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# Description of the Application of the I-O Method Approach in the Defense Sector through Modification of the Social Accounting Matrix (SAM) Model

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***ABSTRACT:*** *This study applies a descriptive approach, the approach in question aims to provide an explanation or description of the application of the I-O method in the defense sector through the modification of the Social Accounting Matrix (SAM) Model, while the type of research applied in this study is descriptive qualitative research, namely interpreting or describing about everything that exists and is related, this interpretation relates to existing relationships or conditions, the process of an ongoing situation, effects or consequences that occur, opinions that are developing, or trends that are growing. In the Input–Output Method, the basic table is a transaction table consisting of: input coefficient table (coefficient matrix), multiplier table, attractiveness index table and driving force index as well as supporting tables and other analysis tables depending on the breadth of the field to be discussed. This study concludes that the I-O model is applied to the defense sector by developing the SAM (Social Accounting Matrix) model. This model is an extension of the I-O model which includes economic sub-sectors or more detailed sub-sectors.*

**ABSTRAK:** Penelitian ini mengaplikasikan pendekatan deskriptif, pendekatan yang dimaksud bertujuan untuk memberikan suatu pemaparan ataupun deskripsi aplikasi pendekatan metode I-O dalam sektor pertahanan melalui modifikasi Model Social Accounting Matrix (SAM), sedangkan jenis penelitian yang diterapkan dalam penelitian adalah penelitian deskriptif kualitatif, yaitu menginterpretasi ataupun mendeskripsikan tentang segala yang ada dan terkait, interpretasi ini berkenaan dengan hubungan ataupun kondisi yang ada, proses suatu keadaan yang tengah berlangsung, efek atau akibat yang terjadi, pendapat yang sedang berkembang, ataupun kencenderungan yang sedang tumbuh. Dalam Metode Input–Output, sebagai tabel dasarnya adalah tabel transaksi yang terdiri dari: tabel koefisien input (matriks koefisien), tabel pengganda, tabel indeks daya menarik dan indeks daya mendorong serta tabel pendukung dan tabel analisis lainnya tergantung kepada luasnya bidang yang hendak dibahas. Penelitian ini menyimpulkan bahwa model I-O diaplikasikan ke dalam sector pertahanan dengan pengembangan model SAM

(Social Accounting Matrix). Model ini merupakan suatu perluasan dari model I-O yang memuat sub-sektor ekonomi atau sub-sektor yang lebih rinci.

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## INTRODUCTION

The matrix is a basic concept in the world of algebra which was first used in 1850 by Sylvester, who defined a matrix as an arrangement of elements in a square (Salaka et al, 2013). The application of matrices in various fields of science makes a very broad study so that the matrix is more generalized (Nur, 2014).

A matrix is a collection of multiple values that have rows and columns. Where the horizontal arrangement is called a row while the vertical arrangement is called a column (Yulian et al, 2009). Meanwhile, according to Anton in Fatchiyah (2011) the concept of the inverse of the matrix is defined as: "A matrix A of order n x n is said to be nonsingular (nonsingular) or reversible if there is a matrix B so that AB = BA = I. Matrix B is called the inverse of multiplication ( multiplicative inverse) of A." (Leon, 2001).

Frederick H. Bell said that mathematical objects consist of facts, concepts, principles and procedures (Suparta, 2011). In line with Bell's view, Thohari stated that mathematical objects include facts, concepts, definitions, operations, and principles and skills (Cahyono, 2013). The description of the object in the matrix includes notation, operations, properties, theorems, and completion procedures. Among the matrix materials that support this are determinants and inverses (Zaini, 2017).

The I-O table is basically a statistical description in the form of a matrix that presents information about transactions of goods and services as well as the interrelationships between units of economic activity (sectors) in a region at a certain time period (Wikarya, 2015). The entries along the rows in the matrix show how the output of an economic sector is allocated to other sectors to meet intermediate demand and final demand, while the entries in the column show the use of intermediate and primary inputs by a sector in its production process (Zuhri, 2015).

