DESIGN OF PERFORMANCE MEASUREMENT SYSTEM IN ENGINEERING DEPARTMENT BASED ON MAINTENANCE SCORECARD FRAMEWORK AND OMAX MODEL: A CASE STUDY OF GLOBAL SANITARY WARE COMPANY

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ABSTRACT

This paper describes how to design a performance measurement system based on the maintenance scorecard (MSC) framework and objective matrix (OMAX) model. The study was conducted in the engineering department of PT XXX Tbk. PT XXX Tbk is a global manufacturing company that produces sanitary wares and plumbing hardwares. The purposes of this research are: to design the appropriate key performance indicators; to measure current performance, and create a plan of action for improvement. The results of this study identified 21 KPIs, which consists of four KPIs for productivity perspective, three KPIs for cost-effectiveness perspective, two KPIs for safety perspective, three KPIs for quality perspective, three KPIs for environmental perspective, and six KPIs for learning perspective. The average value of current performance measurement is 5.307 with rating scale 1-10. In the end, there were 32 proposed action plans to improve performance in this department.

Keywords: *maintenance scorecard, objective matrix, key performance indicator.*

1. INTRODUCTION

PT XXX Tbk is a global manufacturing company that produces sanitary wares and plumbing hardwares. With the corporate vision is “To move forward and provide such products as well as serve to improve cleanliness, comfort, and convenience for many people,” this company strives to improve its performance continuously and sustainably. Moreover Indonesia as one of the country located in the ASEAN region will soon begin to apply the ASEAN Economic Community (AEC) in the late of 2015. To meet the challenge, the company requires a performance measurement system in order to know the performance of current and planned corrective actions with the aim to minimize the gap between desired performance and achieved performance.

In order to provide the best service to people in terms of quality and productivity, this company should be supported by operating standards and all production facilities that work optimally. So instead of that, it takes a structured performance measurement system in the engineering department of PT XXX Tbk. This paper would discuss how to design a performance measurement system based on maintenance scorecard framework and OMAX model. The purposes of this research are: to design the appropriate key performance indicators; to measure current performance; and to create action plans for improvement.

2. LITERATURE REVIEW

2.1 Maintenance Scorecard

According to Daryl Mather (2005) in his book "The Maintenance Scorecard: Creating Strategic Advantage" defines Maintenance Scorecard (MSC) as a approach used to develop and implement strategies for the area of asset management in both the short and long-term. The MSC applied in a hierarchy of objectives or a structured approach through three fundamental levels are corporate level, strategic level and functional level. The MSC approach provides companies with a tool to implement and communicate corporate strategy throughout the company. It is also a means of facilitating innovative thought within an

organization, particularly in terms of new and more efficient means of creating economic growth or the management of risk [a].

The beginning of any measurement regime is first to understand what we want to measure and why. Corporate goals and objectives need to be linked with the competitive advantages that an organization wishes to achieve. Competitive advantages are typically described as "*The set of unique or hard to duplicate abilities, competencies, and capacities contained within an organization that allows it to better compete within the markets that it operates in*." Competitive advantages can be represented in a hierarchy of advantages and goals. This provides for the first step in the communication of corporate objectives. It also allows for the initial step in the creation of the strategy map that will be used to drive these goals and objectives through the entire organization. Instead of taking the approach to measure everything and anything that can be measured, the process first identifies what is needed in order to achieve the overall goals of the company. Achievement of competitive advantages depends on the strategic advantages that we are able to create. Strategic advantages can be described as "*The set of unique or hard to duplicate abilities, competencies, and capacities contained within a organization that support the company's competitive advantages*." A strategic advantage that is may develop to ensure this could be a high level of reliability in its operating plant. The last level of the hierarchy used in the structured approach is that of strategic assets. The principal goal of using the top-down structured approach is the development of strategic assets, which can be explained as "*The abilities, competencies or capacities that are required in order to achieve strategic advantages*." Strategic assets represent the component parts, or the functional level activities, that comprise a strategic advantage. Within the context of the MSC, strategic assets does not refer to critically important equipment specifically; it refers to intangible skills, abilities, and capacities that are contained within an organization [a].

