Productivity Evaluation Through American Productivity Center Approach at PT Sejahtera Furnindo

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Abstract. PT Sejahtera Furnindo, a well-established export furniture company in Central Java, currently only considering the profit level to study its performance. With this approach, company usually pays only a little attention to its resources usage efficiency, that makes it requires a large cost to carry out company activities. For finding a more comprehensive approach, this research offers an evaluation of company productivity measurement using American Productivity Approach (APC). Results of this study showed that total factor productivity during the measurement periods indicate a positive growth level. This illustrates its success in managing labor input and collective capital owned. However, the total productivity revealed a changing level of growth, which illustrated that company had not been able to manage the overall input successfully during the measurement periods. Efforts are needed to increase the profitability focus, the coming period, along with efforts to increase productivity that focus on increasing material productivity and capital productivity as input factors that were also significantly influenced its profitability.

1. Introduction
The success of company in carrying out its business can be seen from how the company uses and processes all of its resources[1]. The more efficient a company processes existing resources, the greater the company will get a profit which is a must for a company to face competition among similar industries[1]. One measure that can connect the input and output sides of a company is productivity [1]. Increased productivity in a performance measurement system is very necessary [3].

Increasing profit is the main goal for every company, including PT Sejahtera Furnindo. In a company performance measurement system, there are seven benchmarks that are considered, namely effectiveness, efficiency, quality, profitability, productivity, quality of work life, and innovation[5].

Basically, from year to year this company always makes improvements in all its production lines, but no measurements are taken to determine the overall productivity index. From this background, the main problem faced in this study is that the company urgently need to determine its productivity index and evaluates its productivity.

2. Productivity
Productivity and production are two different meanings, where an increase in productivity means the use of efficiency from resources in producing goods and services. Many definitions of productivity have been made by international experts and agencies. Productivity includes two basic concepts, namely usability (efficiency) and use result (effectiveness), where power is used to describe the level of human resources, funds, and nature needed to produce certain results, while effectiveness to describe effect and...
quality of the results sought. Total productivity is a formulation of a comparison of tangible output with tangible inputs [5].

2.1. Productivity Cycle
The formal concept called productivity cycle firstly introduced by [5] to be used in continuous productivity improvement. The program consists of four stages, i.e. Productivity Measurement, Productivity Evaluation, Productivity Planning and Productivity Improvement.

The Four elements are a cycle that must be carried out continuously and sustainably in order to obtain optimal benefits. The concept shows that productivity improvement programs must be preceded by productivity measurements. After the level of productivity is known, then the next step is to evaluate or compare the results that are now with the plans that have been previously set. Based on the results of this evaluation planned targets for productivity levels in both the short and long term. To achieve these targets, productivity improvements must be done formally.

2.2. Productivity Measurement Model of American Productivity Center (APC)
The APC model has put forward a measure of productivity that is defined as follows [6]:

\[
\text{Productivity} = \frac{\text{Sales Results}}{\text{Costs}} = \frac{(\text{Number of Outputs x per unit price})}{(\text{Number of inputs x cost per unit})} \cdot \frac{\text{Price}}{\text{Cost}}
\]

(1)

\[
\text{Productivity} = \frac{(\text{Number of outputs})}{(\text{Number of inputs})} \cdot \frac{\text{Price}}{\text{Cost}}
\]

(2)

\[
\text{Profitability} = \text{Productivity} \times \text{Price improvement factors}
\]

(3)

The output prices and costs per unit of input every year are multiplied by the quantity of output produced and the quantity of inputs used in a certain period to obtain a price improvement index, the profitability index can be determined using the following formula:

\[
\text{IPH} = \text{IP} \times \text{IPH} \text{ or } \text{IP} = \frac{\text{IPF}}{\text{IPH}}
\]

(4)

Where:
IPF: Profitability Index
IP: Productivity Index
IPH: Price Improvement Index

APC advantage can cover the shortcomings of other productivity, measurement methods, like OMAX which only assesses the level of productivity weighting [9]. APC is able to calculate productivity index, profitability index, and price improvement index [10]. Following table is previous study that examined productivity measurements.

