CHAPTER 1
INTRODUCTION

1.1 BACKGROUND STUDY

Plant performance indicators are quantifiable measurements that reflect the critical success factors of an organization (F. John Reh, 1997). Plant performance indicators help an organization to define and measure progress toward organizational goals as it is used as a performance management tool. The performance indicators differ depending on the nature of the organization and the organization's strategy. The act of monitoring the performance in real-time is known as business activity monitoring.

Detailed explanation describe plant performance indicators as measures of plant inputs, outputs, outcomes, and impacts that are monitored during plant implementation to assess progress towards its design objectives. They are also used to evaluate a plant's success (Performance Monitoring Indicators, 1996).

Plant performance indicators usually are long-term considerations. The definition of what they are and how they are measured do not change often. The goals for a particular plant performance indicator may change as the organization's goals change, or as it gets closer to achieving a goal.

1.2 PROBLEM STATEMENT

Recently, there has been an upsurge in the level of interest in management by objective, or in establishing performance measures to track progress towards asset maintenance goals. Most companies in the world were focused on keeping up with market demands. In this climate, traditional plant operations were often relegated to a secondary concern. There were just too many new things to think about and explore. Everybody's attention was focused on "breakthrough improvements". Therefore, the mandate for routine plant operations became "just keep up with business while we pursue the pot of gold".

In the first decade of the 2000s, the economic bubble burst. Easy money was gone and managers now worry about how to stay competitive in the new world-wide economy that has emerged. Normally, evaluation of the overall plant performance takes time and involved a lot of steps. This happens when each performance is evaluated individually and usually the plant performance indicator is used for long term consideration (within a year). There is no tool that can be used to evaluate the overall performance in general to see the current condition of the plant. In order to benefit from changing conditions, companies have to adopt a strategy for improvement that fits the specific needs of the organization.

1.3 OBJECTIVES OF STUDY

The objectives of the study include:

1. To identify factors that contributes to plant performance
2. To evaluate and compare different indicators used in plant
3. To select and combine several best indicators
4. To develop plant performance indicator by using spreadsheet
5. To implement the tools to a case study

1.4 SCOPE OF STUDY

The whole project would start with the knowledge gathering and theoretical studies. Information on performance indicator and its significance is collected for better understanding. The comparison between the indicators is done after evaluating different performance indicators of the plant. Then, several best indicators are selected and combined in one spreadsheet in order to evaluate and observe the plant’s performance. The indicators that are chosen include Environmental Performance Indicators, Safety Performance Indicators and Productivity Performance Indicators.

The scope of environmental performance will cover up 3 types of pollution namely air, water and sound pollution. Safety performance will discuss the management, operational and safety performance. Lastly, the scope of productivity performance will covers important aspects in production and profit making processes. Process monitoring will be carried out to correlate the theoretical knowledge with practices. Then, a methodology will be developed according to a step-by-step procedure.

CHAPTER 2
LITERATURE REVIEW

2.1 Definition of Plant Performance Indicator

The term “indicators” is used to indicate observable measures that provide insight into a concept that is difficult to measure directly. Examples of two types of indicators are activities indicators and outcome indicators.

Activities indicators are measures of actions taken in the context of chemical emergency prevention, preparedness, and response programs, which should lead to improvements in safety. Outcome indicators are measures of the extent of improvement in performance or, in other words, reduction in the risks to human health or the environment from chemical accidents.

Plant Performance Indicators will organize information in a way that clarifies the relationships between a plant’s inputs, outputs, outcomes, and impacts and help to identify problems along the way that can impede the achievement of project objectives. They will differ depending on the organization. Classification of indicators is as follow (Performance Indicator, 1999):

- *Input indicators* : monitor the project-specific resources provided
- *Output indicators* : measure goods and services provided by the project
- *Outcome indicators* : measure the immediate, or short-term, results of project implementation
- *Impact indicators* : monitor the longer-term or more pervasive results of the project

2.2 Types of indicators

2.2.1 Environmental Performance Indicators

It discusses specifically about the output and impact of the plant operation on environmental aspect. The output indicators should relate to the components of the project. The first stage measures the operation provided by the project, while the latter measure the short-term and longer-term or more pervasive results of project implementation. The scope for environmental performance indicators will cover up to 3 types of environmental pollution namely air, water and sound pollution. For air and water pollution, the indicator will evaluate the amount of toxic gas emission and waste/toxic release to the environment. On the other hand, for sound pollution, the indicator will evaluate the allowable noise exposure from the plant operation.

2.2.2 Safety Performance Indicators

There are various systems of safety performance indicators intended for use in the safety stakeholder's triangle which are industry, public authorities and communities at local and national levels. For this project, a set of three types of safety performance indicators was proposed namely management performance indicators, operational performance indicators and safety status indicators (Chemical Industry & Chemical Engineering, 2009). These indicators represent the most important factors in the linkage between a possible cause of an accident and its effects.

1. Management performance indicators (MPIs) will provide the information about the management efforts to improve the organization safety performance
2. Operational performance indicators (OPIs) will provide the information about the safety performance of the organization technical operations
3. Safety status indicators (SSIs) will provide the information about accidents, incidents and near-misses, as well as about their consequences.

For each type of safety performance indicators, incorporated elements reflect the short and long term performance of the plant. It also can help to set priorities for future investment of resources. Besides, safety performance indicators can even provide an "early warning" of potential safety problems. For management purposes, safety performance indicators supply the information on safety problems that can help the management to check the outcome against the plan and to develop the appropriate corrective action. This action is important towards a clearer definition of roles and safety-related competencies, to be integrated into the plant operation.

Management performance indicators of the company and its installations will include:

- Number of accident and near-misses reported
- Number of programs and projects on preventive actions
- Number of safety inspections and verifications
- Number of safety meetings, trainings and audits
- Number of emergency preparedness programs

Operational performance indicators will include:

- Number of components malfunctions and damages
- Number of hazardous substances accidental leakages
- Quantity of spilled/burned substances
- Maintenance hours/operation hour
- Number of delays on maintenance of critical components

Safety status indicators will include the following information:

- number of deaths
- number of poisoned/number of hospitalized
- number of behavioral safety observation

2.2.3 Productivity Performance Indicators

It is important to establish a "good" indicator of performance as a parameter and the indicator should have the following properties:

- The value should not change dramatically between individual evaluations. It would be expected to fluctuate about a mean value over a period of for example one week; but these excursions should be small compared with the absolute value
- The changes in mean value over suitable periods should be monotonic, and in the anticipated direction. This demonstrates the importance of selecting a meaningful parameter. The average values of the parameters should be plotted against time.

<u>Example of Productivity Performance Indicators</u>

2.2.3.1 Overall Equipment Effectiveness (OEE)

OEE is a statistical metric for machine and process efficiency. It is calculated by multiplying Rate x Quality x Availability. The product is the value a machine contributes to the production process.