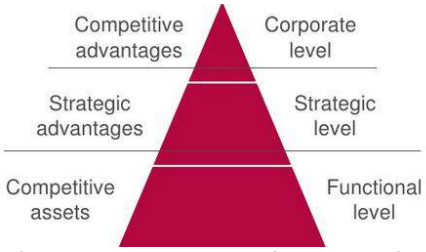

Figure 1. A Structural Approach to Measuring Maintenance [a]

As such the rigorous application of the principles of the MSC begins by the first defining the challenges that an organization faces in its chosen markets, and second through asking six fundamental questions in the defined areas of importance of asset management [a]:

a. Productivity Perspective: how can asset management contribute to the ability to produce more?
b. Cost Effectiveness Perspective: how can we continue to reduce the unit costs of the asset management efforts?
c. Safety Perspective: what can be done to ensure that corporate exposure to safety incidents is within tolerable levels?
d. Quality Perspective: how can we ensure the repeatability of performance of physical assets?
e. Environmental Perspective: what can be done to ensure that corporate exposure to environmental incidents is within tolerable levels?
f. Learning Perspective: how can we continue to be innovative and use asset management as an area of growth?

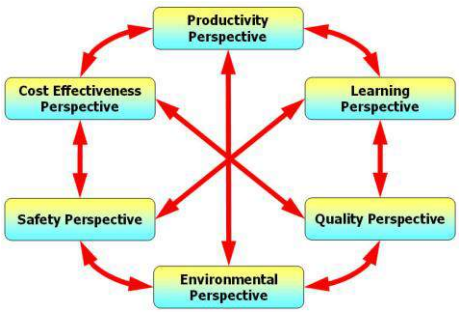

Figure 2. Maintenance Scorecard Model [a]

Three steps are required to implement the MSC, namely [a]:

a. Development
   This phase begins by defining the desired states of performance required to achieve corporate goals and

objectives. The outcome of these actions is a series of quantified measures, goals, and statements that represent the corporate objectives. At the corporate level an array of pressures, market forces, and opportunities need to be analyzed.

b. Creation
In particular the creation phase focuses on the definitions that are gained for the information portfolio that is required to sustain the MSC. This is further defined in the development stages by the adoption of strategy initiatives. This phase can typically include:
   1) Report creation, implementation of reporting software if necessary.
   2) Staged implementation of administrative processes and reliability initiatives. This part of the entire plan is a crucial element to the success or failure of the overall improvement initiative.
   3) Preparation of material for the embedding process.

c. Embedding
This phase is the most vital part of the project and is designed to ensure its success as a permanent strategic initiative. There are three basic actions. First there is the need to communicate the work being done. The second is the implementation of the processes and initiatives required to achieve the competitive advantages that were initially decided upon. And the final requires a close monitoring of the result of the management initiatives and communicating these results, and the achievements of those involved, to the remainder of the organization.

2.2 OMAX Model

Objective matrix (OMAX) model was developed by Dr. James L. Riggs (Department of Industrial Engineering at Oregon State University). This model was first introduced in the 80s in the United States. OMAX is a productivity measurement system. This measurement model incorporates the criteria of productivity into a form that is integrated and related to each other. This model involves all levels in the company, because the system is delivered directly to the units of work to measure its performance [b].

This model consists of three parts (as shown in Table 1), namely [b]:

1. Definition Block
   The first line in this block are factors that affect the performance of the company (or KPIs). And, the second line is the result of the achievement of the company's performance for each KPI.
2. Quantification Block
   In this block, the division level of achievement of the performance is from level 0 to level 10. Level 10 is the highest achievement or targets established by the company. Level 3 is the average value of the achievement of the performance or the achievement of company's performance in previous period. Meanwhile, level 0 is the worst performance achievement ever obtained. Here is the formula to determine other levels of each KPI:
   Interval between Level 0 and level 3 = $\frac{level\ 3 - level\ 0}{3-0}$ (1)
   Interval between Level 3 and level 10 = $\frac{level\ 10 - level\ 3}{10-3}$ (2)
3. Weight and Value Block
   This block is as monitor to analyze the level, weight, and value for each KPI. Line of level is loaded in accordance with the achievement level for each KPI. Line of weigth is filled in accordance with the weight for each KPI. Line of value is the result of an assessment or multiplication between levels and weights for each KPI.