**Table 1. Some previous studies of productivity measurement**

| No | Title                                                                 | Researcher            | Objective                                                                 | Methods               |
|----|----------------------------------------------------------------------|-----------------------|--------------------------------------------------------------------------|-----------------------|
| 1  | A review of literature on manufacturing systems productivity measurement and improvement | Huang (2006)         | propose a productivity measurement methodology based on productivity level metrics | performance-based matrix method |
| 2  | Multifactor Productivity Measurements Model (MFPMM) as Effectual Performance Measures in Manufacturing | Wazed and Shahadat (2008) | to compare productivity measures that are usually used in industry with productivity measurement theories currently available | MFPMM                 |
| No | Title                                                                 | Researcher            | Objective                                                                                                                                                                                                 | Methods                  |
|----|----------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 3  | Productivity Measurement of Hi-tech Industry of China Malmquist Productivity Index – DEA Approach | Qazi and Yulin (2012) | To measure changes in productivity of the Chinese hi-tech industry using the Malmquist productivity index.                                                                                              | Malmquist productivity index. |
| 4  | Review of Productivity Measurement and Improvement procedures in Small and Medium Scale Manufacturing Industries | Deshmukh (2014)      | To measure productivity measurement and improvement procedures in small and medium scale manufacturing industries in the field of management at the business unit level.                                    | Partial and total productivity measurement method |
| 5  | Partial and Total Productivity Measurement Models for Garment Manufacturing Firms | Shibabaw (2015)      | Developing a model of productivity measurement for garment manufacturing companies in Ethiopia.                                                                                                          | Partial and total productivity measurement |
| 6  | Development of Productivity Measurement and Analysis Framework for Manufacturing Companies | Goshu and Matebu (2017) | To propose alternative methodologies for measuring productivity in Ethiopian leather shoe companies.                                                                                                    | Qualitative and quantitative approaches |

3. Methodology

This study was conducted using observational research method, where primary and secondary data were observed and calculated from PT Sejahtera Furnindo as the case study.

3.1. Data Collection

Primary data collected were all input data relevant with labor, material, energy, and capital, as well as all output data that related to quantity and product price. Data of year 2013 and 2017 were able to accessed and used in the study.

3.2. APC Calculation.

Evaluating company productivity via APC approach can be carried out based on constant prices and prevailing prices [6].

3.2.1. Calculation based on constant prices. Output index based on constant prices is calculated from the following equations:

\[
O_0 = \sum_{i=1}^{N} Q_0 x H_0 \tag{5}
\]

\[
O_t = \sum_{i=1}^{N} Q_0 x H_0 t \tag{6}
\]

\[
IO = \frac{O_t}{O_0} \tag{7}
\]

Where:  
- \(Q_0\): Base year output quantity  
- \(Q_t\): Measured year output quantity  
- \(H_0\): Base year output quantity
Labor input index based on constant prices is calculated from the following equations:

Basic year labor input \( L_0 = \sum_{i}^{N} Q L_0 x H L_0 \)  
Measured year labor input \( L_t = \sum_{i}^{N} Q L t x H L_t \)  
Labor input index \( IL = \frac{L_t}{L_0} \)  

Total input index based on constant price is calculated from the following equations:

Base year total input \( I_0 = L_0 + M_0 + E_0 + K_0 \)  
Measured year total input \( I_t = L_t + M_t + E_t + K_t \)  
Total input index \( IIT = \frac{I_t}{I_0} \)  

3.2.2. Calculation of input index uses prevailing price. Labor input with prevailing prices is calculated from the following equation:

Base year labor input \( L_0 = \sum_{i}^{N} Q L_0 x H L_0 \)  
Measured year labor input \( L_t = \sum_{i}^{N} Q L t x H L_t \)  
Labor input index \( IL = \frac{L_t}{L_0} \)  

