

Determining Leading Industries in Optimizing Downstream Potential of North Sumatra Province: an Input-Output Approach

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<i>Article Info</i>	<i>Abstract</i>
<p><i>Article history:</i> Received March 29, 2023 Revised July 10, 2023 Accepted July 31, 2023 Available online July 31, 2023</p> <p><i>Keywords:</i> Input-Output, RAS, Manufacture Industry, Economy Recovery</p> <p>JEL Classification: R11, E32, O11, O21</p>	<p><i>The economic condition of North Sumatra province due to the COVID-19 pandemic has weakened, especially on the supply side, by a negative growth rate in the productivity of the business sector. Industrial downstream could boost economic recovery and inclusive development by creating solid domestic relations with supporting regional industries and increasing high-value-added exports. This study aims to identify priority sectors and analyze the impact of these priority sectors on the manufacturing industry in North Sumatra based on linkage analysis using data during the economic recovery. The data from the I-O table of North Sumatra province in 2016 was sourced from the Central Statistics Agency (BPS) and covered 50 economic sectors. In addition, this study also used data on the GRDP of North Sumatra in 2021. This study applied the RAS Method to determine the value of the technical coefficient matrix of the input-output table in 2021. Then, this study also calculated the value of forward and backward linkages, output multiplier, value-added multiplier, and inoperability. The results revealed three priority sectors in North Sumatra, the Food and Beverage industry; the Base Metal industry; and the Paper and Paper Goods industry, Printing and Reproduction of Recording Media. The study recommends that the government encourage the acceleration of infrastructure by providing financial and policy support to these leading sectors and facilitating distribution channels so that industrial downstream runs optimally to the overall economy.</i></p>

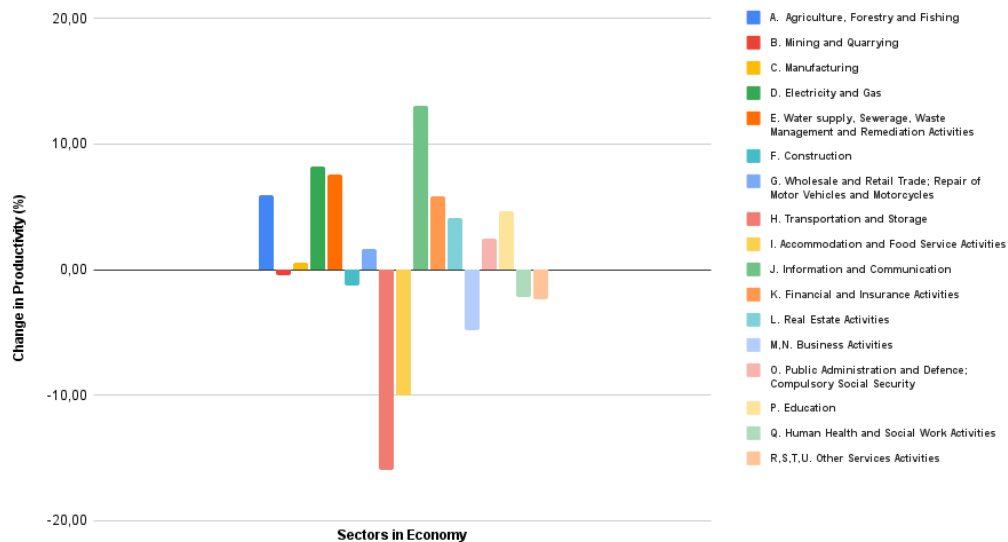
INTRODUCTION

The spread of the COVID-19 pandemic, followed by many people's physical mobility, caused an economic crisis worldwide. Unlike the previous economic concerns, such as the "great depression" in 1929 to the global financial crisis in 2008, the COVID-19 pandemic caused a weakening of both sides of the economy, demand, and supply (Ba & Bai, 2020). This impact is quite visible in the economy of North Sumatra province, where in 2020, the level of household consumption decreased by 2.98 percent, accompanied by a negative growth rate in the productivity of the business sector (BPS Sumatera Utara, 2021a). This condition was accompanied by other negative implicates, such as an increase in the number of poor people and an increase in the open reaction rate (BPS Sumatera Utara, 2021b).