Traffic light system is closely linked to the scoring system. Traffic light system is a system that can indicate the condition of a KPI whether it requires an improvement or not. Indicator of the traffic light system is represented with several colors as follows [h]:

1. The green color indicates the performance has reached the target. Green color is used for threshold from level 7 to level 10.
2. The yellow color means that the performance has not yet reached the target but has approached the target.

Yellow color is used for threshold from level 3 to level 6.

3. the red color means the performance actually below the target. Red color is used for threshold from level 0 to level 2.

Table 1. Assessment Scheme of Model OMAX

Code of KPI				(1) Definition Block
Performance				
Level	10			(2) Quantification Block
	9			
	8			
	7			
	6			
	5			
	4			
	3			
	2			
	1			
Level				(3) Weight and Value Block
Weight				
Value				
Index				

3. RESEARCH METHODOLOGY

This research was conducted at PT XXX Tbk. in the engineering depatment. In introduction section, we mentioned that the main purpose of this study is to design a performance measurement system based on the maintenance scorecard framework that would be used to measure and evaluate the performance of the division whether it has reached its target or not. The initial phase of the maintenance scorecard design is to comprehend deeply the vision and mission of the company, and then to translate it into six-scorecard maintenance perspectives. At the same time, also be conducted both interviews and discussions with the management to find the key success factors (KSFs) of the company as its competitive advantages. Afterwards, determined strategy objectives based on company's KSFs. Furthermore according to strategy objectives, designed key performance indicators (KPIs) for each perspective in engineering department. Weighting each KPI was done by analytical hierarchy process (AHP) method approach. The questionnaire was distributed to 10 respondents, which could be regarded as experts. All respondents have position as a manager or an assistant manager, and have worked minimum for 2 years. And then, made the analysis of pairwise comparison matrix and also be calculated consistency ratio (CR) to determine whether the results of the questionnaire has been consistent. Then, the achievement of actual performance for each KPI would be measured. In this study, the data collected was data from January 2014 to October 2014. And, to obtain the score of the performance achievement for each KPI was used OMAX method approach.

4. RESULT AND DISCUSSION

4.1 Designing of Key Performance Indicators

In the beginning of designing the MSC, translates the vision and mission of PT XXX Tbk into six scorecard perspectives:

1. Productivity Perspective
   Due to high demand, production of this company operates 24 hours a day. It also needs to be supported by reliable production equipment, so it has a lower likelihood of damage. In addition, the company has implemented automated or robotic production system as a means to improve productivity.
2. Cost Effectiveness Perspective
   In improving cost effectiveness, this company estimated budget plan based on activity-based costs. The company continues to improve the whole process at all levels in order to become more effective and efficient.
3. Safety Perspective
   Employees are the most important asset in this company. The productivity of the employees are highly dependent on the level of safety and health of the workplace. In meeting the needs of employees as well as one of the missions of PT XXX Tbk such as "Respect for the individual and fostering cooperation," the company implemented a Health and Safety Management System, which aims to improve the level of health and safety in the workplace.
4. Quality Perspective
   This company has one mission "Presenting useful & high quality products." To fulfill this mission, the company applied the proper and regular maintenance that would enhance the high quality of the performance of machine or production equipment. This would increase the availability time on production and also to decrease the

number of defects that caused by the failure of machine.

5. Environment Perspective
   In response to environmental issues, this company made waste treatment. It aims to collect and filter the waste so that it does not contain harmful substances that may pollute the surrounding environment.
6. Learning Perspective
   Increasingly fierce competition insists this company to innovate constantly in order to be competitive and excel in providing customer satisfaction. So instead of that, PT XXX Tbk need to provide education and training for employees to be able to continue to improve the capability and competence of its employees.

Basically, there are six key success factors (KSFs) of performance achievement in engineering department of PT XXX Tbk, among others: increasing of productivity or delivery on time; cost-effectiveness management; achievement of zero accident; improving quality of the product; care for the environment; creativity and innovation. The next step is to determine the strategic objectives and performance indicators for each perspective as follows:

1. Productivity Perspective:

a. [P1] To schedule maintenance activities accurately.
   There is an indicator that can be used to measure achievement of this strategy objective namely maintenance schedule delays [P1.1]. Maintenance schedule delays can be defined as duration of the delay in implementation of maintenance activities from planned schedule.
b. [P2] To improve the work order completion.
   There is an indicator that can be used to measure achievement of this strategy objective namely percentage of completion of the work order [P2.1]. Percentage of completion of the work order can be defined as a level of achievement in completing the work order that is entered into the engineering department.
c. [P3] To enhance the availability of production equipment or a system.
   There is an indicator that can be used measure achievement of this strategy objective namely availability rate [P3.1]. Availability rate can be defined as percentage of time in which production equipement or a system is operational, ie loading time is reduced by downtime, divided by loading time then multiply it by a hundred percent.
d. [P4] To increase the usage of facility.
   Similar with the others, there is an indicator that can be used to measure achievement of this strategy objective namely performance rate [P4.1]. Performance rate is percentage ratio between output and input, ie total production per minute divided by total of ideal production per minute, then multiply by a hundred percent.

2. Cost Effectiveness Perspective:

a. [C1] To reduce overtime.
   There are two indicators that can be used to measure achievement of this strategy objective namely duration of engineering personnel's overtime per person per month [C1.1] and duration of maintenance section personnel's overtime per person per month [C1.2]. Sometimes personnel must perform maintenance activities at a time outside working hours or on a holiday. it is considered as the overtime.
b. [C2] To improve the accuracy of estimated budget.
   There is an indicator that can be used to measure achievement of this strategy objective namely percentage of budget deviation [C2.1]. This indicator can be defined as percentage ratio between the budget differences and estimated budgets.

3. Safety Perspective:

   a. [S1] To reduce workplace accidents.
   There are two indicators that can be used to measure achievement of this strategy objective namely number of occupational accidents in the plant [S1.1] and number of occupational accidents outside the plant [S1.2]. The number of occupational accidents in plant can be defined as amount of accidents that occur in the plant environment during working time within a year. Whereas, the number of occupational accidents outside the plant

is amount of accidents that occur outside the plant environment during working time within a year.

4. Quality Perspective:

a. [Q1] To reduce level of defects.
There is an indicator that can be used to measure achievement of this strategy objective namely quality rate [Q1.1]. Quality rate is level of quality of production within a certain period.

b. [Q2] To improve the calibration of measuring tools.
There are two indicators that can be used to measure achievement of this strategy objective namely total internal inspection of calibration of measuring tools [Q2.1] and total external inspection of calibration of measuring tools [Q2.2]. Total internal inpection of calibration of measuring tools can defined as amount of internal calibration is performed by engineering department. Whereas, total external inpection of calibration of measuring tools can defined as amount of external calibration is performed by outsourcing.

5. Environment Perspective:

a. [E1] To control the working environment.
There is an indicator that can be used to measure achievement of this strategy objective namely frequency of scrap disposal of work process which contaminated by B3 per year [E1.1]. Each item of the rest of the maintenance activities that contaminated B3 (hazardous and toxic materials) would be collected previously.

b. [E2] To control the 5S program.
There are two indicators that can be used to measure achievement of this strategy objective namely number of workshop for socialization 5S [E2.1] and number of 5S audits [E2.2]. Number of workshop for socialization 5S can be defined as amount of workshops were held to provide insight and knowledge about the implementation of 5S in the workplace/production area. And, number of 5S audits can be defined as amount of audit or assessment of the implementation of 5S in the workplace/production area.

6. Learning Perspective:

a. [L1] To enhance the competence of employees.
There are three indicators that can be used to measure achievement of this strategy objective namely score of employee competence assessment [L1.1], total training for engineering personnel [L1.2], and total training for operator or foreman [L1.3]. Every employees of this company would follow competency tests annually. The purpose of this test is to determine the ability and competence of the employee. This assessment is conducted by HRD department. Training for engineering personnel aims to improve knowledges and skills that support their work. Whereas, training for operator or foreman aims to improve the knowledge of the operator or foreman, or to improve the leadership of foreman.

b. [L2] To foster innovation employees.
There are three indicators that can be used to measure achievement of this strategy objective namely number of proposed operators's innovation [L2.1], number of proposed foreman's innovation [L2.2], and number of proposed engineering department's innovation [L2.3]. Every employee of this company was encouraged to innovate continuously.

