# Productivity Assessment of Herbicide 486 Using *OREGON PRODUCTIVITY MATRIX*



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**Abstract.** This study implements Oregon Productivity Matrix as a methodology to assess production performance in one of the Fertilizer Company located in Gresik, Indonesia. It was identified that productivity performance the Company was declining. The company's main fertilizer product, Herbicide 486 had not been able to fulfil most of the production target which planned by the Production Control department. In order to evaluate productivity performance and determine the degree of success in delivering results against production plan objectives, Oregon Productivity Matrix method was proposed. The assessment result based on the six criteria of Productivity Performance shows that actual productivity cannot catch up with the goal of target productivity. Further, this research determines each criteria's weigh that influence the level of the Company's productivity. The results were 45.21% of raw material requirement, 22.44% of acceptance of raw materials, 15.17% of use of raw materials, 10.75% of packaging machine breakdown, 5.06% of defective products, and 1.37% of electricity consumption

Keywords: *Oregon Productivity Matrix*, Productivity, Fertilizer Company

## 1. Introduction

Productivity is one of important factor which influenced the performance of a company, because productivity result indicates the achievement of company productivity level. Herbicide 486 product is the most widely biological products produced in the Fertilizer Company in Gresik. The problem in this company was that the company's production target had never been fully fulfilled. This happened because the actual productivity performance has decreased in every period. This has triggered the company's urge to increase productivity performance on 486 Herbicide production, so that the company's target can be met.

The Oregon Productivity Matrix (OPM) is chosen as the foundation for the reliability metric. This method is considered well suited for the problem for several reasons:

1. The OPM combines the influence of multiple items into a single quantitative metric; category weighting identifies relative importance yet does not preclude trade-offs
2. The OPM is flexible; category weights can be adjusted according to importance
3. The OPM automatically normalizes widely varying ranges of response values; inputs can be in units familiar to the Reliability Engineer
4. If designed carefully, the OPM format can provide a standardized performance measurement that is valid across a variety of programs, is valid throughout a program's life cycle, and has a verifiable relationship to requirements [1] [2]

## 2. Literature Review

### *2.1 Productivity*

Productivity is defined as the ratio of output divided by input. Output is acceptance (revenues) while input is raw material. Production resources can consist of work equipment (machinery), raw materials and labor. Work equipment is a tool (machine) used to carry out the production process [3]

### *2.2 Oregon Productivity Matrix*

Oregon Productivity Matrix (OPM) is one of method which has multifactor employment index. This method develop matrix calculation and has many advantages, such as its simple implementation. The OPM first application was in the Aviation Industry, Boeing ltd. in 1990. OPM was developed by the University of Oregon, where Reytheon initially used this model to measure performance [4]

This article explores the manner in which this practical tool can be used. The points addressed as OPM method are as follows:

1. The basics of productivity measurement;
2. Partial and total productivity measures;
3. The interrelationship between productivity
4. Features of the Objectives Matrix;
5. Five reasons why the Matrix is especially
6. Six steps to Matrix construction [5]

### *2.3 AHP (Analytic Hierarchy Process)*

Analytic Hierarchy Process is a method which used to assess actions that are associated with a comparison of importance between factors and a comparison of several alternative choices. [6].

## 3. Methodology

Problem formulation referred to company productivity, which were not optimal in several factors, such as the number of defects, effectiveness and efficiency of the use of machinery, labour, material. Production target that were not fully fulfil addressed this research to evaluating which factors that had the most influence in company performance.

Primary data in this study included the history and organizational structure, employee working hours, production processes and weighting criteria. Secondary data were obtained from historical data, publishing journals that related to this study.

Productivity measurement period was carried out for 12 periods, each period having 1 month. Productivity measurement was based on historical data and direct observation in the production department. The following is below:

**Table 1.** Productivity Measurement Period

| Period | Date |
|---|---|
| 1 | 01 January - 31 January 2016 |
| 2 | 01 February - 29 January 2016 |
| 3 | 01 March -31 March 2016 |
| 4 | 01 April - 30 April 2016 |
| 5 | 01 Mei - 31 Mei 2016 |
| 6 | 01 June - 30 June 2016 |
| 7 | 01 July - 31 July 2016 |
| 8 | 01 August - 31 August 2016 |
| 9 | 01 September - 30 September 2016 |
| 10 | 01 October -31 October 2016 |
| 11 | 01 November- 30 November 2016 |
| 12 | 01 December - 31 December 2016 |