The input-output model is a standard method that can be used to measure the impact of changes in the final demand for a product produced by a particular industry/sector in the economy. This model is based on an input-output table (I-O table) which is presented in the form of a matrix (Malba & Taher, 2016). The efficacy of the Input-Output model concerns its ability to measure inter-sectoral linkages (Yanti, 2009).

Analysis of the Input Output Table model (Table I-O) is a tool that will be used to see the interrelationships between sectors in the economy (Mellyawanty et al, 2012). Table IO analysis is a method that is systematically used to measure the interrelationships between sectors in the economic system (Daryanto & Hafizrindia, 2010). The IO model must also be based on assumptions for use in the preparation of the IO table, including: (1) homogeneity, which is a commodity that only produces single output and single input by a sector and there is no substitution of output produced from other sectors, (2) linearity, namely a principle where the production function is linear and homogeneous, which means that there is a change a level between input and output that is proportional, (3) additivity is stated that the total effect of the implementation of production resulting from each sector is carried out separately and shows that the influence outside the input output system is ignored (Suseno & Anas, 2017). According to Chenery-Watanabe (1958) the occurrence of linkages between sectors is divided into two parts, namely backward linkages and forward linkages. And the measure of backward linkage can be seen from the demand side (demand-driven) and forward linkage seen from the demand side (supply-driven) for planning regional development (Daryanto & Hafizrianda, 2010).

Successful economic development can be seen from GDP (Gross Domestic Product) and GNP (Gross National Product). GDP (Gross Domestic Product) is the value of goods and services produced by a country in a certain period which is calculated by adding up all the results of citizens (domestic) plus foreign nationals working in the country, and GNP (Gross National Product). ) is the value of goods and services produced by a country in a certain period (one year) which is measured in units of money. To achieve the success of economic development, good cooperation between economic sectors is needed, in which cooperation results in each activity in the production sector having an attractive (backward linkage) and pushing (forward linkage) power from each sector. Economic development is carried out by developing countries which have the aim of creating economic development that is felt by the community, increasing job opportunities, reducing differences between regions, and a balanced economic structure (Rahmah & Widodo, 2019).

## METHODS

This study applies a descriptive approach, the approach in question aims to provide an explanation or description of the application of the I-O method in the defense sector through the modification of the Social Accounting Matrix (SAM) Model, while the type of research applied in this study is descriptive qualitative research, namely interpreting or describing about everything that exists and is related, this interpretation relates to existing relationships or conditions, the process of an ongoing situation, effects or consequences that occur, opinions that are developing, or trends that are growing. The method of data collection and analysis in this study applies the use of existing data. The data collected consists of various documents, books, manuscripts, mass media, websites or journals. Regarding data collection, internet-based research is applied. Extracting information from various trusted sources is used including electronic documents, reputable online journals, official websites of news agencies and government institutions.

## RESULTS AND DISCUSSION

Prof. Wassily Leontif (1930) introduced the Input–Output Table (Table I–O) and their analysis. Table I–O is a powerful tool for analyzing the economy of a region (country) and is very useful in planning a country's development. (Table I–O) and their analysis. Table I–O is a powerful tool for analyzing the economy of a region (country) and is very useful in planning a country's development.

In the Input–Output Method, the basic table is a transaction table consisting of: input coefficient table (coefficient matrix), multiplier table, attractiveness index table and driving force index as well as supporting tables and other analysis tables depending on the breadth of the field to be discussed. The complete transaction table format is as follows:

Table 1. Transactions in Input-Output Analysis

| | **Alokasi output** | | **Total Penyediaan** | |
|---|---|---|---|---|
| **Sumber input** | **Permintaan antara** | **Permintaan akhir** | **Impor** | **Jumlah output** |
| **a.Input antara** | **Sektor produksi Kuadran II** | **Kuadran I** | | |
| Sektor 1 | $X_{11}$… $X_{1j}$ …. $X_{1m}$ | $F_1$ | $M_1$ | $X_1$ |
| Sektor 2 | $X_{21}$… $X_{2j}$ … $X_{2m}$ | $F_2$ | $M_2$ | $X_2$ |
| …….. | …. … ... … …. | ….. | …. | ….. |
| Sektor i | $X_{i1}$ … $X_{ij}$ ... $X_{im}$ | $F_i$ | $M_i$ | $X_i$ |
| ……… | …. ... …. … …. | …. | …. | …. |
| Sektor n | $X_{n1}$… $X_{nj}$ … $X_{nm}$ | $F_n$ | $M_n$ | $X_n$ |
| | **Kuadran III** (Masukan primer) | **Kuadran IV** (Pembelian faktor langsung) | | |
| **b.Input primer** | $V_1$… $V_j$ …. $V_m$ | | | |
| **Jumlah input** | $X_1$… $X_j$ …. $X_m$ | | | |

Information:

The input-output transaction table above consists of 4 quadrants, namely: 1) Quadrant I consists of final demand, namely goods and services purchased by the public for consumption and for investment; 2) Quadrant II consists of inter-sectoral transactions, namely the flow of goods and services produced by a sector to be used by other sectors (including the sector itself), both as raw materials and as auxiliary materials. Quadrant II is endogenous and quadrant I, III, IV are exogenous; 3) Quadrant III contains primary inputs, namely all the power and funds needed to produce a product but outside the intermediate input category, such as: labor, expertise, capital and others; 4) Quadrant IV describes how the remuneration received by the primary input is distributed into the final demand.

The Input Coefficient Matrix is the same as the input coefficient table but without including the primary input. Then the table will be formed n x n (the number of rows is equal to the number of columns) so it is often called the input coefficient matrix. The formula is: aij = x ij / Xj where aij = coefficient of input sector j from sector i (in row i column j); xij = input usage by sector J of sector i ; Xj = j sector output.

The Multiplier Matrix is a factor that determines the magnitude of change in the entire sector if the number of production in a sector changes. This matrix is needed in projecting the impact of changes in one sector on the whole sector. If the multiplier matrix is multiplied by the final demand matrix (which is projected to change) it will produce new output for the entire sector. The multiplier matrix is the inverse matrix of the matrix (I – A) is B = (I – A)– 1 . The matrix (I – A) is called the Leontif Matrix. Where B = multiplier matrix; I = identity matrix; and A = input coefficient matrix.

Relationship between Output, Multiplier Coefficient and Final Demand. To see the relationship between output, multiplier coefficient and final demand can be seen in the following matrix:

| | | | | |
|---|---|---|---|---|
| $X_1$ | | $b_{1l}$ .... $b_{1j}$ ..... $b_{1n}$ | | $F_1$ |
| .... | | .... .... .... ..... .... | | .... |
| $X_i$ | = | $b_{1l}$ ...... $b_{ij}$ ..... $b_{in}$ | | $F_i$ |
| ... | | .... .... .... .... ..... | | .... |
| $X_n$ | | $b_{nl}$ ..... $b_{nj}$ ..... $b_{nm}$ | | $F_n$ |

Where: bij = cell contents of the ith row of the jth column of the inverse matrix (I – A) – 1 ; Xi = sector i output; Fi = final demand of sector i.; ij = 1,2 ,.... n. The above can be written in the matrix equation is X = (I – A) – 1 F , From this equation it can be seen that every change in final demand from sector 1 (F1) of 1 unit will result in a change in X1 of b1l and of X2 of b21 etc.