- **Availability**

  Availability takes into account **Down Time Loss**, and is calculated as:

Availability *= Operating Time / Planned Production Time*

- **Performance**

  Performance takes into account **Speed Loss**, and is calculated as:

Performance *= Ideal Cycle Time / (Operating Time / Total Pieces)*

  Ideal Cycle Time is the minimum cycle time that process can be expected to achieve in optimal circumstances. It is sometimes called *Design Cycle Time, Theoretical Cycle Time* or *Nameplate Capacity*. Since Run Rate is the reciprocal of Cycle Time, *Performance* can also be calculated as:

Performance *= (Total Pieces / Operating Time) / Ideal Run Rate*

  Performance is capped at 100%, to ensure that if an error is made in specifying the *Ideal Cycle Time* or *Ideal Run Rate,* the effect on OEE will be limited.

- **Quality**

  Quality takes into account **Quality Loss**, and is calculated as:

Quality = *Good Pieces / Total Pieces*

- **OEE**

  OEE takes into account all three **OEE Factors**, and is calculated as:

OEE = *Availability x Performance x Quality*

2.2.3.2 Return on Net Assets

This metric calculates how well a company converts assets to sales, and therefore profits. The simple calculation is Plant Revenue minus Costs divided by Net Assets.

(**Plant Revenue - Costs**) / **Net Assets** = **Return on Net Assets (RONA)**

2.2.3.3 Utilization

A measure of the overall utilization of the asset

$$\text{Utilization, \%} = \frac{\text{Actual Capacity}}{\text{Maximum Capacity}}$$

or it can be calculated as Total Asset Utilization (TAU),

TAU = Availability × Duty Cycle × Efficiency × Yield

where;

- *Availability* is the ratio of the time the asset is available to run to total time in the period examined.
- *Duty Cycle* is the ratio between the time the asset was actually running and the time it was running plus the time it took to set up.
- *Efficiency* is the actual versus the design rate of production for the asset.
- *Yield* is the proportion of the product or service output that was salable.

2.2.3.4 Maintenance Index

A measure of maintenance cost

$$MI = \frac{\text{Maintenance Cost}}{\text{Plant Capacity}}$$

2.3 Significance of Plant Performance Indicator

The ultimate purpose of Plant Performance Indicator is to drive future performance. Whatever Plant Performance Indicators are selected, they must reflect the organization's goals, they must be a key that lead to its success, and they must be quantifiable.

<u>Generally</u>

2.3.1 *Plant Performance Indicators Reflect the Organizational Goals*

An organization that has as one of its goals "to be the most profitable company in the industry" will have Plant Performance Indicator that measure profit and related fiscal measures.

2.3.2 Plant Performance Indicators must be Quantifiable

If a Plant Performance Indicator is going to be of any value, there must be a way to accurately define and measure it. It is also important to define the Plant Performance Indicators and stay with the same definition from year to year.

2.3.3 Plant Performance Indicators must be Key to Organizational Success

Many things are measurable but that does not make them key to the organization's success. In selecting Plant Performance Indicators, it is critical to limit them to those factors that are essential to the organization reaching its goals. It is also important to keep the number of Plant Performance Indicators small just to keep everyone's attention focused on achieving the same goal.

<u>Justification of choosing the indicators</u>

Environmental Performance Indicators

Environmental indicators have been recognized as important tools in the measurement and monitoring of the impact of human activities on the natural environment. In particular, indicators that evaluate pollution are increasingly being used to provide the environmental statistics needed to monitor the trends in the environment and to manage natural resources. During the Earth Summit Conference, it was recognized that continual monitoring and measurement is required to assess the progress towards meeting sustainable development targets and objectives. (Environmental Indicators: Monitoring the state of our environment, December 2001)

Safety Performance Indicators

Recent study has shown that the enforcement of safety regulations on major chemical accident control have not been satisfactory, mainly due to lack of awareness and weak management in the industry. The proposed system and framework for safety performance indicators can support the efforts to improve the safety management in chemical industry. To be able to assess their success in improving safety, the first step to be taken by industry, public authorities, and communities is to establish chemical safety goals and objectives for their organizations, as well as infrastructures for implementing those goals and objectives. Therefore, it requires a clear commitment by the management of an organization to emphasis the implementing of an effective Safety Performance Indicator in their plant. (Guidance on Safety Performance Indicators, OECD 2003)

Productivity Performance Indicators

Recently, there has been an upsurge in the level of interest in management by objective, or in establishing performance measures to track progress towards asset maintenance goals. Another reason why productivity monitoring is important is that it helps companies to determine their strengths as well as their weakness. Once these points are determined, measures can be taken in order to remedy it, as a result it may even bring in greater profits for the company as a whole. (The Importance of Productivity Monitoring, 2008)

"… a nation's standard of living depends on the capacity of its companies to achieve high levels of productivity – and to increase productivity over time."

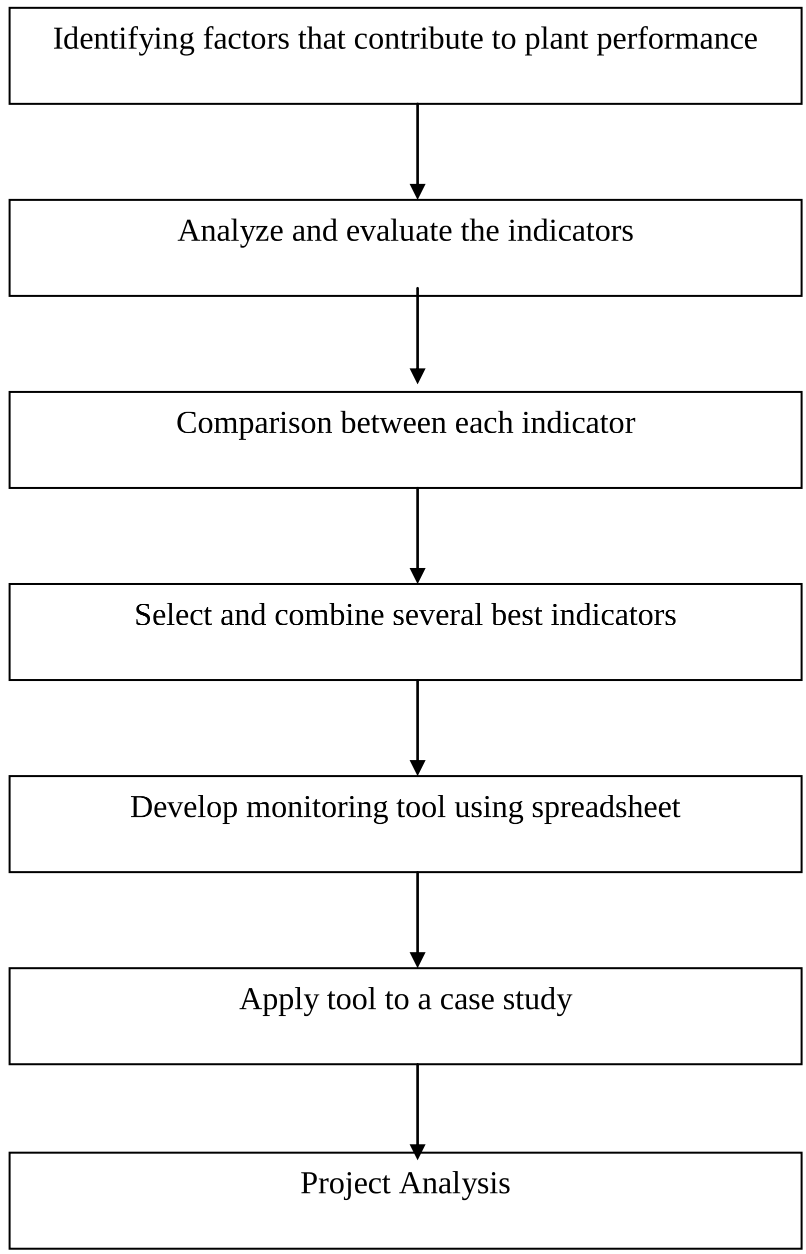
Michael Porter, Professor, Harvard Business School