## 4. Result and Discussion

*4.1Productivy Criteria*

The productivity criteria which used in this research are determined through interview, direct observation, and business processes of Herbicide 485. The complete criteria can be referenced in Table 2:

**Tabel 2. Productivity Criteria**

| Criteria | Ratio |
|---|---|
| raw materials requirement planning | raw materials requirement planning/ acceptance of raw material |
| acceptance of raw material | Raw material arriving/ Order amount |
| use of raw material | use of raw material/ Produced product |
| packaging machine breakdown | packaging machine breakdown hours/ Machine operating hours |
| defective product | Defective product/ Produced product |
| electricity consumption | electricity consumption/ Produced product |

**Table 3.** Productivity Ratio of Each Criteria

| period | Month | Raw Materials Requirement Planning | Acceptance of Raw Material | Use of Raw Material | Packaging Machine Breakdown | Defective Product | | Electricity Consumption |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Repack Product | Composition Mixing | |
| 1 | January | 0.454 | 0.935 | 1.088 | 0.238 | 0.140 | 0.068 | 0.0034 |
| 2 | February | 1.005 | 0.863 | 0.893 | 0.225 | 0.323 | 0.157 | 0.0091 |
| 3 | March | 1.007 | 0.945 | 1.169 | 0.179 | 0.604 | 0.22 | 0.0104 |
| 4 | April | 0.054 | 0.866 | 0.884 | 0.173 | 0.254 | 0.167 | 0.0082 |
| 5 | Mei | 0.792 | 0.868 | 0.636 | 0.19 | 0.22 | 0.099 | 0.0039 |
| 6 | June | 0.558 | 0.902 | 0.924 | 0.158 | 0.303 | 0.103 | 0.0042 |
| 7 | July | 0.642 | 0.899 | 0.845 | 0.144 | 0.351 | 0.117 | 0.005 |
| 8 | August | 0.713 | 0.948 | 0.733 | 0.127 | 0.289 | 0.1 | 0.0056 |
| 9 | September | 0.110 | 0.985 | 0.607 | 0.119 | 0.357 | 0.107 | 0.039 |
| 10 | October | 1.049 | 0.844 | 0.567 | 0.15 | 0.292 | 0.088 | 0.0036 |
| 11 | November | 1.035 | 0.875 | 0.495 | 0.117 | 0.405 | 0.143 | 0.0032 |
| 12 | December | 0.834 | 0.848 | 1.115 | 0.123 | 0.302 | 0.27 | 0.0118 |

Productivity goals were determined by interviewing directly with the production manager. The following is determination of goals for each productivity criteria to be achieved:

**Table 4.** Productivity Goals

| Period | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Raw Materials Requirement Planning** | **Acceptance of Raw Material** | **Use of Raw Material** | **Packaging Machine Breakdown** | **Repack Product** | **Composition Mixing** | **Electricity Consumption** |
| 1 | 96% | 90% | 83% | 12% | 20% | 9% | 4% |
| 2 | 98% | 90% | 85% | 10% | 21% | 6% | 4% |
| 3 | 97% | 90% | 96% | 7% | 24% | 21% | 3.5% |
| 4 | 90% | 95% | 87% | 7% | 24% | 8% | 4% |
| 5 | 95% | 90% | 85% | 8% | 25% | 14% | 4% |
| 6 | 92% | 95% | 86% | 10% | 25% | 11% | 4% |
| 7 | 95% | 85% | 85% | 10% | 28% | 11% | 4% |
| 8 | 90% | 95% | 89% | 10% | 28% | 15% | 4% |
| 9 | 92% | 89% | 91% | 13% | 25% | 8% | 3% |
| 10 | 92% | 88% | 90% | 13% | 24% | 8% | 3% |
| 11 | 88% | 89% | 93% | 8% | 21% | 11% | 4% |
| 12 | 91% | 87% | 91% | 8% | 20% | 6% | 4% |

**Tabel 5.** Criteria Ratio Matrix

| Criteria | K1 | K2 | K3 | K4 | K5 | K6 | Total |
|---|---|---|---|---|---|---|---|
| **K1** | 1.000 | 3.000 | 5.000 | 3.000 | 7.000 | 7.000 | 26.000 |
| **K2** | 0.333 | 1.000 | 3.000 | 3.000 | 5.000 | 2.000 | 14.333 |
| **K3** | 0.200 | 0.333 | 1.000 | 3.000 | 3.000 | 3.000 | 10.533 |
| **K4** | 0.333 | 0.333 | 0.333 | 1.000 | 3.000 | 2.000 | 7.000 |
| **K5** | 0.143 | 0.200 | 0.333 | 0.333 | 1.000 | 0.333 | 2.343 |
| **K6** | 0.143 | 0.500 | 0.333 | 0.500 | 3.000 | 1.000 | 5.476 |
| **Total** | **2.152** | **5.367** | **10.000** | **10.833** | **22.000** | **15.333** | |