The Input-Output (I-O) approach is one of the quantitative analysis instruments. This approach requires modification if it is to be used to assess a country's defense sector. The I-O approach is very easy to do and has no specific application limitations. There are two advantages of I-O analysis, first, it is the most comprehensive and consistent approach to all economic sectors including the defense variable, and is relatively easy to incorporate into other mathematical models. Second, a model that can be used for policy analysis at various stages. This approach has limitations, first, limitations in the application because it is static which applies at a certain time. The second limitation is the need for broad and comprehensive basic data on the economic sector.

The I-O model is a data system, conceptual framework, and quantitative analysis that studies the relationship between (1) economic development; (2) the need for goods and services; and (3) the production of goods and services. The I-O model is based on the I-O Table which consists of exogenous variables in the final demand and gross value added sectors. The rows in the table represent the production sector and one row of gross value added final demand. The number of rows and the number of columns are the total input and output for the national economy, respectively. The I-O model can be developed based on the concepts of GDP, value added, and the production sector. Based on these three concepts, an I-O submodel was developed.

Indonesia's GDP is the sum of the value of finished goods and services produced by the community in a certain year and does not include intermediate goods, namely goods used in the production of other goods (such as defense equipment products that are used for defense development). Added value is the addition of product value at certain stages of production. Therefore, the added value of defense equipment products is the value of defense equipment products when they leave the industry minus the value of raw materials purchased by the defense industry. This added value is the same as payments to production factors such as wages, operating surplus, capital depreciation, indirect taxes and subsidies (Yusgiantoro, 2014).

The I-O table is not a transaction model between producers, but shows the interrelationships between various economic sectors of a country over a certain period of time. Thus the I-O table is a system that can be a very useful model. The I-O table used has the following characteristics:

1. Transactions are recorded not only from producers. The inputs and outputs here are within a broader accounting framework. I-O shows the flow of output from one sector to another and to the final demand.
2. The I-O table shows all domestic economic activities, so the I-O table describes the inputs and outputs of the national account.

The I-O model is designed to explain its macroeconomic implications, the use and production of goods and services in the Indonesian economy as a whole. The I-O model is a cross sectional model for a particular year. For the defense sector, there are three main balance sheets that form a complete system in the production sector: the defense sector, non-defense equipment, and defense equipment.

The following analysis describes an example of an I-O model for Indonesia following the production sector with a 9x9 balance sheet. GDP is the final demand that will be used as a growth target. Final demand and gross value added stand alone in the allocation of outputs and inputs. However, the total input must equal the total output. The next step is to determine the endogenous and exogenous variables. Endogenous variables are calculated from the matrix system by solving matrix equations, and exogenous variables are determined outside the system. It is assumed that the three main accounts in the production sector are determined endogenously, while the final demand which is the GDP balance is exogenous.

The transaction matrix consists of seven matrix balances, therefore the endogenous variable consists of nine matrix elements. Exogenous elements consist of consumption (private and government), gross domestic capital formation and net exports, combined in one column, column 10. Gross value added is also combined in one row, namely row 11. Xij cells show the amount of input in billions of rupiah from sector (i) to sector (j). it is assumed that the sum down a column, j, is written Xj (including y) and the parallel addition of a row, I, is written Xi must equal Xj. The effect of changes in GDP on individual sectors of the economy can be determined by solving a 9x9 matrix (a system of 9 equations and 9 unknown variables). Define Yn as the total output for each balance, with n = 1, …, 9.

The total number of Yn outputs must equal the total number of Yn inputs. Each level of output y1 to y9 and at a certain growth target F will require y1 to y9 as follows:

$$Y_1 = a_{11}y_1 + a_{12}y_2 + a_{13}y_3 + \cdots + a_{19}y_9 + F_1$$

$$Y_2 = a_{21}y_1 + a_{22}y_2 + a_{23}y_3 + \cdots + a_{29}y_9 + F_2$$

. . . .

. . . .