"Productivity growth is central to our ability to compete internationally while improving our standard of living at home."

A Competitiveness Strategy for America, Competitiveness Policy Council, March 1993

CHAPTER 3

METHODOLOGY AND PROJECT WORK



3.1 Framework of identifying the Safety Performance Indicators

1. Step one: Define the goals and objectives with respect to safety
2. Step two: Review the guidance and choose relevant parts
3. Step three: Adapt and define the indicators
4. Step four: Identify the element that will be measured by each indicator determine the appropriate metrics (or scale) for the performance indicators
5. Step five: Apply the appropriate metrics (or scale) to the indicators follow-up and evaluation

3.2 Method that can be applied to a case study to evaluate the plant performance:

1. Conduct an audit
2. Assessment of the data collected
3. Evaluate the overall performance
4. Analyze the result

3.3 Framework of Plant Performance Indicator (PPI) Tool

a. To start using PPI Tool, user has to click either ‘Tool Description’ or ‘Indicator’ tab. In ‘Tool Description’ tab, user will be provided with the description of the tool while ‘Indicator’ tab will allow the user to proceed with the next step.
b. As ‘Indicator’ tab is clicked, user will be able to select types of indicator that they prefer to be evaluated.
c. To further proceed, user need to follow step by step procedure as indicated in Figure 1

3.4 Extended Framework for *Environmental Performance Indicator* (Applied for air and water pollution)

a. User need to follow the flow of the procedure as indicated in Figure 2

3.5 Extended Framework for *Environmental Performance Indicator* (Applied for sound pollution)

a. The procedure is mentioned in Figure 3

3.6 Extended Framework for *Safety Performance Indicator*

a. A step by step procedure for Safety Performance Indicator is as stated in Figure 4