4.2 Weighting of Each Perspective, Strategy Objective, and KPI by AHP Method

In this study, weighting was conducted by using AHP. AHP is a multi-criteria decision-making method developed by Saaty, which is designed to capture the perception of a person or group of people who are closely related to certain issues through a procedure that is made to acquire a preference scale. This method makes it possible to draw up a problem into a hierarchy process, then given a numeric value in term of preference scale that indicates the relative importance of one element to another element in term of each criterion. The values of the pairwise comparisons in the AHP are determined according to the scale introduced by Saaty (1980). Finally, the assessment is then processed to determine which elements

should have the highest priority [f], [g]. Table 2 shows the data of the people who responded to the questionnaire, such as their position and length of work. Furthermore Geomean values from the survey results would be calculated, e.g. in comparison productivity to environmental, obtained Geomean = $\sqrt[10]{\frac{1}{2} \text{ x } 3 \text{ x } 4 \text{ x } 3 \text{ x } \frac{1}{3} \text{ x } \frac{1}{4} \text{ x } 2 \text{ x } \frac{1}{3} \text{ x } 1 \text{ x } \frac{1}{2}}$ = 0.93, in order to obtain pairwise comparison matrix for each perspective as shown in Table 3. After that, to be normalized as shown in Table 4.

Table 2. Data of respondents

No. Respondent	Position	length of work
1	Manager of Production 1	36 years
2	Manager of Production 2	27 years
3	Manager of Product Design & Development	17 years
4	Manager of Quality Assurance	2 years
5	Manager of Production 3	24 years
6	Manager of HRD	30 years
7	Manager of PPIC	13 years
8	Assistant Manager of Engineering	18 years
9	Assistant Manager of Slip & Mold	20 years 3 months
10	Manager of R&D	7 years 2 months

Table 3. Pairwise Comparison Matrix for Each Perspective

Perspective	Productivity	Cost-Effectiveness	Safety	Quality	Environment	Learning
Productivity	1.00	1.17	0.96	0.84	0.93	1.47
Cost-Effectiveness	0.85	1.00	0.46	0.87	0.71	2.17
Safety	1.04	2.18	1.00	1.27	1.46	2.58
Quality	1.20	1.15	0.79	1.00	1.06	2.15
Environment	1.07	1.41	0.68	0.94	1.00	1.12
Learning	0.68	0.46	0.39	0.46	0.90	1.00
Total	5.84	7.37	4.28	5.38	6.06	10.49

Table 4. Normalization Result of Pairwise Comparison Matrix for Each Perspective

Perspective	Productivity	Cost-Effectiveness	Safety	Quality	Environment	Learning	Eigen vector	Weight
Productivity	0.17	0.16	0.22	0.16	0.15	0.14	1.00	0.17
Cost-Effectiveness	0.15	0.14	0.11	0.16	0.12	0.21	0.87	0.15
Safety	0.18	0.30	0.23	0.24	0.24	0.25	1.43	0.24
Quality	0.20	0.16	0.18	0.19	0.17	0.21	1.11	0.19
Environment	0.18	0.19	0.16	0.18	0.16	0.11	0.98	0.16
Learning	0.12	0.06	0.09	0.09	0.15	0.10	0.60	0.10

Due to the number of criteria that compared more than two elements, it is necessary to count its consistency ratio to determine the consistency of the answers of the respondents. Here is the calculation of consistency ratio (CR):

1. Calculation of product of the matrix and its weight:

$$\begin{vmatrix} 1 & 1.17 & 0.96 & 0.84 & 0.93 & 1.47 \\ 0.85 & 1 & 0.46 & 0.87 & 0.71 & 2.17 \\ 1.04 & 2.18 & 1 & 1.27 & 1.46 & 2.58 \\ 1.20 & 1.15 & 0.79 & 1 & 1.06 & 2.15 \\ 1.07 & 1.41 & 0.68 & 0.94 & 1 & 1.12 \\ 0.68 & 0.46 & 0.39 & 0.46 & 0.90 & 1 \end{vmatrix} X \begin{bmatrix} 0.17 \\ 0.15 \\ 0.24 \\ 0.19 \\ 0.16 \\ 0.10 \end{bmatrix} = \begin{bmatrix} 1.02 \\ 0.89 \\ 1.46 \\ 1.13 \\ 1.00 \\ 0.61 \end{bmatrix}$$

