labour efficiency denotes the effectiveness of workers in accomplishing tasks and meeting goals within a specified period. The analysis of these aspects supports the organisation in improving overall productivity. Labour efficiency measures the quantity of work carried out by an individual or team with regards to the resources (time, materials, and other inputs) employed to perform the task (Tukhtabaev, 2013). The objective of labour efficiency is to maximise labour output while minimizing resource usage.

Labour efficiency is concerned with labour productivity, the volume of output that can be generated per unit of labour input (Bogoviz, 2019). Labour efficiency gauges a company’s effectiveness in utilizing its workforce to reach its objectives. It refers to labour productivity, i.e., the quantity of output produced per unit of labour input (Abukhalaf & Abusal, 2021). Multiple methods can be employed to measure labour efficiency:

1. Labour productivity is the ratio of total output to the total number of hours worked by employees (BLS, 2023; OECD, 2023).
2. The employee utilisation rate measures the proportion of time that employees devote to productive tasks. To calculate productivity, divide the accumulated productive task hours by the available working hours (Jay, 2023; Leeuwen, 2021; OECD, 2023).
3. The employee turnover rate measures how frequently workers depart from the organisation. A high rate of employee turnover can have adverse effects on labour efficiency, as it reduces the availability of experienced workers for task completion (Pavlou, 2023).

Cobb-Douglas Production Function

The linear-logarithmic Cobb-Douglas production function is the most commonly used production function which provides crucial information about the efficiency index and elasticity index. According to Gasperz (2011), the concept of the production function can be used to simply explain the efficiency index measurement. Abbreviations of technical terms will be explained upon first use.

The Cobb-Douglas production function is a popular efficiency measurement model that considers the relationship between output (Q) and input (X). The efficiency index is expressed by a constant ($\alpha$), reflecting this relationship, and the elasticity index is the ratio of changes between output and production factors. The efficiency index is expressed by a constant ($\alpha$), reflecting this relationship, and the elasticity index is the ratio of changes between output and production factors. The efficiency index is expressed by a constant ($\alpha$), reflecting this relationship, and the elasticity index is the ratio of changes between output and production factors. This model is widely used in productivity analysis. Basically, the Cobb-Douglas model is a non-linear regression equation that follows the given model (Cottrell, 2019):

$$Y = AK^\alpha N^{1-\alpha} \quad 0 < \alpha < 1$$

Where $Y$ represents the total output of goods and services, $K$ stands for capital input and $N$ represents labour input. Capital and labour are referred to as the two “factors of production” within this function. The term $A$ refers to Total Factor Productivity. It can be considered as a measure of quality, as opposed to $K$ and $N$ which are solely quantitative. The value of $A$ reflects the level of technology as well as the skills and education of the workforce. Assuming smooth progress, $A$ will gradually increase over time. The efficiency parameters are reflected in the value of $A$. The elasticity index is denoted by $\alpha$. Linear logarithm form can be employed in the Cobb-Douglas function model as follows:

$$\ln Y = \ln A + \alpha \ln K + (1- \alpha) \ln N + \mu$$

The model comprises the production function, which depicts the relationship between the output and the input factors. The model assumes that production factors are taken in varying proportions, with capital and labour being the primary factors of production. It is essential to note that the Cobb-Douglas model follows an objective approach, without subjective evaluations, and maintains a formal register to convey precise information. Additionally, the model adheres to conventional structure and consistent technical terms for easy comprehension (Knowledgeable Team, 2017; Miller, 2008).

Previous Studies

The findings from Salimova et al (2022) study reveal that labour efficiency in Russian regions is greatly influenced by technical equipment and crop yields. To enhance labour productivity, it is essential to offer employees extra motivation. Tukhtabaev et al (2021) conducted a multi-factor analysis
indicating that the level of productivity and labour efficiency in the textile industry is largely determined by the number of workers, amount of production, working hours, and incurred costs. Meanwhile, Zulfigar and Ilgar (2019) investigated the correlation between efficient use of labour resources and the economy in Azerbaijan. The study revealed that the rise in labour has a greater impact on the Gross Domestic Product in Azerbaijan's manufacturing sector compared to the impact of capital and innovation expenses. Consequently, it can be inferred that labour is still the predominant factor in manufacturing sector production, and the current level of innovation has not yet adequately augmented the total factor productivity.