. . . .

$$Y_8 = a_{81}y_1 + a_{82}y_2 + a_{83}y_3 + \cdots + a_{89}y_9 + F_8$$

$$Y_9 = a_{91}y_1 + a_{92}y_2 + a_{93}y_3 + \cdots + a_{99}y_9 + F_9$$

Table 2. Hypothetical Diagram of Simple I-O Model

| Alokasi Output | | Permintaan Antara | Permintaan | Output |
|---|---|---|---|---|
| | | Sektor Produksi | | |
| Struktur Input | | 1 ………….. 9 | Akhir | Total |

| | | | | | |
|---|---|---|---|---|---|
| Input Antara | Sektor Produksi | 1 | $X_{ii}$…………..$X_{ij}$ | $F_1$ | $Y_1$ |
| | | . | …………………. | . | . |
| | | . | …………………. | . | . |
| | | . | …………………. | . | . |
| | | . | …………………. | . | . |
| | | . | …………………. | . | . |
| | | 9 | $X_{ji}$…………..$X_{jj}$ | $F_9$ | $Y_9$ |
| Nilai Tambah Bruto (Input Primer) | | | $V_1$…………..$V_9$ | | |
| Input Total | | | $V_1$…………..$V_9$ | | |

Equation (1) of the total endogenous balance yn for the 9x9 matrix can be rewritten as equation (2):

$$\begin{vmatrix} a_{11} & . & . & . & a_{19} \\ . & & & & . \\ . & & & & . \\ . & & & & . \\ a_{91} & . & . & . & a_{99} \end{vmatrix} \begin{vmatrix} y_1 \\ . \\ . \\ . \\ y_9 \end{vmatrix} + \begin{vmatrix} F_1 \\ . \\ . \\ . \\ F_9 \end{vmatrix} = \begin{vmatrix} y_1 \\ . \\ . \\ . \\ y_9 \end{vmatrix}$$

The form of matrix (4) can be simplified as follows:

$y_n = (A_n)\ (y_n) + F_n$ (5)

This mathematical formula can be interpreted as the number of rows of the endogenous balance 1 through 9 in Table I-O obtained by multiplying the coefficient matrix of each row of the endogenous balance by the level of the balance recorded in each column and plus the exogenous balance F, which is expressed in equation 6 as follows:

$$y_n = (I - A_n)^{-1} F_n = Ma\ F_n$$

With:

yn = unknown variables

Fn = variable – known variable – GDP target

An = coefficient – coefficient matrix

I = identity matrix

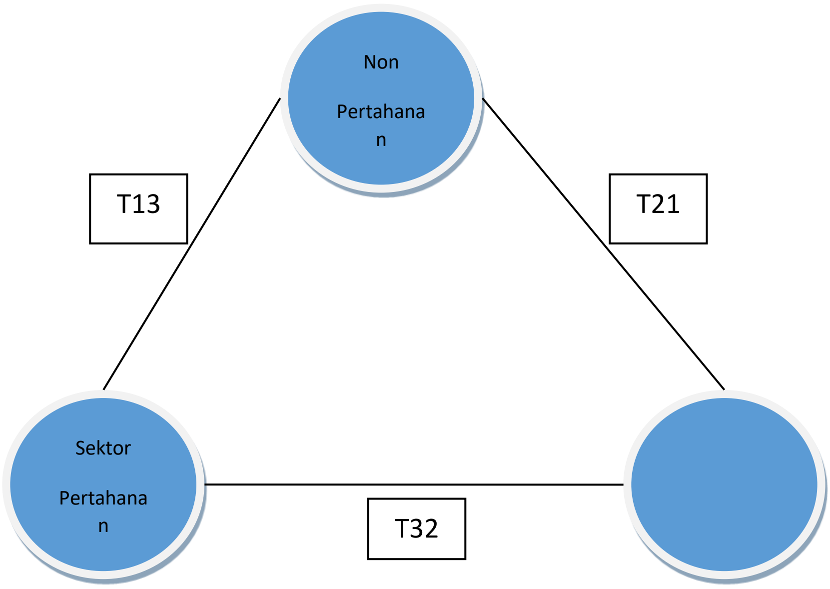
Ma = fixed multiplier inverse Leontief matrix

One of the limitations of the fixed multiplier Ma derived in equation 6 has the assumption that the expenditure elasticity is one (unitary).