Total input with prevailing price

Base year total input \( I_0 = L_0 + M_0 + E_0 + K_0 \)  
Measured year total input \( I_t = L_t + M_t + E_t + K_t \)  
Total Input Index \( IIT = \frac{I_t}{I_0} \)  

3.2.3. Calculation of profitability index uses prevailing price. Profitability index based on prevailing price is calculated from the following equations:

Profitability index of labor input \( IPF_L = \frac{I_0}{I_0} x 100 \)  
Profitability index of material input \( IPF_M = \frac{I_0}{I_M} x 100 \)  
Profitability index of energy input \( IPF_E = \frac{I_0}{I_E} x 100 \)  
Profitability index of capital input \( IPF_K = \frac{I_0}{I_K} x 100 \)  
Profitability index of total input \( IPF_T = \frac{I_0}{I_T} x 100 \)  

3.2.4. Calculation of price improvement index. Price improvement index is calculated from the following equations:

Price improvement index for labor input \( IPH_L = \frac{IPF_L}{IPF} \)  
Price improvement index for material input \( IPH_M = \frac{IPF_M}{IPF} \)  
Price improvement index for energy input \( IPH_E = \frac{IPF_E}{IPF} \)  
Price improvement index for capital input \( IPH_K = \frac{IPF_K}{IPF} \)  
Price improvement index for total input \( IPH_T = \frac{IPF_T}{IPF} \)  

4. Results and Discussion

4.1. Data Collection

Data of production output sales and input data (labor, material, energy and capital) were calculated based on constant prices in Table 2 and based on prevailing prices Table 3.
Table 2. Output and input data based on constant prices

| NO | Description       | Based Period   | Constant Prices |
|----|-------------------|----------------|-----------------|
|    |                   | 2013           | Period 2 | Period 3 | Period 4 | Period 5 |
| (1) |                  | (2)            | (3)      | (4)      | (5)      | (6)      | (7)      |
| 1   | Output Total      | 5,778,000,000  | 6,872,000,000  | 7,000,000,000 | 7,896,000,000 | 8,618,000,000 |
| 2   | Labor             | 2,502,000,000  | 2,658,000,000  | 2,814,000,000 | 2,874,000,000 | 2,994,000,000 |
| 3   | Material          | 313,250,000    | 348,575,000    | 404,175,000   | 434,700,000   | 460,700,000   |
| 4   | Energy            | 13,837,161     | 14,523,261     | 15,690,126    | 16,503,787    | 16,956,431    |
| 5   | Capital           | 2,420,778,800  | 1,902,000,700  | 1,570,142,650 | 1,429,017,625 | 1,247,407,600 |
| 6   | Input Total       | 5,249,865,961  | 4,923,098,961  | 4,804,007,776 | 4,754,221,412 | 4,719,064,031 |

Table 3. Output and input data based on prevailing prices

| NO | Description       | Based Period   | Based on Prevailing Prices |
|----|-------------------|----------------|-----------------------------|
|    |                   | 2013           | Period 2 | Period 3 | Period 4 | Period 5 |
| (1) |                  | (2)            | (3)      | (4)      | (5)      | (6)      | (7)      |
| 1   | Output Total      | 5,778,000,000  | 5,986,000,000 | 6,700,000,000 | 7,502,000,000 | 8,429,000,000 |
| 2   | Labor             | 2,502,000,000  | 3,252,000,000 | 4,074,000,000 | 4,809,000,000 | 5,694,000,000 |
| 3   | Material          | 313,250,000    | 404,765,000   | 569,825,000   | 695,975,000   | 771,875,000   |
| 4   | Energy            | 13,837,161     | 14,523,261    | 15,690,126    | 16,503,787    | 17,047,001    |
| 5   | Capital           | 2,420,778,800  | 1,891,473,700 | 1,564,977,150 | 1,411,670,125 | 1,235,042,600 |
| 6   | Input Total       | 5,249,865,961  | 5,562,761,961 | 6,224,492,276 | 6,933,148,912 | 7,717,964,601 |