3.7 Extended Framework for *Productivity Performance Indicator*

a. The procedure for Productivity Performance Indicator is explained in Figure 5

3.8 Framework to view Summary of Overall Report

a. Procedure for the Summary of Overall Report can be referred in Figure 6

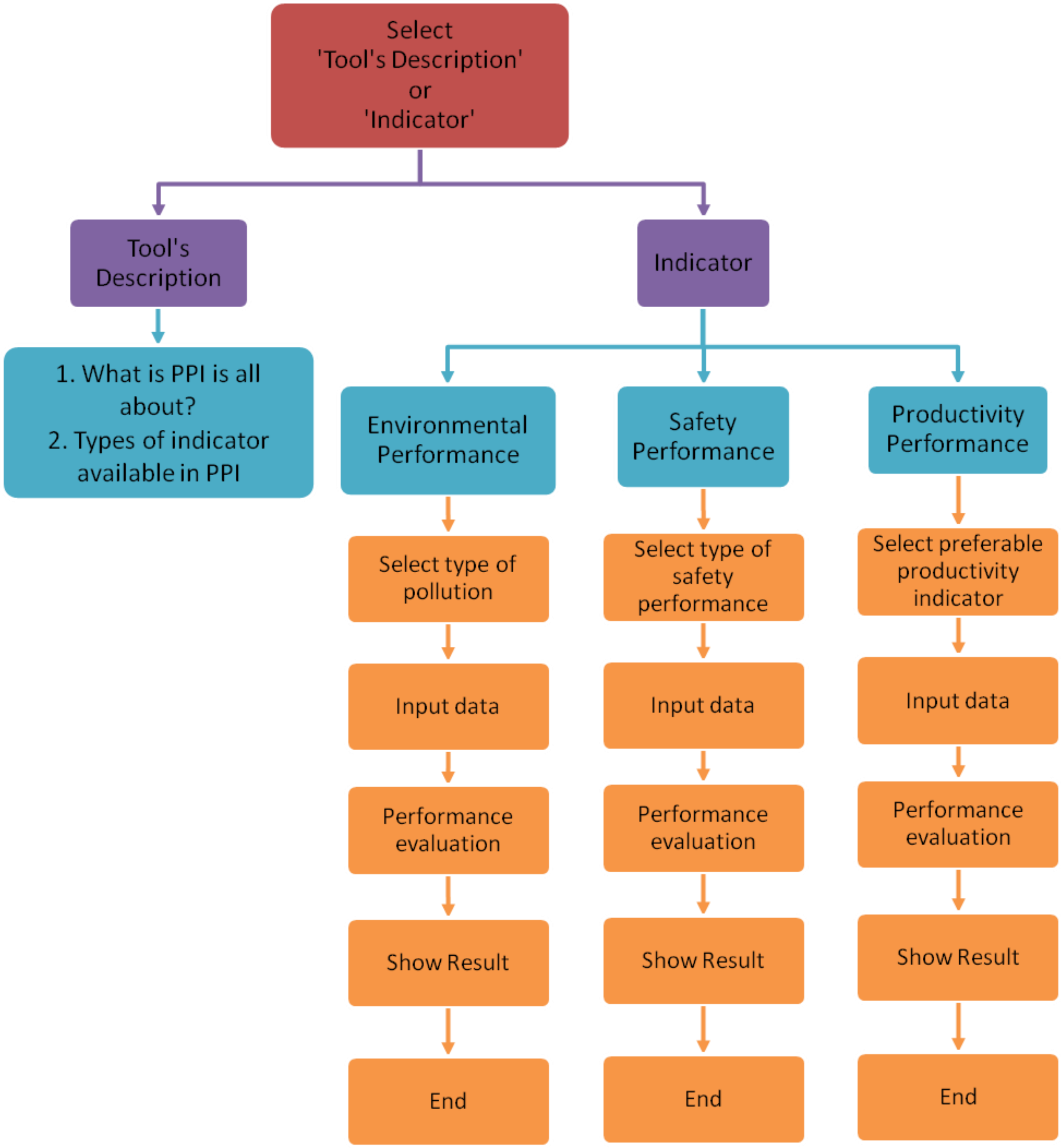


Figure 1: Framework of Plant Performance Indicator (PPI) Tool

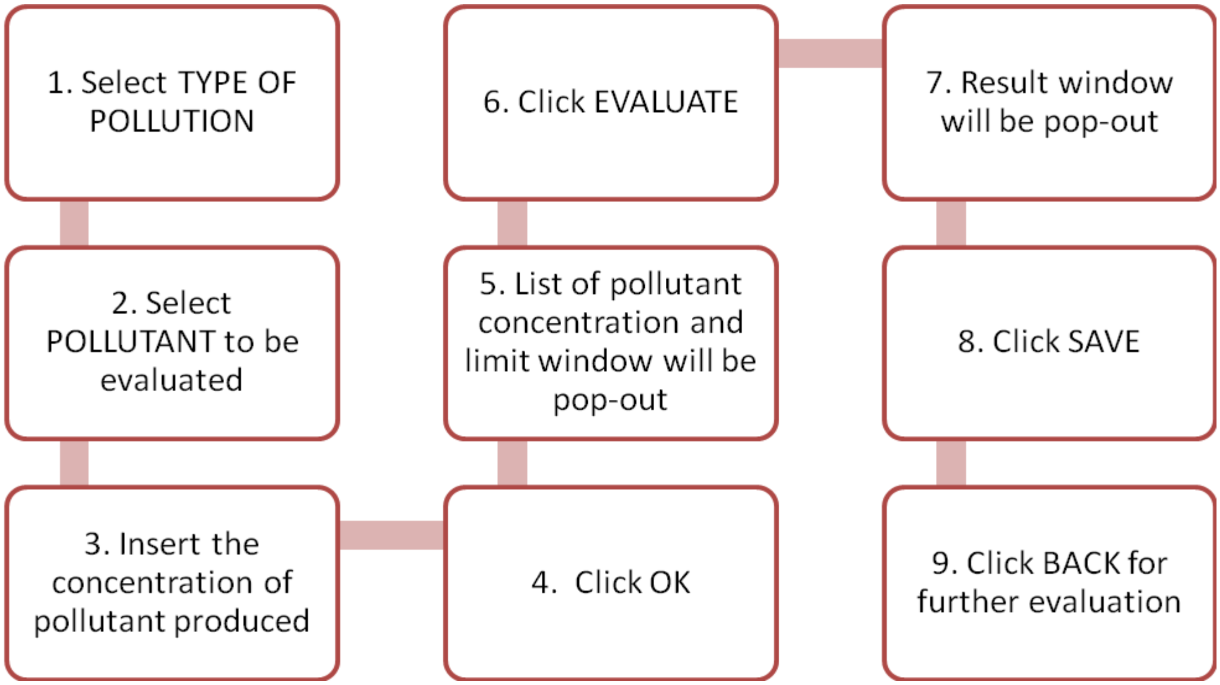


Figure 2: Extended Framework for *Environmental Performance Indicator*
(Applied for air and water pollution)

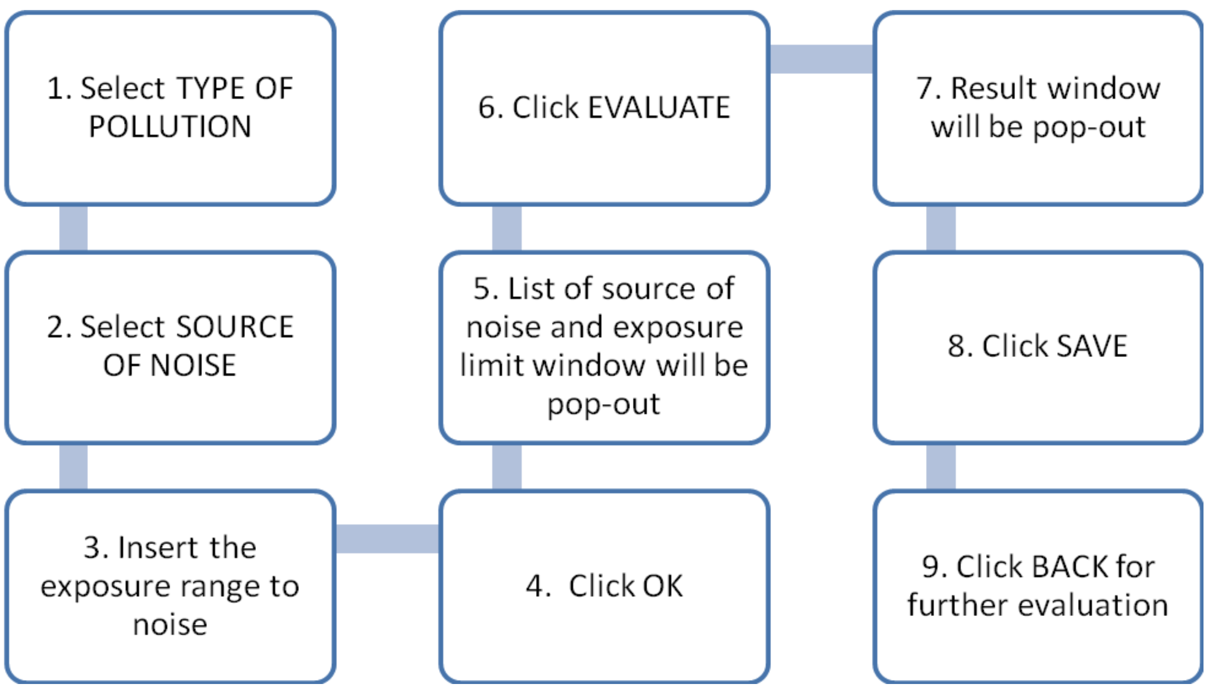


Figure 3: Extended Framework for *Environmental Performance Indicator*
(Applied for sound pollution)

Figure 4: Extended Framework for *Safety Performance Indicator*

Figure 5: Extended Framework for *Productivity Performance Indicator*

Figure 6: Framework to view Summary of Overall Report

Key milestone/Gantt chart of Final Year Project 2 (FYP2)