In response to these problems, the central government, through the National Economic Recovery (PEN) program, which the North Sumatra provincial government is also implementing, is trying to boost the economy, both from the demand and supply sides. The government is spending money to handle COVID-19 through vaccinations and enforcing health protocols so people can

return to normal activities. In addition, the government is also pushing the economy from the demand side by restoring the level of public consumption through social assistance programs, such as unconditional cash transfer or (*Bantuan Langsung Tunai/BLT*), food assistance in the form of necessities, electricity subsidies, and the pre-employment card program (*Kartu Pra Kerja*) (Ahda & Mahudin, 2020). On the supply side, the government is pushing for it by establishing five policies, including opening a productive sector that is safe nationally and regionally, accelerating fiscal realization, increasing bank credit, continuing monetary and macroprudential stimulus, and accelerating economic and financial digitization, especially in the development of MSMEs (Bank Indonesia, 2020).

Graph 1. Changes in Sectoral Productivity of North Sumatra Province in 2021 Compared to 2019 (In Percentage)



Source: BPS 2020, Data Processed

The impact of these policies helped recover the economy of North Sumatra. It can be seen in 2021 when household consumption increased and was accompanied by improved business sector performance compared to 2020 (BPS Sumatera Utara, 2022). Nonetheless, the economic condition of North Sumatra has yet to recover fully, especially from a supply-side perspective. It can be seen in the productivity of several sectors, such as (i) mining and quarrying, (ii) construction, (iii) transportation and warehousing, (iv) provision of accommodation and food and drink, (v) corporate services, (vi) health and social activities, and (vii) other services that are still under pre-pandemic conditions.

To fully restore the economy, the North Sumatra provincial government must implement various incentives (such as subsidies and tax breaks) to increase the productivity of economic sectors. However, implementing these incentives cannot be carried out thoroughly due to the limited financial

resources owned by the government (Foong et al., 2022a). Therefore, an analysis is needed to determine priority sectors that impact other sectors. The urgency of implementing this analysis aligns with the potential for industrial downstream transformation owned by the province of North Sumatra. The abundant availability of raw materials, location, and level of agglomeration can encourage an increase in the added value of primary commodities through industrialization (Bappenas, 2020).

Industrialization will increase the manufacturing sector's role, which has the most significant multiplier effect on all economic sectors (Lenchuk, 2016). It can be seen from the strong linkages of the manufacturing industry to other sectors, both based on forward linkage (use of inputs from other sectors) and backward linkages (providing inputs for other sectors) (Yülek, 2017). In addition, the manufacturing industry is vital in creating fast economic growth and can last for a long time, at least for the past two decades (Haraguchi et al., 2017). Sector growth will also encourage the availability of broader employment opportunities and better wages so that they can contribute to poverty alleviation (Lavopa & Szirmai, 2012). Therefore, downstream industries centered on the manufacturing industry can be a solution for accelerating growth and economic development in a region.

Several studies have been conducted empirically to determine priority sectors after the economic shock because of the Covid-19 pandemic. Avenyo et al. (2021) use the IO model to determine priority sectors in the manufacturing industry group to encourage economic recovery in South Africa. Five components are considered in determining priority sectors in this study: power dispersion index, structural significance relative to the industry, average propagation length, sectoral purchase coefficient, and inoperability multiplier. Then, Foong et al. (2022b) by expanding on the IO approach carried out by Yu et al. (2014), determines priority sectors for recovery in the oleo-chemical industry in Malaysia based on aspects of economic impact, connectivity, sector size, income multiplier, and inoperability—meanwhile, Amheka et al. (2021) that also applies the IO model, pays attention to four components in determining priority sectors in East Nusa Tenggara Province. These include economic impact, sector connectivity, size, and income multiplier.

This study differs from previous studies, such as using some analysis steps. First, Input-Output tables using the RAS method to estimate the economic technology matrix in North Sumatra Province. Then, analyzing Inter-Sector Linkages and classifying the industries into four groups. In addition, output multiplier, value-added multiplier, and inoperability analysis were conducted to determine the leading industry subsectors in North Sumatra.

The current study has two objectives. First, it aims to identify priority sectors in the manufacturing industry in North Sumatra based on linkage analysis using data during the economic recovery. Even though the government has implemented a series of policies to recover North Sumatra's economy, several productivity sectors have not yet reached the conditions before the pandemic. Limited funds owned by the government become a problem in

encouraging productivity growth in the overall economic sectors. Therefore, determining priority sectors that can positively impact other sectors is a critical issue to be carried out.