4.2. Data Processing

4.2.1. Calculation of partial productivity. Partial productivity ratio is calculated from the following equation:

\[
\text{Partial productivity ratio} = \frac{\text{Output Total}}{\text{Input Partial}} \quad (30)
\]

4.2.2. Calculation of total factor productivity. Total productivity is calculated from the following equation:

\[
\text{Total factor productivity ratio} = \frac{\text{Net Output}}{\text{Input (Labour+Capital)}} \quad (31)
\]

4.2.3. Productivity level measurement with APC Model. In processing this data several calculations were carried out in constant and prevailing price. Calculation of productivity index numbers using constant price is shown in Table 4, while calculation of profitability index numbers using prevailing prices is shown in Table 5. Moreover, calculation of price improvement index is then shown in Table 6.
### Table 4. Output and input index of productivity during 2014 period against 2013 (base)

| NO | Description   | Constant Prices | Index | Change |
|----|---------------|------------------|-------|--------|
| (1) | (2)           | (3)              | (4)   | (5)    | (6=4/3) | (7= 6-5) % |

| NO | Description   | 2013        | 2014        | 2013 | 2014 | Change |
|----|---------------|-------------|-------------|------|------|--------|
| 1  | Output Total  | 5,778,000,000 | 6,872,000,000 | 1    | 1.19 | 0.19   |
| 2  | 1. Labor      | 2,502,000,000 | 2,658,000,000 | 1    | 1.06 | 0.06   |
| 3  | 2. Material   | 313,250,000  | 348,575,000  | 1    | 1.11 | 0.11   |
| 4  | 3. Energy     | 13,837,161   | 14,523,261   | 1    | 1.05 | 0.05   |
| 5  | 4. Capital    | 2,420,778,800 | 1,902,000,700 | 1    | 0.79 | -0.21  |
| 6  | Input Total   | 5,249,865,961 | 4,923,098,961 | 1    | 0.94 | -0.06  |

**Productivity (IP):**

| NO | Description   | Prevailing Prices | Index | Change |
|----|---------------|-------------------|-------|--------|
| (1) | (2)           | (3)              | (4)   | (5)    | (6=4/3) | (7= 6-5) % |

| NO | Description   | 2013        | 2014        | 2013 | 2014 | Change |
|----|---------------|-------------|-------------|------|------|--------|
| 1  | Labor         | 2.309       | 2.585       | 100  | 111.95 | 11.95 |
| 2  | Material      | 18.445      | 19.715      | 100  | 106.88 | 6.88  |
| 3  | Energy        | 417.571     | 473.172     | 100  | 113.32 | 13.32 |
| 4  | Capital       | 2.387       | 3.613       | 100  | 151.37 | 51.37 |
| 5  | Total         | 1.101       | 1.396       | 100  | 126.83 | 26.83 |

### Table 5. Output and input index of profitability during 2014 against 2013 (base)

| NO | Description   | Prevailing Prices | Index | Change |
|----|---------------|-------------------|-------|--------|
| (1) | (2)           | (3)              | (4)   | (5)    | (6=4/3) | (7= 6-5) % |

| NO | Description   | 2013        | 2014        | 2013 | 2014 | Change |
|----|---------------|-------------|-------------|------|------|--------|
| 1  | Output Total  | 5,778,000,000 | 5,986,000,000 | 1    | 1.04 | 0.04   |
| 2  | 1. Labor      | 2,502,000,000 | 3,252,000,000 | 1    | 1.30 | 0.30   |
| 3  | 2. Material   | 313,250,000  | 404,765,000  | 1    | 1.29 | 0.29   |
| 4  | 3. Energy     | 13,837,161   | 14,523,261   | 1    | 1.05 | 0.05   |
| 5  | 4. Capital    | 2,420,778,800 | 1,891,473,700 | 1    | 0.78 | -0.22  |
| 6  | Input Total   | 5,249,865,961 | 5,562,761,961 | 1    | 1.06 | 0.06   |