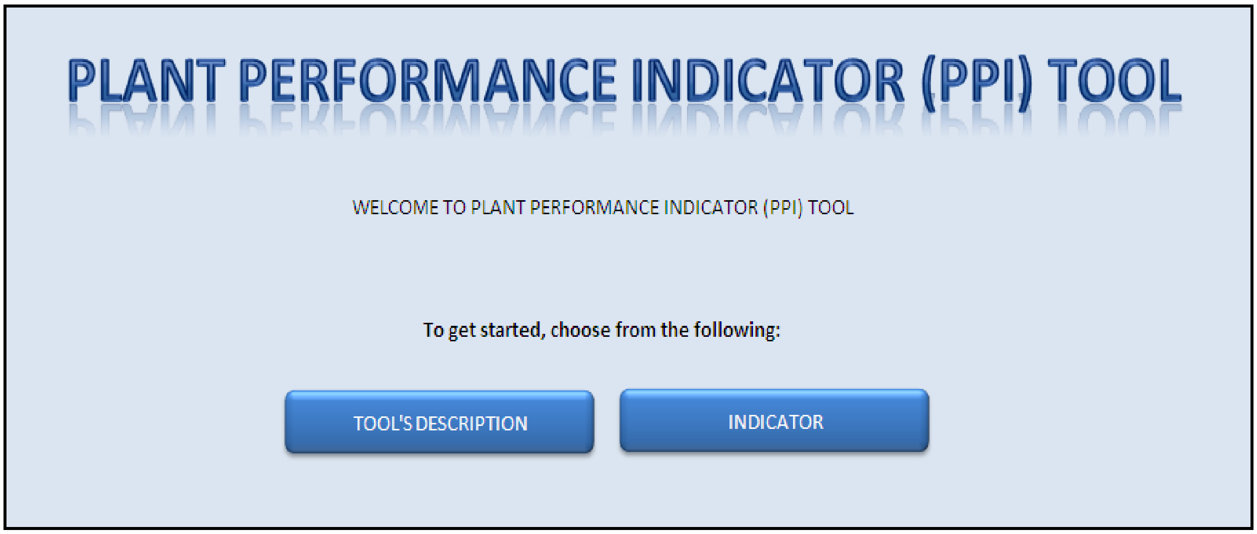
No	Details	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	Project work continue														
	• research on each performance indicator														
2	Development of the tool														
	• basic interface for introduction														
	• work on the environmental performance														
3	Submission of Progress Report 1														
4	Progress in project work														
	• progress in safety performance indicator														
	• detailed info included in the tool														
5	Submission of Progress Report 2														
6	Project work continues														
	• progress in productivity performance indicator														
7	Poster exhibition														
8	Submission of Dissertation (soft bound)														
9	Oral Presentation and submission of dissertation (hard bound)														