2. Calculation of quotient for productivity: $= \frac{1.02}{0.17} = 6.1$
3. Calculation of quotient for cost-effectiveness: $= \frac{0.89}{0.15} = 6.12$
4. Calculation of quotient for safety: $= \frac{1.46}{0.24} = 6.13$
5. Calculation of quotient for quality: $= \frac{1.13}{0.19} = 6.1$
6. Calculation of quotient for environment: $= \frac{1}{0.16} = 6.1$
7. Calculation of quotient for learning: $= \frac{0.61}{0.10} = 6.07$
8. Calculation of value of λmax [f], [g]:

$$\lambda max = \frac{\text{Total of quotient}}{\text{number of criteria}} \quad (3)$$

$$\lambda max = \frac{36.62}{6} = 6.1$$

9. Calculation of value of CI [f], [g]:

$$CI = \frac{\lambda \text{ max} - \text{number of criteria}}{\text{number of criteria} - 1} \quad (4)$$

$$CI = \frac{6.1-6}{6-1} = 0.02$$

10. Calculation of value of CR [f], [g]: (if number of criteria (N) = 6 then RCI = 1.24 as given in Table 5)

$$CR = \frac{CI}{RCI} \quad (5)$$

$$CR = \frac{0.02}{1.24} = 0.02$$

Table 5. Random Consistency Index (RCI) [g]

N	1	2	3	4	5	6	7	8	9
RCI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

The result of the calculation of CR of 0.02. Thus this value shows a good consistency due to do not exceed the maximum value of CR of 0.1. Overall the above steps would also be applied when performing weighting on both the strategic objectives and the KPIs. Results of weighting each KPI when sorted from the highest priority, namely: number of occupational accidents in the plant (weight of 17%); quality rate (weight of 12%); frequency of scrap disposal of work process which contaminated B3 per year (weight of 8.6%); percentage of budget deviation (weight of 7.7%); number of occupational accidents outside the plant (weight of 6.8%); number of workshop for socialization 5S (weight of 5.8%); maintenance schedule delays (weight of 0.0488); performance rate (weight of 4.5%); availability rate (weight of 3.86%); percentage of completion of the work order (weight of 3.56%); duration of engineering personnel's overtime per person per month and duration of maintenance section personnel's overtime per person per month (both have the same weight of 3.45%); total external inspection of calibration of measuring tools (weight of 3.4%); total internal inspection of calibration of measuring tools (weight of 3.1%); number of 5S audits and total training for engineering personnel (both have the same weight of 1.9%); score of employee competence assessment and number of proposed engineering division's innovation (both have a weight of 1.8%); number of proposed operators's innovation (weight of 1.6%); number of proposed foreman's innovation (weight of 1.5%); total training for operator or foreman (weight of 1.4%).

4.3 Measurement of Current Performance

Table 6 shows both the targets in 2014 for each KPI and its achievements (actual). Some indicators were measured monthly, where its actual achievement is obtained from the average of measurement of each month. In the table below, seen that some indicators haven't reached the target yet.

Table 6. Documenting The MSC

Code	Strategy Objective	#	Code	Key Performance Indicator	Unit	Target 2014	Actual	Freq.
P1	Schedule maintenance activities accurately	1	P1.1	Maintenance schedule delays	Days	21	33.9	Monthly
P2	Improve the work order completion	2	P2.1	Percentage of completion of the work order	%	90	88.19	Monthly
P3	Enhance the availability of a machine or a system	3	P3.1	Availability rate	%	95	98.43	Monthly
P4	Increase the usage of facility	4	P4.1	Performance rate	%	95	98.55	Montly
C1	Reduce overtime	5	C1.1	Duration of engineering personnel's overtime per person per month	Hours	20	21.42	Monthly
		6	C1.2	Duration of maintenance section personnel's overtime per person per month	Hours	20	15.35	Monthly
C2	Improve the accuracy of estimated budget	7	C2.1	Percentage of budget deviation	%	-10	-3	Yearly
S1	Reduce workplace accidents	8	S1.1	Number of occupational accidents in the plant	#	0	0	Yearly
		9	S1.2	Number of occupational accidents outside the plant	#	0	0	Yearly
Q1	Reduce level of defects	10	Q1.1	Quality rate	%	90	79.21	Monthly
Q2	Improve the calibration of measuring tools	11	Q2.1	Total internal inspection of calibration of measuring tools	#	2,060	1,941	Yearly
		12	Q2.2	Total external inspection of calibration of measuring tools	#	33	34	Yearly
E1	Control the working environment	13	E1.1	Frequency of scrap disposal of work process which contaminated B3 per year	#	20	33	Yearly
E2	Control the 5S program	14	E2.1	Number of workshop for socialization 5S	#	4	3	Yearly
		15	E2.2	Number of 5S audits	#	12	12	Yearly
L1	Enhance the competence of employees	16	L1.1	Score of employee competence assessment	#	3.7	3.75	Yearly
		17	L1.2	Total training for engineering personnel	#	30	39	Yearly
		18	L1.3	Total training for operator or foreman	#	4	6	Yearly
L2	Foster innovation employees	19	L2.1	Number of proposed operators's innovation	#	30	3	Yearly
		20	L2.2	Number of proposed foreman's innovation	#	4	2	Yearly
		21	L2.3	Number of proposed engineering department's innovation	#	12	0	Yearly