Secondly, this study also aims to analyze the impact of priority sectors and the challenges faced in their development in North Sumatra. The downstream potential and the possibility of high linkage effects from the manufacturing industry sector can be reasons for the government to prioritize this sector. However, the manufacturing industry's impact on other sectors must be studied empirically. It is because many sub-sectors within the industry allow variations in the value of linkages. In addition, previous literature that examines the manufacturing industry's linkages to other economic sectors in North Sumatra is still scarce, especially when using data during the economic recovery. Hence, this study will provide recommendations and strategies for meeting challenges to develop priority sectors based on research results.

RESEARCH METHODS

The data used is the 2016 I-O table which consists of 50 sectors of North Sumatra province sourced from the Central Statistics Agency (BPS). North Sumatra province GRDP data for 2021 is used to update the I-O table.

Input-Output Table

The Input-Output table is a statistical presentation in the form of a matrix that describes the reduction of goods and services transactions in various economic activities. Table I-O shows a picture related to

1. The structure of the economy in a region which includes the output and added value of each sector,
2. The structure of the input, which is a transaction of the use of goods and services between production sectors,
3. The structure of the supply of goods and services, both production within its territory, as well as goods produced in other regions, and
4. The structure of demand for goods and services, including demand by various production sectors and demand for consumption, investment, and exports outside the region.

Rows in the I-O table describe how a sector's output is allocated. In this case, some of the output is given to fulfill intermediate requests, and the other is for final requests. The total final demand is the Gross National Product (GNP). At the same time, the table column shows the use pattern of intermediate inputs and primary inputs available from other sectors for production activities. All rows in the primary input have the same nominal value as the sum of all columns in the final request. The following equation states that the I-O model's balance between final demand and output is as follows. (Daryanto & Hafizrianda, 2010):

$$X_i = \sum_j x_{ij} + Y_i \dots\dots\dots (1)$$

Where X_i is the gross output for sector i ($i = 1, 2, \dots, n$), x_{ij} is the amount of output of sector i used as input for sector j ($j = 1, 2, \dots, n$), and Y_i is final

demand related to sector output i . Based on Leontief's assumption, the input used in a sector is a function of the level of output in other sectors, so the technical efficiency (a_{ij}) can be determined which is written as:

$$a_{ij} = \frac{X_{ij}}{X_j} \dots\dots\dots(2)$$

a_{ij} is the amount of sector i input needed to produce each sector output. From equation (2), we can obtain $x_{ij} = a_{ij}X_j$, which can be distributed to equation (1) so that it becomes as follows:

$$X_i = \sum_j a_{ij} X_j + Y_i \dots\dots\dots(3)$$

Equation (3) if written in matrix notation, will be:

$$X = AX + Y \dots\dots\dots(4)$$

X is output, Y is final demand, and A is an $n \times n$ dimensional matrix that describes the technical input coefficients with a_{ij} as its elements). Leontief's inverse matrix $((I - A)^{-1})$ with the element a_{ij} is needed to get the output value, which shows the magnitude of the change in sector i output for every one rupiah change in final demand in sector j , as follows:

$$X = (I - A)^{-1} Y \dots\dots\dots (5)$$

I-O tables are usually not compiled every successive year because the estimation procedure is complex and requires considerable financial resources. The technique commonly used to update the I-O table is the RAS method which Stone introduced (1961) with the following steps:

1. Determine the technology matrix at the beginning of the year, $A(0)$;
2. Determine the total output of sectors $X(1)$, the total output between sectors $U(1)$, and the total input between sectors $V(1)$ where these values are the results of the survey;
3. Determine the desired convergence criteria $\varepsilon \leq 10^{-6}$;
4. Determine $U^1 = [A(0)][X(1)]i$, where

$$X(1) = \begin{bmatrix} X_1(1) & 0 & 0 \\ 0 & X_2(1) & 0 \\ 0 & 0 & X_3(1) \end{bmatrix} \text{ and } i = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

5. Compare the values of U^1 and $|U^1 - U(1)| \leq 10^{-6}$ if no adjustments have been made through $R^1 = [U(1)][U^1]^{-1}$;

$$U(1) = \begin{bmatrix} U_1(1) & 0 & 0 \\ 0 & U_2(1) & 0 \\ 0 & 0 & U_3(1) \end{bmatrix} \text{ and } U^1 = \begin{bmatrix} U_1^1 & 0 & 0 \\ 0 & U_2^1 & 0 \\ 0 & 0 & U_3^1 \end{bmatrix}$$

$$R^1 = \begin{bmatrix} r_1 & 0 & 0 \\ 0 & r_2 & 0 \\ 0 & 0 & r_3 \end{bmatrix}$$