CHAPTER 4

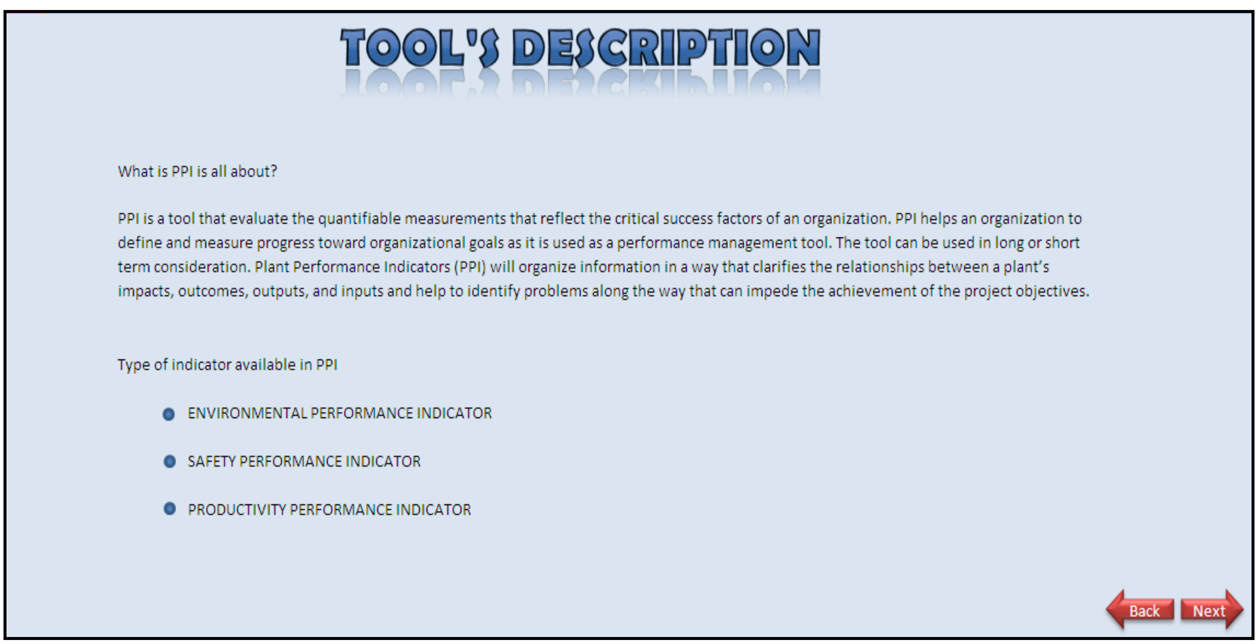
RESULT AND DISCUSSION

Plant Performance Indicator (PPI) Tool Interface

1. Main Page

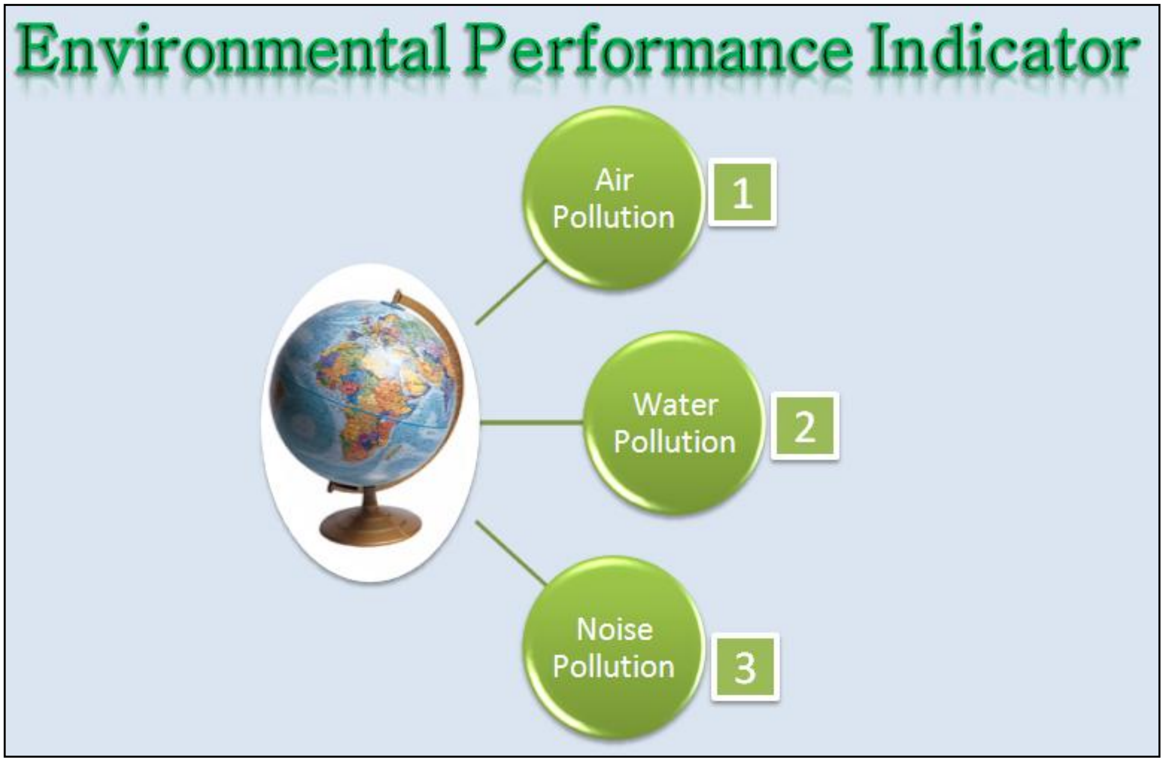


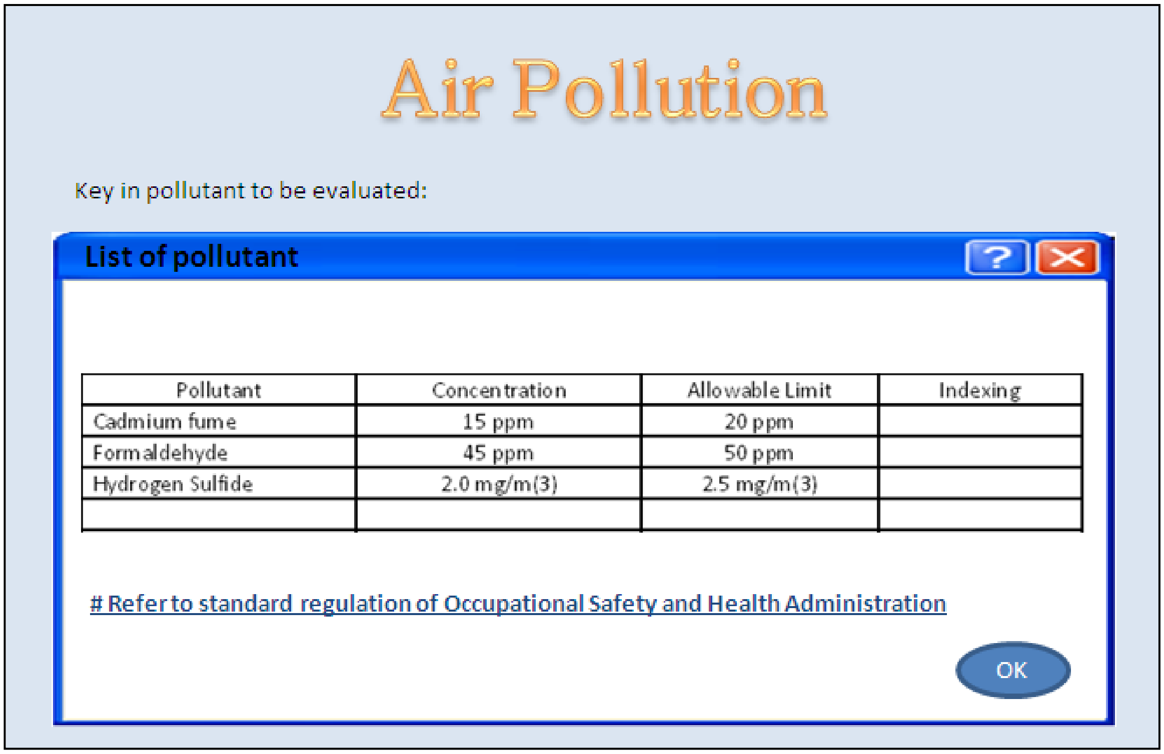
2. Tool's Description Tab



3. Indicator Tab

4. Environmental Performance Indicator





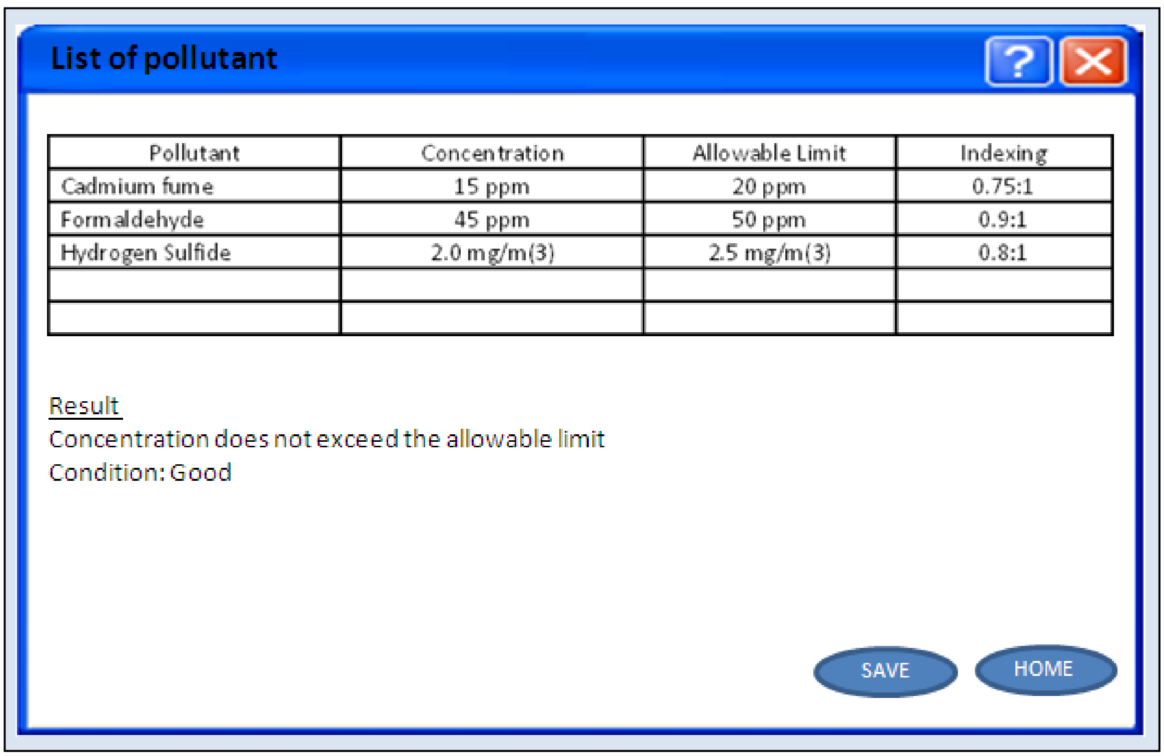
Air Pollution

Key in pollutant to be evaluated:

List of pollutant

Pollutant	Concentration	Allowable Limit	Indexing
Cadmium fume	15 ppm	20 ppm	
Formaldehyde	45 ppm	50 ppm	
Hydrogen Sulfide	2.0 mg/m(3)	2.5 mg/m(3)	

Refer to standard regulation of Occupational Safety and Health Administration



List of pollutant

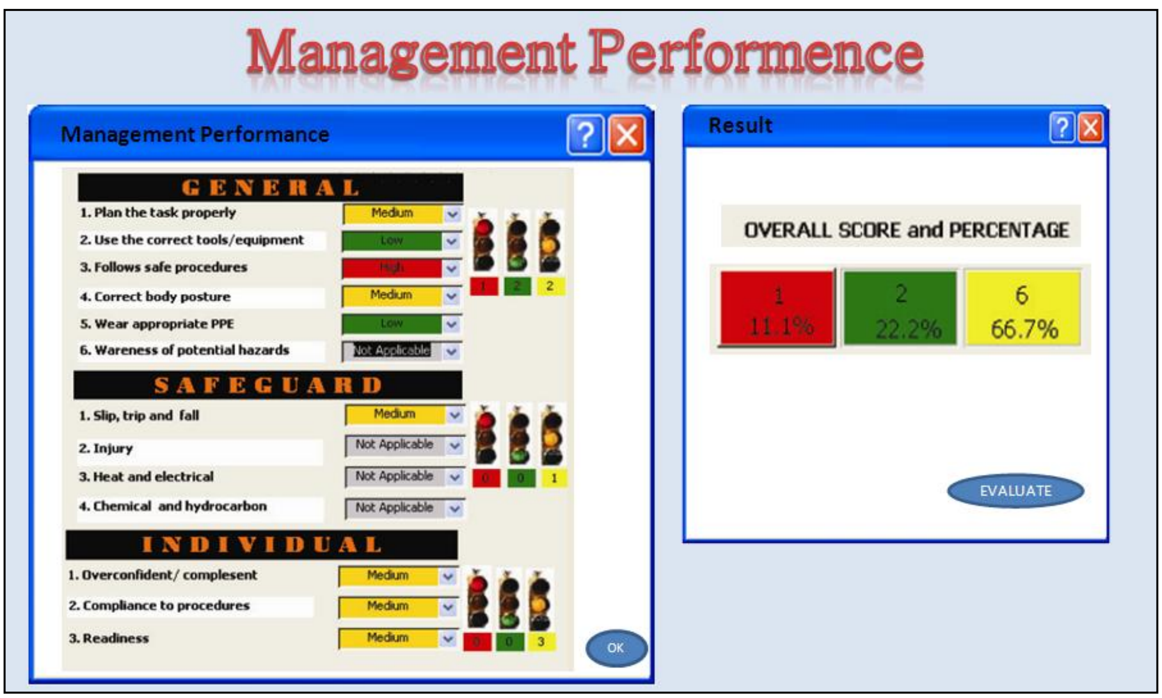
Pollutant	Concentration	Allowable Limit	Indexing
Cadmium fume	15 ppm	20 ppm	0.75:1
Formaldehyde	45 ppm	50 ppm	0.9:1
Hydrogen Sulfide	2.0 mg/m(3)	2.5 mg/m(3)	0.8:1

Result

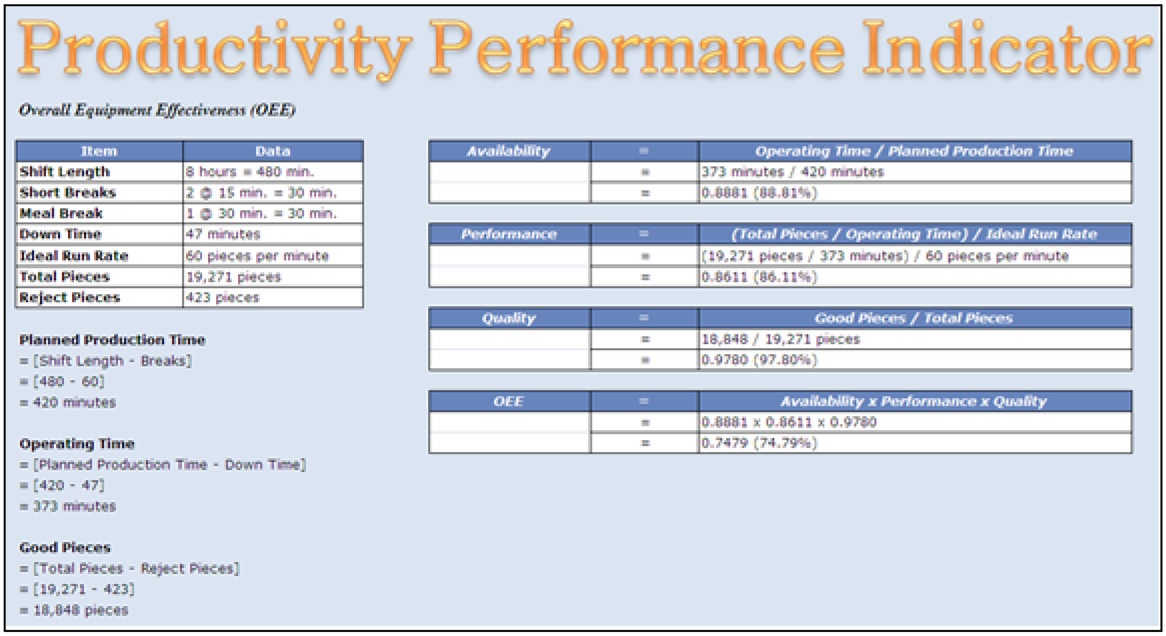
Concentration does not exceed the allowable limit

Condition: Good

5. Safety Performance Indicator



6. Productivity Performance Indicator



Productivity Performance Indicator

Overall Equipment Effectiveness (OEE)

Item	Data
Shift Length	8 hours = 480 min.
Short Breaks	2 @ 15 min. = 30 min.
Meal Break	1 @ 30 min. = 30 min.
Down Time	47 minutes
Ideal Run Rate	60 pieces per minute
Total Pieces	19,271 pieces
Reject Pieces	423 pieces