**Profitability (IPF):**

| NO | Description | Prevailing Prices | Index | Change |
|----|-------------|-------------------|-------|--------|
| (1) | (2)         | (3)              | (4)   | (5)    | (6=4/3) | (7= 6-5) % |

| NO | Description   | 2013        | 2014        | 2013 | 2014 | Change |
|----|---------------|-------------|-------------|------|------|--------|
| 1  | Labor         | -           | -           | 100  | 79.71 | -20.29 |
| 2  | Material      | -           | -           | 100  | 80.18 | -19.82 |
| 3  | Energy        | -           | -           | 100  | 98.71 | -1.29  |
| 4  | Capital       | -           | -           | 100  | 132.59| 32.59  |
| 5  | Total         | -           | -           | 100  | 97.77 | -2.23  |

### Table 6. Price improvement during 2014 period against 2013 (base)

| NO | Input Factor | Profitability Index (PIF) | Productivity Index (PI) | Prices Improvement Index (PIH) |
|----|--------------|---------------------------|-------------------------|-------------------------------|
| (1) | (2)          | (3)                       | (4)                     | (5) = (3)/(4)                |
| 1   | Labor        | 79.71                     | 111.95                  | 0.71                          |
| 2   | Material     | 80.18                     | 106.88                  | 0.75                          |
| 3   | Energy       | 98.71                     | 113.32                  | 0.87                          |
| 4   | Capital      | 132.59                    | 151.37                  | 0.88                          |
| 5   | Input Total  | 97.77                     | 126.83                  | 0.77                          |
4.3. Analysis of Data Processing Results

4.3.1. Calculation Analysis of Partial Productivity. Analysis with this method is quite simple and easy to implement by a company to find out the ratio of output to one type of input.

4.3.2. Calculation Analysis of Total Factor Productivity. The ratio of total factor productivity is calculated as in Table 7.

| Years  | Output (Rp)  | Labor (Rp)  | Capital (Rp) | Productivity Ratio Total Factor | Index | Change (%) |
|-------|--------------|-------------|--------------|---------------------------------|-------|------------|
| 2013  | 5,778,000,000 | 2,502,000,000 | 2,420,778,800 | 1.174                           | 1.000 | 0          |
| 2014  | 6,872,000,000 | 2,658,000,000 | 1,902,000,700 | 1.507                           | 1.284 | 0.284      |
| 2015  | 7,000,000,000 | 2,814,000,000 | 1,570,142,650 | 1.597                           | 1.360 | 0.360      |
| 2016  | 7,896,000,000 | 2,874,000,000 | 1,429,017,625 | 1.835                           | 1.563 | 0.563      |
| 2017  | 8,618,000,000 | 2,994,000,000 | 1,247,407,600 | 2.032                           | 1.731 | 0.731      |

Based on the table the highest value ratio is in 2017, which is 2.032 or interpreted 2.32% of the product produced from the costs incurred by the company for capital and paying for its workforce.

4.3.3. Calculation Analysis of Total Productivity with American Productivity Center. The productivity index, profitability index, and prices improvement index calculation is shown in Table 8.

| Index                  | 2013 | 2014 | 2015 | 2016 | 2017 | Average |
|------------------------|------|------|------|------|------|---------|
| Productivity index     | 100  | 126.83 | 132.39 | 150.90 | 165.93 | 135.21  |
| Profitability index    | 100  | 97.77 | 112.68 | 98.31 | 99.23 | 101.60  |
| Prices improvement index | 1    | 0.77  | 0.85  | 0.65  | 0.60  | 0.77    |

From Table 8 we can analyze the performance of PT Sejahtera Furnindo each year as follows:

- In 2014, the productivity increased by 26.83%, compared to labor productivity in base period. Similarly, the price improvement index increased by 0.77, which caused a decrease in profitability of 2.23%.
- In 2015, productivity increased by 32.39%, compared to productivity in the base period. The increment in productivity demonstrated by an 0.85% increment in the price improvement index, which was caused by an increase in the profitability index of 12.68%.
- In 2016, there was an increase in productivity 50.90%, compared to the productivity of the base period. Similarly, the price improvement index increased by 0.65%, which caused a decrease in the profitability index by 1.69%.
- In 2017, productivity was increased by 65.93%, compared to the base period. The price improvement index also increased 0.60%. However, the profitability index decreased by 0.77%.