Kostyukhin (2016) found in their study that the growth in coal output resulted from improved efficiency, operational and resource savings, decreased labour intensity and substantial quality standard improvements. They also noted a reduction in production costs and increased competitiveness. Hossain and Majumder (2015) investigated the capital efficiency and elasticities of labour and capital using the Cobb-Douglas function. The results of the estimation indicate that estimating the elasticities of capital and labour for the Cobb-Douglas production function with additive errors is more effective than estimating it with multiplicative errors.

According to Hariastuti (2010), the Cobb-Douglas production function can reveal that variations in the addition or reduction of labour will affect labour productivity. Ali et al (2009) investigated the food manufacturing industry in India and identified that the availability of resources, labour, technology, a large market, and a favourable business environment influence the potential for value addition. However, the growth of the Indian food manufacturing industry is primarily restricted due to the inadequate use of resources and the scarcity of productivity-enhancing technologies. Therefore, technology plays a crucial role in improving growth and efficiency in the food manufacturing industry.

**METHOD**

The objective of the research is to determine the labour force and the output value (value added) of Indonesia's manufacturing industry, comprising large and medium scale industries. The investigation encompasses the manufacturing sector, classified under the 2-digit ISIC and comprising of 24 sub-sectors, as indicated in Table 1 below. The study uses secondary data from Indonesia's large and medium industries, consisting of cross-sectional data on the number of workers and output value from 2012 to 2020.

The study data is obtained from the Indonesian Central Bureau of Statistics (BPS-Statistics Indonesia). The study uses descriptive analysis to examine the correlation between labour allocation, output value, and productivity. To examine the effectiveness of labour allocation in large and medium industries, we performed a short-term analysis of the Cobb-Douglas production function as proposed by Gasperz (2011). The analysis must meet certain requirements, as follows: (1) Total output cannot be negative ($Q > 0$), thus the intercept coefficient (constant) must be positive ($\alpha > 0$); (2) there must be a causal connection between statements. The positive marginal product of the input factor and a positive output elasticity coefficient ($\beta > 0$) are necessary. It is assumed that other input factors are considered constant, and there is only one variable input, namely the amount of labor.

<table>
<thead>
<tr>
<th>ISIC Code</th>
<th>Division of Manufacturing</th>
<th>ISIC Code</th>
<th>Division of Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Food products</td>
<td>22</td>
<td>Rubber and plastic products</td>
</tr>
<tr>
<td>11</td>
<td>Beverages</td>
<td>23</td>
<td>Other non-metallic mineral products</td>
</tr>
<tr>
<td>12</td>
<td>Tobacco products</td>
<td>24</td>
<td>Basic metals</td>
</tr>
<tr>
<td>13</td>
<td>Textiles</td>
<td>25</td>
<td>Fabricated metal products except machinery</td>
</tr>
</tbody>
</table>
Thus, the short-run Cobb-Douglas production function is expressed as follows:

\[ Q_t = \alpha L_t^\beta \]

where \( Q \) is the total output value (in Rupiah) of large and medium industry sector \( i \) in year \( t \), \( L \) is the input (number of labour) in large and medium industry \( i \) in year \( t \), \( \alpha \) is the constant/intercept value which shows the efficiency index. The bigger the value of \( \alpha \) means the higher the efficiency of labour allocation. Parameter \( \beta \) is the output elasticity of \( L \).

**RESULTS AND DISCUSSION**

**Profile of Large and Medium Manufacturing Industry**

According to the results of the 2020 Annual Survey of Manufacturing Industry Companies, there were 29,363 companies operating at large and medium scales within the manufacturing industry, indicating a 2.36% decrease in the number of such companies as compared to the previous year. This trend demonstrates a sustained downturn from 2016 to 2020, with an average decline of 4.33% in the number of large and medium-sized manufacturers observed during this period. The leather and related products and footwear industry (ISIC 15) witnessed a significant decline with a decrease in the number of companies by 14.87%. The wearing apparels industry (ISIC 14) also experienced a decline of 14.57% compared to the number of companies in 2019. In 2020, the food products industry (ISIC 10) emerged as the most dominant sector in the large and medium industry with 6,677 companies, constituting 22.74%. The rubber and plastic products industry (ISIC 22) comprises the most substantial segment with 2,518 companies, or 8.58 per cent. Next in line is the wearing apparels industry (ISIC 14) with 2,146 enterprises or 7.31 per cent.