6. Carry out the adjustment stage by $A^1 = R^1 A(0)$;
7. Determine $V^1 = i' [A^1] [X(1)]$;

8. Compare the values of V^l and $|V^l - V(1)| \leq 10^{-6}$ if no adjustments have been made through $R^l = [V(1)] [V^l]^{-1}$;

$$V(1) = \begin{bmatrix} V_1(1) & 0 & 0 \\ 0 & V_2(1) & 0 \\ 0 & 0 & V(1) \end{bmatrix} \text{ and } V^l = \begin{bmatrix} V_1^1 & 0 & 0 \\ 0 & V_2^1 & 0 \\ 0 & 0 & V_3^1 \end{bmatrix}$$

$$S^l = \begin{bmatrix} s_1 & 0 & 0 \\ 0 & s_2 & 0 \\ 0 & 0 & s_3 \end{bmatrix}$$

9. Carry out the adjustment stage by $A^2 = A^1 S^l = R^l A(0) S^l$;
10. Perform the next iteration, from stage 5 to 9, until the criteria $\varepsilon \leq 10^{-6}$.

The calculation of iterations called convergence as the final value of the RAS approach aims to achieve a state of equilibrium (Toh, 2006). From a macroeconomic point of view, total demand equals total supply in equilibrium. The iteration process is repeated until the multiplier results are the same from one iteration to another.

Inter-Sector Linkages

Every sector in the economy is integrated because the output of one sector is the input for other sectors. This linkage occurs because an interdependence relationship is divided into two, namely, forward and backward. The measure of forward linkage is seen from the supply side (supply-driven), while the measurement of the backward linkage, which departs from Leontief's model, looks at the demand side (demand-driven). Rasmussen (1958), as cited in (Utami, 2013), indicates the measure of forward linkage and backward linkage as follows:

$$FL_i = \sum_{j=1}^n g_{ij} \dots \dots \dots (6)$$

$$BL_i = \sum_{j=1}^n g_{ij} \dots \dots \dots (7)$$

Where FL_i is the forward linkage of sector i , BL_j is the backward linkage of sector j , and g_{ij} is the element of Leontief's inverse matrix; $G - (I - A)^{-1}$.

The measure of linkage stated by Rasmussen (1958) is better than the linkage measure by Chenery & Watanabe (1958) because it has considered both direct and indirect linkages; in addition, the value of backward linkage (BL_i) based on Rasmussen's measure is the same as the output multiplier number, which reflects the effect of the increase in final demand in sector j on the output of the overall economic activity. In other words, this measure shows the magnitude of the change in the economy's output from a one-unit increase in final demand in sector j . Meanwhile, the forward linkage value (FL_i) represents the magnitude of the rise in output in sector i if the final demand in each of the other sectors increases by one unit. Rasmussen (1958) argues two types of index measures: the power and sensitivity of dispersion. Both indices can be used to identify critical sectors in economic development. BPS (2014) states the definition of the Power Dispersion Index (PDI) as the ability to spread and the Degree of Sensitivity Index (DSI) as the sensitivity of the spread. The formula for each of these indices is as follows:

$$PDI_j = \frac{\sum_{i=1}^n g_{ij}}{\binom{1}{n} \sum_i \sum_j g_{ij}} \dots\dots\dots(8)$$

$$DSI_i = \frac{\sum_{j=1}^n g_{ij}}{\binom{1}{n} \sum_i \sum_j g_{ij}} \dots\dots\dots(9)$$

PDI_j is the dispersive power coefficient, DSI_i is the degree of sensitivity coefficient, g_{ij} is the element of Leontief's inverse matrix, and n is the number of matrix sectors. PDI and DSI compare both forward and backward impacts against the average effect of all sectors. Thus, the PDI value > 1 indicates that the backward linkage of the sector is higher than the average backward linkage of all sectors. If the DSI value > 1 , then the forward linkages of the sector are higher than the average forward linkages of all sectors. A sector with an PDI and DSI value of greater than one is categorized as a leading or critical area sector. The economic sector can be classified into four groups based on the spreading power index (PDI) and the degree of sensitivity index (DSI) (Ronalia, 2021), as follows:

1. Group I
Sectors that have relatively high PDI and DSI (above average) are therefore the leading sector groups.
2. Group II
Sectors that have a low PDI (below average), but a high DSI (above average). This group is a potential sector group.
3. Group III
Sectors that have low PDI and DSI (below average) are a group of lagging sectors.
4. Group IV
Sectors that have a high PDI (above average), but a low DSI (below average) are therefore included in the potential sector group.

