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# Leontief Input-Output Method for The Fresh Milk Distribution Linkage Analysis

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**ABSTRACT**

This research discusses about linkage analysis and identifies the key sector in the fresh milk distribution using Leontief Input-Output method. This method is one of the application of Mathematics in economy. The current fresh milk distribution system includes dairy farmers→collectors→fresh milk processing industries→processed milk distributors→consumers. Then, the distribution is merged between the collectors' axctivity and the fresh milk processing industry. The data used are primary and secondary data taken in June 2016 in Kecamatan Jabung Kabupaten Malang. The collected data are then analyzed using Leontief Input-Output Matrix and Maple software. The result is that the merging of the collectors' and the fresh milk processing industry's activities shows high indices of forward linkages and backward linkages. It is shown that merging of the two activities is the key sector which has an important role in developing the whole activities in the fresh milk distribution.

Keywords: Fresh Milk Distribution, Leontief Input-Output Method, Forward Linkages, Backward Linkages, Key Sector

## INTRODUCTION

Mathematics is a subject which underlies and serves many other subjects that are needed in the development of modern science and technology [1]. Mathematics functions as a tool to help finding the right solution to solve problems. Using mathematics, every problem that occurs in many kinds of fields can be solved through mathematical approach and a mathematical modeling is formed. One of these mathematical applications is the Leontief Input-Output Method. Leontief Input-Output Method is a mathematical modeling which is used to determine the value of the production output that needs to be expensed by the industries in the same economic system in order to preserve other industrial processes. This is the basic method to illustrate the economic activities as a linkage system between goods and services, and also to analyze the intersectoral or industrial linkages in economy [2].

Leontief Input-Output Method has different kinds of applications in economy. In the article from [3], and [4], the Leontief Input-Output Method has been applied in many modern science and technology development. Some of the method's application on the pollution control problems have been discussed in [5], [6], and [7]. Basically, the Leontief Input-Output Method uses inverse matrix or linear system of equation to construct an economic model. This method shows how the output from one industry can be the input for other industries and determines the linkage between each of the industries or sectors in economy [8]. This method is used to calculate the index of Backward Linkage that provides how much the sector demands from the other sectors of the economy, whereas the index of Forward Linkage provides the quantity of

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products demanded from the related sectors to the sector [9]. This linkage analysis was originated by [10], which was then used as a mean to identify the key sector by [11]. When one sector has high index values of backward and forward linkage, the sector has overall above average linkages of economy sector; thus, it is assumed that the sector is the key sector in the economy [9].

The aim of this article is to discuss about the Leontief Input-Output Method which is used to analyze the linkages and to identify the key sector in the fresh milk distribution. The fresh milk distribution system found in this article is: dairy farmers→collectors→fresh milk processing industries→processed milk distributors→consumers. However, in this research the collectors' and the fresh milk processing activities are merged. The data used are the primary and secondary data obtained through interview, questionnaire and observation in June 2016. These data were taken from the dairy farmers, Koperasi Agro Niaga Jabung as the collector and the fresh milk processing industry, and the distributors within the area of Kecamatan Jabung Kabupaten Malang. Next, the data were analysed using the Leontief Input-Output Matrix and Maple software. In the economic activity, fresh milk is a dairy product which might potentially improve the national economy in the future. Beside consumed freshly, milk is also the raw material for the fresh milk processing industry. Several products produced from fresh milk are pasteurized milk, butter, cheese, yoghurt, skimmed milk or non-fat milk and some other food products. This fact indicates that the growth in dairy farming industries will affect other industries. Furthermore, the growth in the fresh milk processing industry has strong linkages with the growth in the dairy farming sector. Most of this fresh milk processing industries are located in the area whose majority of the citizens are dairy farmers. Through this linkage analysis on the fresh milk distribution, the fresh milk processing industry has both backward linkages towards the raw material related to the dairy farmers, and forward linkages towards the food and beverage industry.

## METHODS

This research is an industrial mathematic research focusing on the problems within the fresh milk distribution system in Kecamatan Jabung on June 2016. The objects of this research are several groups of dairy farmers in Kecamatan Jabung, Koperasi Agro Niaga Jabung as the collector as well as the fresh milk processing industry, and the processed milk distributors in Kecamatan Jabung. The explanation level of this research is up to description level. Thus, this research will describe the phenomenon of the research objects.

This research uses the qualitative and quantitative analysis techniques. The qualitative analysis is conducted through direct observation of the condition of the fresh milk distribution system in Kecamatan Jabung. The data is obtained through interview with several groups of dairy farmers, the KOPERASI as the fresh milk collector as well as the fresh milk processing industry, and the processed milk distributor in Kecamatan Jabung. The quantitative analysis includes income and added value analysis. The data obtained are then analyzed. Before analyzing the data, the first step is to process it using raw data tabulation.

To fill in the table 1, we conduct income and added value analysis for each of the activity. After that, we analyze backward and forward linkage using Input-Output Method.

### Income Analysis

The amount of income from each sector within 1 month can be formulated as follows:

$$I_i = Q_i \text{ x } P_i \tag{8}$$

where:

$I_i$ = Income of sector-i for 1 month

$Q_i$ =Quantity of Product sold by sector-i within 1 month

$P_i$ = Price per product sold by sector-i within 1 month.

**Added Value Analysis**

The amount of added value is obtained from the margin of operational cost and income of each of the sector within 1 month. These operational costs include production cost, trade system cost, maintenance cost, shipping cost, or other costs which are adjusted to the expense of each sector. The added value analysis can be formulated as follows:

$$VA_i = I_i - OC_i \quad (9)$$

where:

$VA_i$ = Added value of sector-i within 1 month
$OC_i$ = Operational cost of sector-i within 1 month.