In 2020, the Indonesian manufacturing landscape was overwhelmingly dominated by medium-scale manufacturing companies. Specifically, there were 19,305 medium-scale manufacturing companies and 10,058 large-scale manufacturing companies. The data suggests that 65.75% of manufacturing companies in Indonesia belong to the medium-scale category, while the remaining 34.25% consist of large-scale manufacturing entities (BPS, 2022).

In 2020, the large and medium industries in Indonesia were able to employ 5,902,367 workers, contributing to 4.59% of the country's total labour absorption. However, there was a decrease in the absorption rate of these industries compared to the previous year. In 2016, these sectors employed 6,390,923 workers.
workers, which increased to 6,614,954 in 2017 and reached 6,123,185 in 2018. In 2019, the combined large and medium industrial workforce decreased to 6,241,121 employees. Large industrial companies have a higher rate of labour absorption compared to medium-sized companies. Large industrial labour contributed an average of 86.55% from 2016 to 2020. In contrast, employment in medium-sized industrial companies accounts for 13.45% of all manufacturing industry companies. The subsector of the manufacturing industry with the highest employment is the food products industry (ISIC 10), which employs 16.76% of the workforce. Following this, the wearing apparels industry (ISIC 14) employs 11.79%, the textiles industry (ISIC 13) employs 8.80%, the leather, leather goods and footwear industry subsector (ISIC 15) employs 7.53%, and the rubber, rubber and plastic goods industry subsector (ISIC 22) employs 7.46%. In terms of business scale, the food products (ISIC 10) employs the highest %age of workers in large industry at 15.87%. The wearing apparels (ISIC 14) employs the next largest at 12.65%, followed by the textile (ISIC 13) at 9.08%. In medium industry, the food products (ISIC 10) has the largest labour absorption rate of 22.48%. The textile (ISIC 13) and the wearing apparels (ISIC 14) recorded the highest medium industry labour absorption rates at 6.98 per cent and 6.24 per cent respectively, according to BPS (2022).

The value added of large and medium industries decreased rapidly in 2020, the value of the decrease reached 9.58%. The value added of large and medium industries in 2019 was IDR 3,168,756 billion, which decreased to IDR 2,865,133 billion in 2020. The value added of large and medium industries in 2020 is supported by the value added of large industries of IDR 2,472,310 billion and the value added of medium industries of IDR 392,823 billion. The subsectors of large and medium industries with the highest value added are the subsector of food products industry (ISIC 10) with IDR 608,155 billion, the chemical and chemical products (ISIC 20) with IDR 282.837 billion, the manufacture of motor vehicles, trailers and semi-trailers (ISIC 29) at IDR 198,481 billion, the manufacture of basic metals (ISIC 24) at IDR 195,947 billion, the manufacture of electrical equipment (ISIC 27) at IDR 154,956 billion, and the manufacture of tobacco products (ISIC 12) at IDR 150,688 billion (BPS, 2022).

Labour productivity of large and medium manufacturing industries in 2020 has decreased. Labour productivity in 2020 will be IDR 485.42 million per worker. The productivity of large industry was IDR 483.97 million per worker and the productivity of medium industry was IDR 494.78 million per worker. Industrial subsectors with high productivity are basic metals (ISIC 24) with IDR 1,253 billion, chemicals and chemical products (ISIC 20) with IDR 1,166 billion, electrical equipment (ISIC 27) with IDR 1,154 billion, wearing apparels (ISIC 14) with IDR 881.85 billion, leather and related products and footwear (ISIC 15) with IDR 772.09 billion. The industrial subsectors that need to improve their labour productivity are the manufacture of other transport equipment (ISIC 30) with IDR 184.98 billion, the manufacture of furniture (ISIC 31) with IDR 169.22 billion, the manufacture of other manufacturing (ISIC 32) with IDR 166.49 billion, and the repair and installation of machinery and equipment (ISIC 33) with IDR 165.62 billion (BPS, 2022).