In industrial sector activities, the term inoperability is defined as a decrease in production system capacity due to unintentional events or natural causes that can trigger a chain of relationships between one sector and another sector that are mutually exclusive (Lian & Crowther, 2005). Inoperability can occur because it is triggered by one or several external disturbances, such as natural disasters or major accidents. Inoperability can be used as an analytical tool to measure the impact of the COVID-19 pandemic on the industrial sector. The decline in economic output due to COVID-19 must be evaluated. In this study, Φ_i is measured based on the output loss of the sector relative to its ground state, as stated by (Foong et al., 2022d) in the following equation:

$$\Phi_i = (-\Delta X_i) / (X_i) \dots\dots\dots(11)$$

Where ΔX_i and X_i are changed in economic output during the pandemic and economic output based on primary conditions, the value for Φ_i describes the actual shock during a pandemic (Foong et al., 2022c).

RESULT AND DISCUSSION

North Sumatra Province Technology Matrix Appraisal for 2021

The calculations were performed using the R Studio application to obtain an estimated technology matrix for 2021 that converged on the 19th iteration with a tolerance value for convergence of 1E-06. Table 1 shows the results of the iterations.

Table 1. Iteration Matrix of the 2021 Iteration of the Estimated Results of the North Sumatra Province

Iteration Number-	Value		
		10	3,07E-05
		11	2,00E-05
1	0,0134	12	1,30E-05
2	0,00115	13	8,50E-06
3	0,00062	14	5,55E-06
4	0,0004	15	3,62E-06
5	0,00026	16	2,36E-06
6	0,00017	17	1,54E-06
7	0,00011	18	1,00E-06
8	7,21E-05	19	6,55E-07
9	4,70E-05		

Inter-Sector Linkage Analysis

Analysis of the I-O table describes a sector's backward and forward linkages so that it can be seen how a sector uses output originating from other sectors or encourages the development of other sectors, either directly or indirectly. The results of calculating forward and backward linkages for the industrial sector in North Sumatra are presented in Table 2.

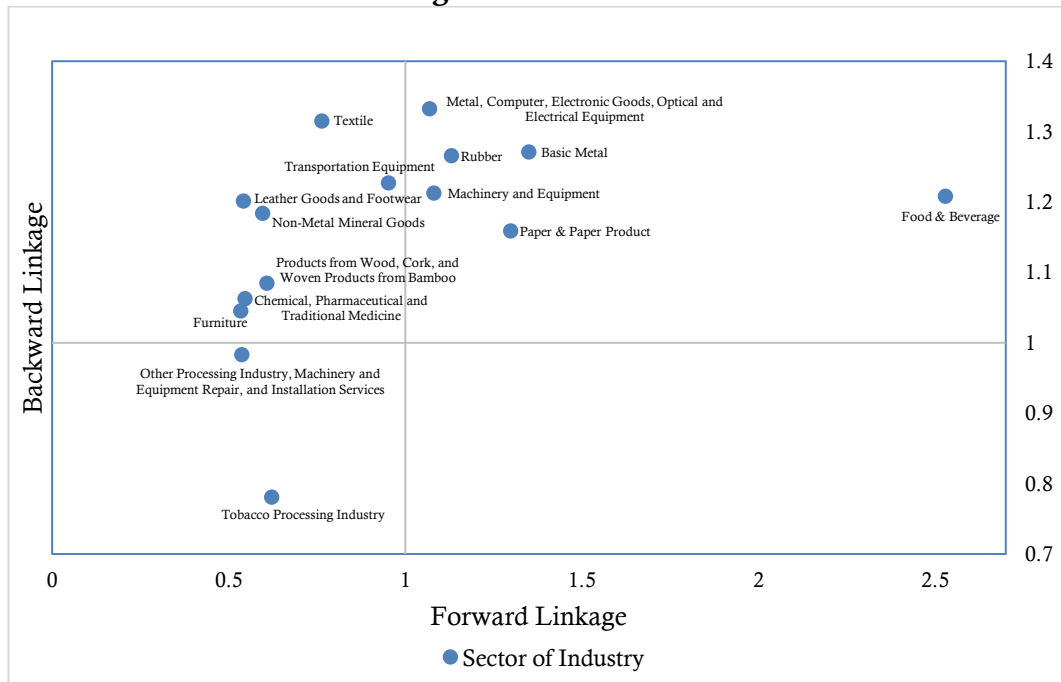
Table 2. Forward Linkage (FL) and Backward Linkage (BL) Industrial Sector in North Sumatra Province