**Tabel 6.** Criteria Weight

| Rank | Criteria | Weight |
|---|---|---|
| 1 | Raw materials requirement planning | 0.429 |
| 2 | Acceptance of raw material | 0.213 |
| 3 | Use of raw material | 0.144 |
| 4 | Packaging machine breakdown | 0.102 |
| 5 | Defective product | 0.073 |
| 6 | Electricity consumption | 0.039 |

Calculation of the ratio constant is used to determine ratio of pairwise comparison in the matrix. If the CR value is less than 10% or less than 0.1 then consistency can still be accepted.

$\lambda$ Max = (Ratio$_1$ x Weight$_1$) + (Ratio $_2$ x Weight $_2$) + (Ratio $_3$ x Weight $_3$) + (Ratio $_4$ x Weight $_4$) + (Ratio $_5$ x Weight $_5$) + (Ratio $_6$ x Weight $_6$) (1)

$\lambda$ Max = (2,152 x 0,429) + ( 5,367 x 0,213) + (10,000 x 0,144) + (10,833 x 0,102) + (22,000 x 0,039) + (15,333 x 0,073) = 6,593

$$CI = \frac{\lambda max - n}{(n-1)} \quad (2)$$

$$= \frac{6,593 - 6}{(6-1)} = 0,119$$

$$CR = \frac{CI}{RI} \quad (3)$$

$$= \frac{0,119}{1,24} = 0,096$$

Where are:
CI = *Consistency Index*
RI = *Random Consistency*
CR = *Constanta Ratio*
n = Total Criteria

**Table 7.** CR Calculation

| Code | Total Criteria | Eigen factor | Result |
|---|---|---|---|
| 1 | 2.152 | 0.429 | 0.924 |
| 2 | 5.367 | 0.213 | 1.141 |
| 3 | 10.000 | 0.144 | 1.440 |
| 4 | 10.833 | 0.102 | 1.100 |
| 5 | 22.000 | 0.039 | 0.861 |
| 6 | 15.333 | 0.073 | 1.126 |
| | | $\lambda$ Max | 6.593 |
| | | CI | 0.119 |
| | | CR | 0.096 |

Based on the calculation of constanta ratio (CR) in each criterion weighting, it can be obtained 0.096. It states that the questionnaire results is reliable because the CR value is <0.1 or <10%.

*4.2 Productivity Measurement with the Oregon Productivity Matrix*

Comparison between Goals Index and Actual Index during 12 Periods can be shown below:

**Table 8.** Comparison between Goals Index and Actual Index during 12 Periods

| Period | Goal Index | Actual Index |
|---|---|---|
| 1 | 8.64 | 6.087 |
| 2 | 8.784 | 6.594 |
| 3 | 8.673 | 8.205 |
| 4 | 9.279 | 3.171 |
| 5 | 8.067 | 5.778 |
| 6 | 9.492 | 6.300 |
| 7 | 7.929 | 6.231 |
| 8 | 9.207 | 7.470 |
| 9 | 8.034 | 4.764 |
| 10 | 8.247 | 6.372 |
| 11 | 8.36 | 6.597 |
| 12 | 8.145 | 6.615 |


**Figure 1.** Comparison between Goal and Actual Achievement

Based on the plot image in figure 1, the comparison of the expected and actual goal values obtained can be determined. The actual line shape in the plot diagram is stable but all actual points still has not fulfilled the goal points of company. Some result like in third period, the actual line approach the goal line. The actual point index is the largest in third period and the smallest fourth period. The actual point index has increased in the 3rd, 5th, 6th, 9th, 12th period and has decreased in the 1st, 2nd, 4th, 7th, 8th, 10th, 11th period. Criteria position is used to determine which criteria will be prioritized for improvement

## 5. Conclussion

Based on the result of this research, weight of criteria that influenced the level of Company Productivity were 45.21% of raw material requirement, 22.44% of acceptance of raw materials, 15.17% of use of raw materials, 10.75% of packaging machine breakdown, 5.06% of defective products, and 1.37% of electricity consumption

During the 12 periods of productivity measurement, actual achievements of the company has never achieved the expected goal. Therefore, improvement efforts to increase the company productivity are critically necessary. Criteria will be prioritized for improvement based on the rank order of the OPM results.

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