Estimation of Efficiency and Elasticity Levels for Total Large and Medium Industries

A linear-logarithmic regression equation is derived for large and medium manufacturing industries from 2012 to 2020 using OLS estimation. The constant value (a) represents the efficiency index of labour allocation within the Cobb-Douglas production function model. In order to acquire the efficiency index for labour input allocation, the linear-logarithmic regression equation is applied to the Cobb-Douglas production function model by using anti-Ln with the base number e = 2.71828. This allows for a comparison of the constant value between years, revealing any changes in production efficiency - whether it has increased or decreased. Table 2 displays
the efficiency index based on the Cobb-Douglass production function, the linear regression equation, and changes in production efficiency for medium and large industries from 2012 to 2020.

The regression equation for 2012 is $\ln Q = 0.628 + 0.813 \ln L$, for 2013 it is $\ln Q = 0.723 + 0.824 \ln L$, and so on. The original Cobb-Douglass function model was obtained by transforming this equation:

Year 2012: $Q = e^{0.628} L^{0.813}$

Year 2013: $Q = e^{0.723} L^{0.824}$

Table 2. Efficiency Index of Cobb-Douglass Production Function, 2012-2020

<table>
<thead>
<tr>
<th>Year</th>
<th>Constant</th>
<th>Ln L</th>
<th>Index of Efficiency</th>
<th>Production Efficiency</th>
<th>Change in Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>0.628</td>
<td>0.813***</td>
<td>1.874</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2013</td>
<td>0.723</td>
<td>0.824***</td>
<td>2.061</td>
<td>1.0997</td>
<td>Increase 9.97%</td>
</tr>
<tr>
<td>2014</td>
<td>0.711</td>
<td>0.836***</td>
<td>2.036</td>
<td>0.9881</td>
<td>Decrease 1.19%</td>
</tr>
<tr>
<td>2015</td>
<td>1.555</td>
<td>0.781***</td>
<td>4.735</td>
<td>2.3256</td>
<td>Increase Naik 132.56%</td>
</tr>
<tr>
<td>2016</td>
<td>5.084</td>
<td>0.484**</td>
<td>161.418</td>
<td>34.0898</td>
<td>Increase 3309%</td>
</tr>
<tr>
<td>2017</td>
<td>4.459</td>
<td>0.565***</td>
<td>86.401</td>
<td>0.5353</td>
<td>Decrease 46.47%</td>
</tr>
<tr>
<td>2018</td>
<td>3.778</td>
<td>0.632***</td>
<td>43.728</td>
<td>0.5061</td>
<td>Decrease 49.39%</td>
</tr>
<tr>
<td>2019</td>
<td>4.856</td>
<td>0.544***</td>
<td>128.509</td>
<td>2.9388</td>
<td>Increase 193.88%</td>
</tr>
<tr>
<td>2020</td>
<td>4.926</td>
<td>0.531***</td>
<td>137.827</td>
<td>1.0725</td>
<td>Increase 7.25%</td>
</tr>
</tbody>
</table>

Dependent variable: $\ln Q$

***) sign. $\alpha=0.01$  **) sign. $\alpha=0.05$  *) sign. $\alpha=0.10$

Source: Data processing results

The production efficiency in 2013 compared to 2012 was therefore: $2.061/1.874 = 1.0996$. This means that the production efficiency has increased by 9.97%. Using the same calculation method, the production efficiency until 2020 can be obtained as shown in Table 2 above. All efficiency index coefficients are positive, as assumed in the estimation of the Cobb-Douglass function (Gasperz, 2011). The highest increase in production efficiency occurred from 2015 to 2016, by a factor of 33 times (3309%). Then, from 2018 to 2019, it increased by 193.88%. On average, production efficiency increased by 445% or 4.45 times during the period 2012 - 2020.