Sector Code	Sector	FL	BL
I-13	Food and Beverage Industry	2,531	1,208
I-14	Tobacco Processing Industry	0,622	0,781
I-15	Textile and Apparel Industry	0,765	1,315
I-16	Leather Industry, Leather Goods and Footwear	0,542	1,201
I-17	Wood Industry, Products from Wood and Cork and Woven Products from Bamboo, Rattan, and the Like	0,608	1,084
I-18	Paper and Paper Products Industry, Printing and Reproduction of Recorded Media	1,299	1,159
I-19	Chemical, Pharmaceutical and Traditional Medicine Industries	0,547	1,063
I-20	Rubber Industry, Rubber, and Plastic Products	1,131	1,266
I-21	Non-Metal Minerals Industry	0,597	1,184

I-22	Basic Metal Industry	1,350	1,271
I-23	Metal, Computer, Electronic Goods, Optical and Electrical Equipment Industries	1,069	1,333
I-24	YTDL Machinery and Equipment Industry	1,082	1,213
I-25	Transportation Equipment Industry	0,953	1,227
I-26	Furniture Industry	0,535	1,045
I-27	Other Processing Industry, Machinery and Equipment Repair and Installation Services	0,538	0,983
Mean		0,945	0,945

Table 2 shows that the industrial sector with the highest backward linkage was the Metal, Computer, Electronic Goods, Optical, and Electrical Equipment industry (sector code I-23) with a BL value of 1.332763. It was followed by the Textile and Apparel industry (sector code I-15) with a BL value of 1.314826 and the Rubber, Rubber Goods, and Plastic industry (sector code I-19) with a BL value of 1.265507. Meanwhile, when viewed from forward linkages, the sector with the highest forward linkages was the Food and Beverage industry (sector code I-13), with an FL value of 2.530578. It was followed by the Base Metal industry sector (sector code I-22) with an FL value of 1.350136 and the Paper and Paper Goods industry, Printing and Reproduction of Recorded Media (sector code I-18) with an FL value of 1.298681.

Graph 2. Classification of Industrial Sector Quadrants Based on Forward and Backward Linkage



The classification of the quadrants of the industrial sector in North Sumatra based on the value of forward and backward linkages is illustrated in

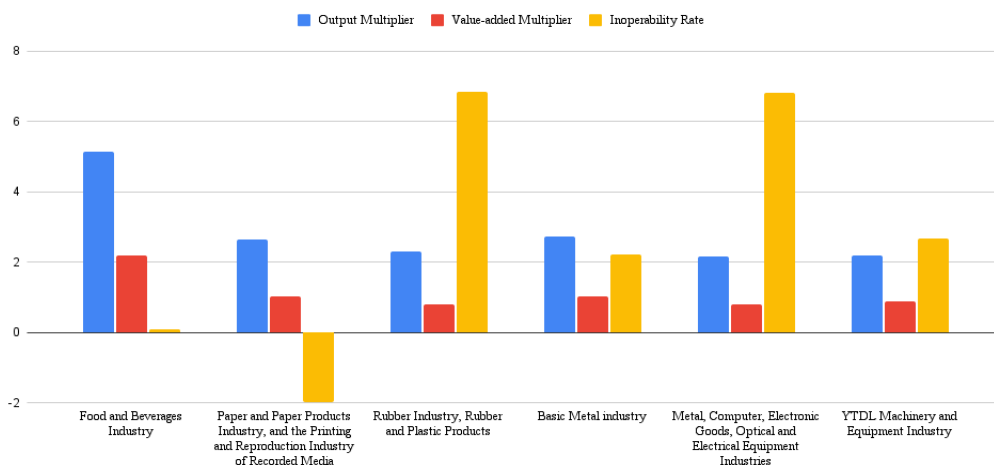
Graph 2. With sectors that have relatively high values of forward and backward linkages above the average, quadrant 1 includes

- The Food and Beverage industry, Paper and Paper Products industry, Printing and Reproduction of Recorded Media;
- Rubber industry, Rubber, and Plastic Products;
- Base Metal industry;
- Metal, Computer, Electronic Goods, Optical and Electrical Equipment industries; and
- YTDL Machinery and Equipment industry.