4.4. Evaluation of Productivity

The next step is to evaluate decrease causes in company productivity during measurement period. To find out more details the problem causes in company productivity used to with formation of causal diagram. The following is an analysis for each input productivity, which graphed in Figure 1:
Material Input
2015 has the lowest material productivity level compared to other periods. The low material productivity in the 2015 period can be identified as: (1) Quality of raw materials received from supplier under standard; (2) Availability of raw materials in supplier is limited; (3) Operators are less careful in cutting raw materials so that much material is wasted.

Labor Input
In 2015 there was a decrease compared to the previous period. There are several things that must be evaluated for labor input including: (1) The length of time the machine is set up; (2) lack of motivation of the workforce due to the low system of rewards; and (3) Lack of workforce knowledge about techniques to improve company quality and productivity.

Energy Input
In 2015 there was a decline in productivity compared to the previous period, 2014. This was caused by several things including: (1) Overtime increases so that energy used also increase; and (2) the machine often breaks down or stalled in a standstill due to lack of raw materials.

Capital Input
The capital input increased every year. Increased capital productivity has not been followed by an increase in the profitability index. Evidently in 2014 there was a decrease in profitability of 2.23%, 2016 fell 1.69% and 2017 fell by 0.77%.

4.5. Planning Strategy of Corporate Productivity Improvement
The first step that can be done in improving productivity is to prioritize problems that are very influential in increasing productivity in accordance with the input factors of company.

- To maintain the quality of raw materials, additional quality control personnel to incoming materials is needed. Company also ought to tighten inspection of raw materials received from suppliers.
- To minimize the machine set up time, they must improve the operator skills by conducting regular training machine.
- To increase the workers’ motivation, rewards system achieving target can be applied.

5. Conclusion
This observational study had revealed that PT Sejahtera Furnindo was able to increase the productivity index, profitability index, and price improvement from 2013 to 2017. This is something important that they do not realize before. The average productivity index has increased 35.2% per year, while the average profitability index made 1.6% increment per year, and the average price improvement index improved by 0.77% per year. Factors that can provide improvements in increasing the company
productivity was cost savings policy for workers, optimizing the use of raw materials, also energy saving by minimizing overtime working hours.

References
[1] Mulyadi JS 2001 System Planning and Management Control (Yogyakarta: Aditya Media)
[2] Aprilia Dian P 2014 Productivity Analysis with Uses Marvin E. Mundel Method (Study Case in UD Sabar Jaya Malang) (Malang: Brawijaya University)
[3] Suliantoro H, Arvianto A and Kusumo P 2012 Jurnal Teknik Industri I 54-67
[4] Pujotomo D, Santoso H and Nursanti H 2012 Jurnal Teknik Industri 3 26-34
[5] Sink D 1985 Productivity management: planning, measurement and evaluation, control, and improvement (New York: Wiley)
[6] Sumanth DJ 1984 Productivity engineering and management: productivity measurement, evaluation, planning, and improvement in manufacturing and service organizations. (New York: McGraw-Hill College)
[7] Gapersz V 2000 Total Business Management: Strategy of Productivity Improvement at Bussiness Global (Jakarta:PT Gramedia Pustaka utama)
[8] Gaperzs V 1997 Total Business Management in the Era of Globalization (Jakarta:PT Gramedia)
[9] Walpole R, Myers R, Myers S and Ye K 1995 Probability & statistics for engineers & scientists (Bandung: ITB Publisher)
[10] Okafor BE 2013 2013 Int. J. Eng. Technol. 2013 3 245-57
[11] Fitri, P and Sari, R 2015 JOSI 14 138-55
[12] Deshmukh Y 2014 IJERT 3