Then, the achievement of the performance would be measured using OMAX model approach. In determining the value of each level, need to be further analyzed how the highest (as level 10) and lowest achievement (as level 0) of a KPI. Similarly, should be calculated average achievement (as level 3) of each KPI. Next will be determined value of each KPI. Based on the evaluation of KPI every month, then the traffic light system was applied to make it easier to analyze the measurement results (as shown in Table 7 & Table 8). In the tables, it was seen that during 2014 there were several indicators in learning perspective has red performance. It certainly will be a common concern, so it is expected that these indicators can be increased gradually later. The rating of performance obtained from sum of product of the scores and weights for each KPI in a certain period. Meanwhile, performance index shows increasing or decreasing of the performance in a period. Performance index is difference between current performance and prior performance (as shown in Table 9). Thus, the results would be plotted as shown in Figure 4. From the graph shows that the highest performance occurred in October with a value of 6.959 with rating scale of 1-10, and the lowest performance occurred in August with a value of 4.14. Overall, the average value of performance measurment in engineering department of 5.307 for 10 months in 2014. The analysis of the performance index calculation, shows that the highest increase in performance occurred in September with an index of +65.19%, while the highest decline in performance in March with an index of -26.633%.

Table 7. Result of Performance Measurement by Traffic Light System

Month \ KPI	P1.1	P2.1	P3.1	P4.1	C1.1	C1.2	C2.1	S1.1	S1.2	Q1.1
January	2	10	10	2	6	7	2	10	10	4
February	0	7	5	2	8	10	10	10	10	4
March	2	8	9	5	4	4	2	10	10	0
April	2	10	8	5	4	9	6	10	10	2
May	3	7	4	2	0	1	0	10	10	2
June	8	2	2	6	5	2	5	10	10	2
July	2	2	0	2	1	7	2	10	10	9
August	6	2	8	3	0	0	2	10	10	0
September	7	2	6	7	3	2	7	10	10	6
October	10	0	9	10	10	3	8	10	10	4

Table 8. Result of Performance Measurement by Traffic Light System (cont'd)

Month \ KPI	Q2.1	Q2.2	E1.1	E2.1	E2.2	L1.1	L1.2	L1.3	L2.1	L2.2	L2.3
January	0	1	0	0	10	3	1	3	0	0	0
February	1	0	1	10	10	3	5	3	0	0	0
March	1	0	2	0	10	3	3	0	0	0	0
April	1	10	2	0	10	3	10	10	10	10	0
May	6	3	10	0	10	3	2	0	0	0	0
June	2	0	5	0	10	3	2	0	0	0	0
July	3	3	2	0	10	3	0	0	0	0	0
August	10	1	2	0	10	3	2	0	0	0	0
September	9	3	10	10	10	3	1	0	0	0	0
October	4	7	5	10	10	3	7	0	0	0	0

Table 9. Result of Performance Rating

Period	Value of Performance	Performance Index (%)
January	4.731	-
February	5.861	23.037
March	4.269	-26.633
April	5.945	40.238
May	4.725	-21.870
June	4.829	2.507
July	4.760	-1.732
August	4.140	-12.899
September	6.855	65.190
October	6.959	2.364
Average	5.307	7.020