The industry is the leading sector group in North Sumatra. Sectors in quadrant 2 are with forward linkages below the average and backward linkages above the average of all industrial sectors, consisting of the Textile and Apparel industry, Leather industry, Leather Goods and Footwear; Wood industry, Products from Wood and Cork, and Woven Products from Bamboo, Rattan, and the Like; Chemical, Pharmaceutical and Traditional Medicine industries; non-metal mineral goods industry; Transportation Equipment industry; and the Furniture industry. The industry is a potential sector group in North Sumatra. Meanwhile, sectors in quadrant 3 have a forward and backward linkage value below the average of the entire industrial sector. These sectors are lagging sector groups in North Sumatra.

The value of forward and backward linkages only shows the magnitude of a sector's influence on other sectors. Even though it has demonstrated an industry that can be used as a leading sector, further analysis is needed to determine the impact that this sector has on the economy. In addition, limited financial resources must also be considered in determining the sectors to be encouraged by the government. Therefore, analyzing industries that are less affected by the pandemic is necessary. It is relevant, considering that the recovery costs are not too high if a sector is not too affected by the pandemic. Thus, the government can focus on accelerating and developing the industry.

Graph 3. Output Multiplier, Value-added Multiplier, and Inoperability of the Leading Industry Subsectors



Graph 3 shows the results of calculating the value of the output multiplier, value-added multiplier, and inoperability rate of sectors classified as leading sectors. The output multiplier value will show the impact of an increase in final demand in a particular industry on an economy's overall output or production. There were three sectors with the highest output multiplier values, namely the Food and Beverage industry (5.13); the Basic Metal industry (2.74); The Paper and Paper Products industry, and the Printing and Reproduction industry of Recorded Media (2.63). Based on these findings, if the Food and Beverage industry, which has the highest output multiplier value, experiences an increase in final demand by 1 unit value, then the overall output of other sectors will increase by 5.13 unit values.

A value-added multiplier explains the impact of an increase in final demand in a sector on the added value of all economic sectors. Self-added value in the I-O table represents sectoral GRDP values. Thus, the value-added multiplier shows the implications of an increase in final demand from a sector on regional GRDP. The results of the analysis in Graph 3 show the three sectors with the highest value-added multiplier values, namely the Food and Beverage industry (2.20), the Base Metal industry (1.03), and the Paper and Paper Products industry, and the Printing and Reproduction industry of Recorded Media (1.02). If the final demand for the Food and Beverage industry increases by 1 unit, GRDP will increase by 2.20 unit values.

This study also estimates the inoperability rate, which measures the impact of the pandemic causing operational disruptions to the economy. The higher the inoperability rate in a sector, the more significant the operational disruption experienced by that sector. Three sectors had the lowest inoperability rate, namely the Paper and Paper Goods industry and the Printing and Reproduction of Recorded Media industry (-1.97), the Food and Beverage industry (0.10), and the Base Metal industry (2.22).

Based on this analysis, the sector with the highest output and value-added multiplier was the Food and Beverage industry, Base Metal industry, the Paper and Paper Products industry, and the Printing and Reproduction of the Recorded Media industry. At the same time, these three industry sectors had the lowest inoperability rate compared to other leading sectors. Therefore, if the government aims to increase output value and GRDP downstream, then the government can make these three sectors a priority sector for development.

Discussion

Downstreaming is integral to manufacturing industry development efforts because downstream can create an investment-based, production-based, strong, and high-value-added industrial structure. In addition, downstream can create more inclusive development (Bank Indonesia, 2022). Research by Utami (2013) states that inter-sectoral linkages are essential because they provide a multiplier effect for the economy, ranging from output, income, and employment multiplier. The linkage effect will determine the leading sector,

where the leading sector of an economy can make an investment in that sector more valuable for the economy.

Furthermore, in line with the research results, Irawan & Soesilo (2021) stated that downstream policies carried out in conjunction with accelerated infrastructure development and adequate energy availability will create smooth production and logistics, ultimately providing added economic value. Downstreaming is the right policy to carry out because leading industries can attract and encourage the growth of other sectors. In addition, downstream will have a significant impact on the economy (Ronalia, 2021). Several studies such as Lestari et al., (2021) & Rusli et al., (2022) show that downstream, the products developed will provide added value and encourage the economy to be better. In addition, downstream can also facilitate the development of ideas, innovations, and know-how in utilizing derivative products that will ultimately provide high selling value.