## RESULT AND DISCUSSION

In this research, we merge the collectors' and the fresh milk processing industries' activities in the fresh milk distribution system model as follows:

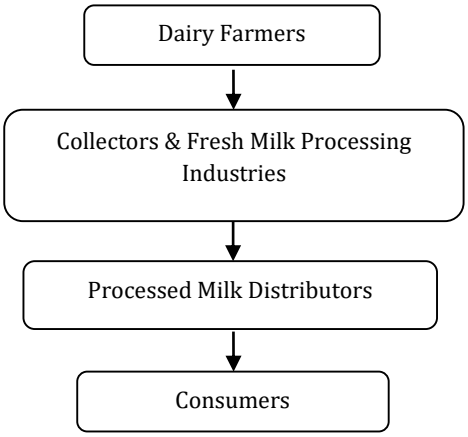


**Figure 1.** Fresh Milk Distribution System Model by Merging the Collectors' and the Fresh Milk Processing Industries' Activities

Using equation (8) and (9), the data is processed and the result is put into the input-output table of fresh milk distribution as follows:

**Table 1.** Input-Output Table of Fresh Milk Distribution by Merging the Collectors' and the Fresh Milk Processing Industries' Activities (in Million Rupiah)

| Output / Input | Farmers | Collectors and Fresh Milk Processing Industries | Distributors | Final Demand | Total Output |
|---|---|---|---|---|---|
| **Farmers** | 0 | 7.856,859 | 0 | 0 | 7.856,859 |
| **Collectors and Fresh Milk Processing Industries** | 2.526,24 | 0 | 357,312 | 0 | 2.883,552 |
| **Distributors** | 0 | 0 | 0 | 488,927 | 488,927 |
| **Added Value** | 3.510 | 2.124,631 | 478,727 | | |
| **Total Input** | 6.036,24 | 9.981,49 | 836,039 | | |

*(Source: Data Processing Result)*

Table 2 shows that the output or the dairy farming product, that is the fresh milk, is used as the input or raw material for the collectors and the fresh milk processing industries, in this case is the Koperasi Agro Niaga (KAN) Jabung, with the total value of Rp7,856.859 million. The collectors distribute the fresh milk to the fresh milk processing industries located outside of

Desa Jabung, but these collectors also function as the small scale fresh milk processing industries. Besides selling the fresh milk to the processing industries, the collectors also give an output in the form of cattle food that is used as the input for the dairy farmers with the total value of Rp2,526.24 million. Then, the output or the product from the fresh milk processing industries by the collectors is distributed to the processed milk distributors with the total value of Rp357.312 million. Next, the output from the distributors is sold to the consumers with the total value of Rp488.927 million. The added value or the income of each of the activities are Rp3,510 million, Rp2,124.631 million, and Rp478.727 million.

From table 2, we can generate a matrix as follows

$$A = \begin{bmatrix} 0 & 7.856{,}859 & 0 \\ 2.526{,}24 & 0 & 357{,}312 \\ 0 & 0 & 0 \end{bmatrix}. \quad (10)$$

Substitusing Matrix A from (10) into Equation (4) and we obtain Leontief Inverse Matrix as follow

$$\alpha = \begin{bmatrix} 1.4913 & 1.1738 & 0.5017 \\ 0.6241 & 1.4913 & 0.6373 \\ 0 & 0 & 1 \end{bmatrix}. \quad (11)$$

Furthermore, substitute $\alpha$ from (11) into Equation (6) and (7). Using Maple software, we obtain indices of backward linkages and forward linkages which can be seen on table 3.

**Table 2.** Linkage Indices of Merging the Collectors' and the Fresh Milk Processing Industries' Activities in the Fresh Milk Distribution

| Activities | Forward Linkages | Activities | Backward Linkages |
|---|---|---|---|
| **Farmers** | 1.3730 | **Farmers** | 0.9171 |
| **Collectors & Fresh Milk Processing Industries** | 1.1935 | **Collectors & Fresh Milk Processing Industries** | 1.1555 |
| **Distributors** | 0.4336 | **Distributors** | 0.9274 |

*(Source: Data Processing Result)*

On table 3, we can see that the farmers' activity has low index of backward linkages, that is 0.9171 (BL<1), while the forward linkages have high index, that is 1.3730 (FL>1). These numbers show that the farmers' activity can only shove the activities in front of them, but it cannot attract the growth of the activities behind. Whereas for the distributors' activity, the indices of forward linkages and backward linkages are low, those are 0.4336 (FL<1) and 0.9274 (BL<1). These numbers show that the distributors' activity does not influence the growth of others' activities.

On the other hand, the merging of the collectors' and the fresh milk processing industries' activities has high indices of both forward linkages and backward linkages, those are 1.1935 (FL>1) and 1.1555 (BL>1). These numbers show that the merging of the two activities has high forward and backward linkages so that it can be concluded that this might be the key sector, which can improve the growth of all activities in the fresh milk distribution.

Thus, we know that the merging of the collectors' and the fresh milk processing industries' activities can be the key sector within the fresh milk distribution. Therefore, developments in the merging of the two activities will have great influences to the growth of the whole activities within the fresh milk distribution.

## CONCLUSION

Leontief Input-Output Method can illustrate the intersectoral linkages and identify the key sector in the fresh milk distribution. It is clearly shown that the merging of the collectors' and the fresh milk processing industries' activities offers high indices of both backward linkages and forward linkages, so that it can be the key sector in the fresh milk distribution. The key sector has strong attraction and thrust towards the growth of upstream as well as downstream industries. Therefore, the merging of the two activities has great influences and needs more

attention in terms of its relation with the developments of the whole activities in the fresh milk distribution.

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