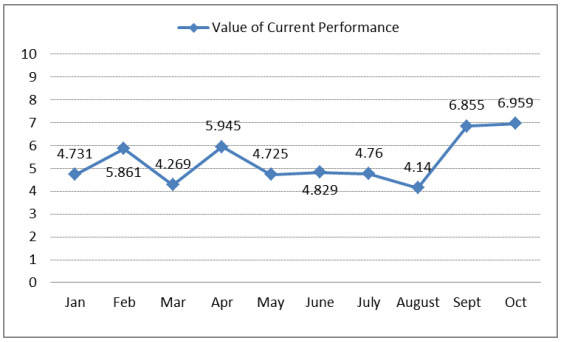

Figure 4. Graph of Performance vs Month

4.4 Development of Action Plan

Eventually, to improve performance, the following are the action plans for each KPI that would be proposed to this department, are:

1. Action plans for KPI [P1.1]:
   - Improve the management of spare-parts, including cutting blade, with better procurement planning.
   - Determine priority of a maintenance job or a component or production equipment.
   - Improve the accuracy of estimates of the processing time of a maintenance activity.
2. Action plans for KPI [P2.1]:
   - Increase the speed to repair the damaged production equipment, by dividing the work based on the expertise of each personnel.
   - Mapping the expertise for engineering personnels.
3. Action plans for KPI [P3.1]:
   - Make planned maintenance activities regularly.
   - Improve implementation of preventive maintenance.
   - Increase the ease of autonomous maintenance.
   - Improve implementation of corrective maintenance.
   - Improve implementation of predictive maintenance.

4. Action plans for KPI [P4.1]:
   - Reduce production equipment or machinery that is idle or minor stoppage.
   - Increase the speed of production with process improvements or adaptation of a new technology.
5. Action plans for both KPI [C1.1] & KPI [C1.2]:
   - Make Log-Book for each execution of maintenance activities.
   - Planning the job description and the tools required, before starting maintenance work.
6. Action plans for KPI [C2.1]:
   - Make budget estimates based on the budget of the previous maintenance activities.
7. Action plans for both KPI [S1.1] & KPI [S1.2]:
   - Give punishment to the worker who do not use APD (personal protective equipment).
   - To disseminate the use of APD regularly.
   - To disseminate the importance of safety in performing a job.
8. Action plans for KPI [Q1.1]:
   - Make sure and check the conditions of production facilities before being used regularly and routinely.
9. Action plans for KPI [Q2.1]:
   - Calibrate the measuring tools regularly.
   - Support personnel to obtain certification of calibration for various measuring tools.
10. Action plans for KPI [Q2.2]:
    - Doing “tandem” in calibrating instruments performed by the outsourcing.
11. Action plans for KPI [E1.1]:
    - Dispose scrap of work process which contaminated B3 (hazardous and toxic materials)
12. Action plans for KPI [E2.1]:
    - Increase the number of workshops on 5S to raise awareness of workers to implement 5S in their workplace.
    - Organizing 5S competition in their workplace.
13. Action plans for KPI [E2.2]:
    - Run and improve 5S audit periodically.
14. Action plans for KPI [L1.1]:
    - Increase the number of training followed by engineering personnel annually
    - Increase collaboration with training institutions in carrying out in-house training or giving consultation.
15. Action plans for KPI [L1.2]:
    - Make plans and targets the development of engineering personnel.
16. Action plans for KPI [L1.3]:
    - Provide training to operators in order to enhance autonomous maintenance.
17. Action plans for KPI [L2.1], KPI [L2.2], and KPI [L2.3]:
    - Provide additional incentives or awards for engineering personnels, foremen, and operators who make innovation proposal.
    - Conduct employee satisfaction surveys for engineering personnels, foremen, and operators, by measuring their satisfaction.

5 CONCLUSION

Design of MSC was conducted in PT XXX Tbk, identified 21 KPIs that can be used to measure performance and create action plans for improvement. AHP method is used to determine the priority of all indicators, and found three indicators that occupy the top positions, namely: number of occupational accidents in the plant (weight of 17%); quality rate (weight of 12%); frequency of scrap disposal of work process which contaminated B3 per year (weight of 8.6%). And, model OMAX was used to perform the current performance measurement. The average results of current performance measurement is 5.307 with rating scale 1-10. The analysis of the performance index calculation, shows that the highest increase in performance occurred in September with an index of +65.19%, while the highest decline in performance in March with an index of -26.633%. In the end, there were 32 proposed action plans to improve performance in this department.

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