The leading industries in optimizing the downstream potential of north Sumatra Province have opportunities and Challenges in Priority Sector Development, such food and beverage industry. The food and beverage industry plays a very dominant role in contributing to North Sumatra's GRDP compared to other industries in other manufacturing sectors. In 2021, the industry would contribute 73.26 percent of the total GRDP the manufacturing sector generates. The potential for developing the food and beverage industry in North Sumatra is also driven by improvements in public consumption, especially during the economic recovery period. It is evidenced by the average expenditure per capita for food by the people of North Sumatra province, which grew from IDR 598,245 in 2020 to IDR 607,812 in 2021 (BPS Sumatera Utara, 2022). On the other hand, the food and beverage industry is an industry that has a high-intensity level of use of fossil fuels (BBM) (Zaekhan et al., 2022). The Energy and Mineral Resources Minister has set a higher fuel price (Kementerian Energi dan Sumber Daya Mineral, 2022). Increasing fuel prices can increase production and product distribution costs in the food and beverage industry.

Second, Base Metal Industry The base metal industry is one of the industries significantly contributing to the national GDP, namely 5.87% in 2020. This industry is also one of the leading industrial sub-sectors in North Sumatra, with a contribution value of 14.39 trillion in GRDP in 2020 (BPS Sumatera Utara, n.d.). In addition, this industry contributes a significant enough number of workers in Indonesia, namely 6.34%. Then, this industry also has the highest investment value of Industrial FDI to total investment with an annual average of 30.1% (Kementerian Perindustrian Republik Indonesia, 2021). However, there are challenges in the sector where raw material prices continue to increase, especially for steel which is ultimately hampered by production costs and gas prices still high in Indonesia. Additionally, demand has not been balanced with domestic production levels, so it still relies on imports and the unregulated sector—the base metal industry with the downstream program (Kementerian Perindustrian RI, 2011).

This, Paper and Paper Products Industry, Printing and Reproduction of Recorded Media. There is an excellent opportunity to develop the paper and paper goods industry, printing and reproducing recorded media in North Sumatra. The Industry Ministry ([Kementerian Perindustrian RI, 2021](#)) suggests that the industry has several advantages, such as increasing demand for paper packaging from MSMEs, the potential for developing alternative raw materials, and relatively low production costs. Nonetheless, the paper and paper goods industry, printing, and reproduction of recorded media also must face several challenges. Conversion of natural forest land into industrial forest plantations for the raw material needs of the paper industry can cause environmental problems and social conflicts ([Susilawati & Kanowski, 2020](#)). In addition, the digitization of information due to technological developments has encouraged the paperless movement or reduced the use of paper ([Oliveira et al., 2021](#)). During the COVID-19 pandemic, this industry experienced difficulties with raw materials and constraints due to logistical problems ([DataIndonesia, 2022](#)). It can lead to decreased demand for the paper and paper products industry, printing, and reproduction of recorded media.

CONCLUSION

The crisis that occurred due to the COVID-19 pandemic has not entirely recovered. In recovering the economy, the North Sumatra provincial government needs to implement various incentives (subsidies and tax breaks) and determine priority sectors that have a linkage effect on other sectors. It is in line with the transformation of the downstream industry owned by North Sumatra province so that industrialization will create a multiplier effect for all economic sectors. By using an updated input-output (IO) analysis using the RAS method, this study aims to identify priority sectors in the manufacturing industry in North Sumatra based on linkage analysis and analyze the impacts caused by priority sectors and the challenges faced in their development.

The results show that the industrial sector with the highest backward linkages is the Metal Goods, Computers, Electronic Goods, Optical and Electrical Equipment industries. Based on the forward linkages, it is the Food and Beverage industry. Then, based on the analysis, the Food and Beverage industry; the Base Metal industry; the Paper and Paper Goods industry, and the Printing and Recording Media Reproduction industry are the sectors with the highest output multiplier and value-added multiplier values. Therefore, downstream is vital to create an investment-based industrial structure, production strong, and high added value.

Based on the research results, the authors recommend that the government increase output value and GRDP downstream by developing priority sectors and accelerating infrastructure development. Besides, the use of directed credit to facilitate investment, promoting sectors with linkage spillover, providing financial and policy support to these leading sectors, and purchasing key intermediates could emphasize the conventional economy. Its findings correspond with some conclusions posed by Lane ([2022](#)) and Huq & Ichihashi

(2023). It aims not to hinder production activities, focusing on optimizing the potential of priority sectors to accelerate economic growth in North Sumatra and expediting distribution channels within and outside the province not to impede the logistic process.

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