The I-O model was developed to provide qualitative and quantitative interpretations for certain sectors in the overall economic activity. The following sections use I-O for Indonesia, namely:

1. A data frame at a particular point in time. Data systems for aggregate defense planning are presented in tables for estimating the output and income of various economic groups. I-O covers 81 matrix cells.
2. An I-O static analysis system explains the relationship between spending in certain years with pressure on a particular sector and the effect of its relationship with the industrial sector. This system is a static version of the I-O model in a given year.
3. A dynamic model for a given year, based on a static model with a base year, the I-O model can be projected using various economic growth scenarios. These scenarios can be used to analyze the policies of various sectors in Indonesia. Various studies can be carried out for future projection purposes so that the I-O model becomes a dynamic model.

Figure 1 is a diagram of the interconnectedness of sectors. The consistency requirement is best explained by a feedback mechanism within the entire system from a triangular angle. One of the important uses of this I-O model is to illustrate the backward linkage and forward linkage (backwad linkage and forward linkage) from one sector to another.




**weapon system main tool**

Figure 1. Simple Interrelationship Between I-O . Balance Sheet Items

The approach introduced by Ramussen and Miller uses the Leontief inverse or fixed multiplier matrix. In its simplest form the measure of backward linkage of sector j in column j, the dependence of the production of sector j on the inputs, given by the summation of the balance sheets in column j of the matrix is known as direct backward linkage. However, Leontief's inverse works in direct and indirect relationships between sectors. Therefore, a useful and comprehensive measure of the backward linkage of sector j is provided by the number of accounts in column j of the direct and indirect coefficient matrix, (I – Ac)-1, for accounts marked by rij. I is the identity matrix and Ac is the coefficient matrix of the total input portion. The matrix Ac is the same as the matrix An. The direct and indirect linkages take advantage of the sum of the balances in row I of the coefficient matrix, (I – Ar)1 for the balance marked qik. Ac is the coefficient matrix in the share of the total output. B and F in equations 7 and 8 describe the jth row and I column of the total effect on the overall economy. If the influence of a particular sector is large, an increase in investment in that sector will increase the relative income of other distributors or expenditure on users. So the backward and forward linkages for sectors j and I are:

Backward linkage: $B_j = \sum_{i=1}^{9} r_{ij} = (I - Ac)^{-1}$ (7)

Forward linkage: $F_i = \sum_{i=1}^{9} q_{ik} = (I - Ar)^{-1}$ (8)

The I-O model was further developed into a Social Accounting Matrix (SAM) model. The SAM model is an extension of the I-O model which includes economic sub-sectors or more detailed sub-sectors. Table 3 shows an I-O model development for the defense, military and non-military sectors, which is combined with the non-defense sector expressed in the non-defense sector and GDP national income.

Table 3. Input – Output Model

| Baris / Kolom | Militer Military | Nirmiliter non-military | Non Pertahanan Non-defense | PDB | Total Output |
|---|---|---|---|---|---|
| Militer | Matriks Utama Main Matrix | | | | |
| Nirmiliter | | | | | |
| Nonpertahanan | | | | | |
| Nilai Tambah (Added Value) | Matriks Nilai Tambah Value Added Matrix | | | | |
| Faktor dari Luar (Exogenous) | | | | | |
| Total Input Total Input | | | | | |

## CONCLUSION

The I-O model is applied to the defense sector by developing the SAM (Social Accounting Matrix) model. This model is an extension of the I-O model which includes economic sub-sectors or more detailed sub-sectors. This study shows one of the developments of the I-O model for the defense, military and non-military sectors, which is combined with the non-defense sector expressed in the non-defense sector and GDP national income.

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