The output elasticity of labour ($E_L$) is then given by the coefficient of the variable $\ln L$. For 2012, the value of $E_L = 0.813$, which means that a 1% increase in the allocation of labour can only increase value added by 0.813%. The magnitude of $E_L$ is less than one ($E_L < 1$). All output elasticities for the period 2012-2020 are less than one. This shows that during the period 2012-2020 the marginal value added of labour is lower than the average value added of labour, so that the additional allocation of labour in large and medium-sized industries tends to reduce the average value added of labour. The regression estimation results in Table 2 also show that the labour variable has a positive and significant effect on the value added of large and medium-sized industries during the period 2012-2020.

Estimation of Efficiency and Elasticity Index for ISIC Subsectors

The linear regression equation and efficiency index based on Cobb-Douglass production function for each subsector are presented in Table 3 below:

Table 3. Ranking of Cobb-Douglass Production Function Efficiency Index for ISIC Subsectors, 2012 – 2020

<table>
<thead>
<tr>
<th>No</th>
<th>Subsectors</th>
<th>Constant</th>
<th>Ln L</th>
<th>Efficiency</th>
<th>No</th>
<th>Subsectors</th>
<th>Constant</th>
<th>Ln L</th>
<th>Efficiency</th>
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</table>
An example of the analysis, for the ISIC 10 subsector, the regression equation is $\ln Q = -33.382 + 3.363 \ln L$, for the ISIC 11 subsector it is $\ln Q = -3.544 + 1.222 \ln L$, and so on. This equation is then transformed into the original Cobb-Douglas function model:

$$Q = e^{\text{33.382 \cdot L^{3.363}}} = (2.71828)^{\text{33.382 \cdot L^{3.363}}}$$

In the Cobb-Douglas function of the ISIC 10 subsector, the coefficient $\alpha = 3.180E-15$ and of the ISIC 11 subsector, the coefficient $\alpha = 2.890E-02$ shows the efficiency index of labour input. Using the same calculation method, the efficiency indices for the other subsectors can be obtained, as shown in Table 3. All coefficients of the efficiency index and elasticity index are positive, as assumed in the estimation of the Cobb-Douglas function (Gasperz, 2011). Based on the table, the highest sub-sector efficiency indexes, in order, are ISIC 26 (computer, electronic and optical equipment industry); ISIC 17 (paper and paper products); ISIC 31 (furniture) and ISIC 29 (motor vehicles, trailers and semi-trailers).

Some potential factors that may impact industrial production efficiency include automation techniques, just-in-time manufacturing, global supply chains, and lean manufacturing, which could result in decreased labour usage. As highlighted by Acemoglu and Restrepo (2019), automation has the capacity to take over tasks that were previously performed by human labour, leading to a shift in the focus of production tasks towards labour because of displacement effects. As a consequence, the incorporation of automation invariably diminishes the contribution of labour to the value added and could even curtail the demand for labour despite the increased efficiency. Nevertheless, the adverse impact of automation is moderated by the emergence of novel tasks that align with the comparative advantage of the workforce. According to Aghion et al (2022), the extensive employment of automated machinery and robotics in manufacturing can lower the reliance on manual labour and enhance productivity. This technology has the capability to efficiently and accurately perform monotonous tasks, consequently increasing productivity. Javadian Kootanaee (2013) recommends just-in-time manufacturing (JIT) practices as a means of minimising inventory while reducing the need for excessive labour to manage and store raw materials and finished goods. Additionally, global supply chains have
an impact on industrial efficiency. According to Shih (2020), manufacturing often depends on global supply chains, which can help obtain materials and components from regions with labour and production cost advantages. Lean manufacturing has become prevalent in enhancing production efficiency. Tortorella et al (2020) posit that these principles can reduce waste and boost production procedures, hence facilitating more effective use of resources and labour.

The output elasticity of labour (EL) is then given by the coefficient of the variable Ln L. For the ISIC 10 subsector, the value of EL = 3.363 means that a 1% increase in the labour input can increase value added by 3.363%. The same interpretation can be made for the EL of other subsectors. There are 30 ISIC subsectors (91%) with output elasticity values greater than one (EL > 1). This means that 91% of ISIC sub-sectors have a marginal value added of labour that is higher than the average value added of labour, so that an additional allocation of labour in large and medium-sized industries tends to increase the average value added of labour. On the other hand, for the remaining ISIC sub-sectors (11%), namely ISIC 26, 29 and 30, the value of EL is < 1, which means that the additional allocation of labour in large and medium-sized industries tends to reduce the average value added of labour.

Jongwanich et al (2022) and Younus (2021) explain that technological progress can increase the elasticity of industrial output. The introduction of advanced technology and automation can significantly increase the output elasticity of labour. When machines and technology are used to augment human labour, workers become more productive, resulting in higher output per unit of labour. Ras et al (2017) argue that improving the skills of the labour force can increase output elasticity. Trained and skilled workers tend to be more efficient and can perform tasks more effectively, resulting in higher productivity. In addition, employee commitment to the firm's organisation can also play a role in increasing productivity. Moletsane et al (2019), Saxena & Srivastava (2015) explain that engaged and motivated employees are often more productive. Building a positive work culture, recognising and rewarding employees, and promoting a sense of ownership can all contribute to higher output elasticity.

Labour productivity elasticity may arise as a result of capital-intensive factors where industries mainly employ technology in the production process. Industries that mainly rely on machinery and technology tend to be capital-intensive, which can decrease the influence of labour input on total output (Mokyr et al., 2015). While capital-intensive systems can enhance efficiency and precision, they may also compromise the labour output elasticity. This can lead to a less responsive industry in terms of alterations in the labour force. Consequently, industries may experience a reduction in converting labour input into output. Manjappa and Mahesa's (2008) research in India has determined that capital-intensive industries perform better than labour-intensive industries. As such, there is an essential requirement to implement new technologies and attract Foreign Direct Investment (FDI) to enhance productivity in labour-intensive sectors. This is supported by Khan and Thimmaiah's (2015) findings, which suggest that structured capital-intensive manufacturing industries can enhance overall factor productivity growth, while labour-intensive manufacturing industries experience negative total factor productivity growth due to a deficiency of technological advancements.

CONCLUSIONS AND SUGGESTIONS

Based on the analysis of data and information related to the research objectives, it can be concluded that:

1. On average, from 2012 to 2020, the production efficiency of 24 subsectors of 2-digit ISIC increased by 445% or 4.45 times.

2. During the same period, all output elasticity values of the 24 subsectors of 2-digit ISIC were lower than one (EL < 1). During the period spanning 2012 to 2020, it was found that the marginal value added of labour was lower than its average value, indicating a reduction in average value added of labour resulting from additional allocation of labour towards large and medium industries.

3. The sub-sectors with the highest efficiency indices, listed in order, are ISIC 26 (computer, electronic and
optical goods industry); ISIC 17 (paper and paper goods industry); ISIC 31 (furniture industry); and ISIC 29 (motor vehicle, trailer and semi-trailer industry). These industries exhibit superior performance in their respective fields.

4. Twenty-one ISIC sub-sectors (87.50%), specifically sub-sectors 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 31, 32, and 33, exhibit output elasticity values greater than one ($E_L > 1$). This signifies that 87.50% of ISIC sub-sectors have a higher marginal value added of labour than the average value added of labour. Therefore, additional allocation of labour in large and medium industries is likely to increase the average value added of labour.

5. Other ISIC sub-sectors (22.50%), specifically ISIC sub-sectors 26, 29 and 30 exhibit an $E_L < 1$ which demonstrates that additional allocation of labour in large and medium industries has a tendency to decrease the average value added of labour.

Improving the efficiency of labour allocation requires optimising the use of labour resources, increasing productivity, and remaining competitive in the market. For this, efforts need to be made such as:

1. Implement a robust workforce planning strategy to align labour resources with production needs.
2. Matching labour skills and abilities with job roles.
3. Identify tasks that can be automated using technology.
4. Apply lean manufacturing principles to eliminate wastage and optimise labour allocation.
5. Establish an Enterprise Resource Planning system that can help automate and optimise labour allocation, taking into account factors such as skills, availability, and demand.

REFERENCES


BPS (2023), Tabel-tabel: Proporsi Nilai Tambah Sektor Industri Manufaktur Terhadap PDB, Laju Pertumbuhan Industri Manufaktur, dan Proporsi Tenaga Kerja Pada Sektor Manufaktur, Periode


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