Planned Production Time
= [Shift Length - Breaks]
= [480 - 60]
= 420 minutes

Operating Time
= [Planned Production Time - Down Time]
= [420 - 47]
= 373 minutes

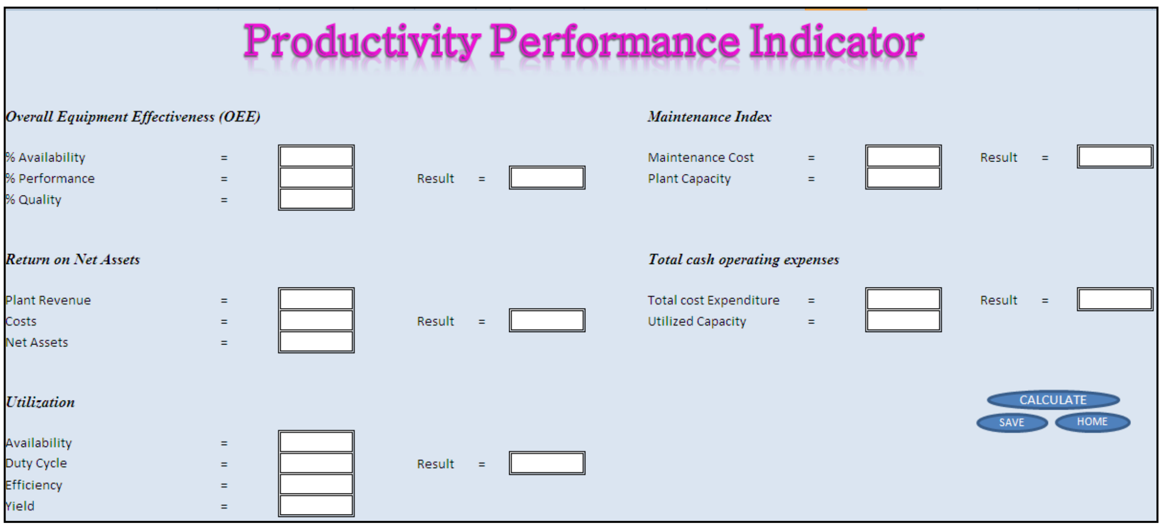
Good Pieces
= [Total Pieces - Reject Pieces]
= [19,271 - 423]
= 18,848 pieces

Availability	=	Operating Time / Planned Production Time
	=	373 minutes / 420 minutes
	=	0.8881 (88.81%)

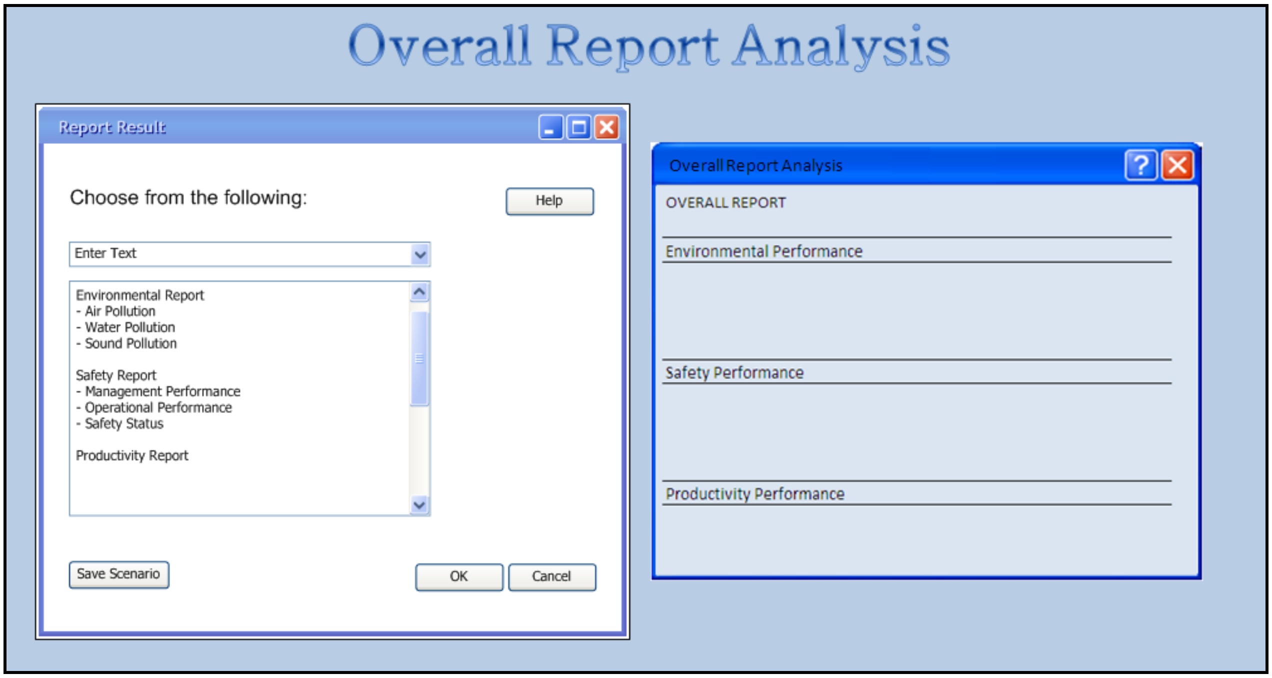
Performance	=	(Total Pieces / Operating Time) / Ideal Run Rate
	=	(19,271 pieces / 373 minutes) / 60 pieces per minute
	=	0.8611 (86.11%)

Quality	=	Good Pieces / Total Pieces
	=	18,848 / 19,271 pieces
	=	0.9780 (97.80%)

OEE	=	Availability x Performance x Quality
	=	0.8881 x 0.8611 x 0.9780
	=	0.7479 (74.79%)



7. Overall Report Analysis



<u>User guideline</u>

Environmental Performance Indicator

- User need to select pollutant that available at their plant and key in the data. List of pollutant for air, water and noise pollution and their allowable limit will be provided in the tool. The allowable limit for those pollutants is based on the standard regulation of Occupational Safety and Health Administration.
- Indexing system will be used to evaluate the data. For example, in air pollution indicator, if the concentration of pollutant is 25ppm and the allowable limit is 20ppm, the indexing result would be 1.25:1. This result will be indicated as beyond the limit. Therefore, we can say that the plant is not in good condition. Too many pollutants have been released to the environment.
- Then, user can save the result and return to 'HOME' menu to proceed to other indicator. (i.e Water and Noise Pollution)

- Indicator like Air Quality Index (AQI) will be considered to be included in the tool because this will definitely enhance the public awareness on air quality status. Example is as follow:

Logo	Indicator	AQI Color	AQI Description	AQI (% exceed)
			Good	0-20%
			Moderate	21-40%
			Unhealthy for sensitive groups	41-60%
			Unhealthy	61-80%
			Very unhealthy	81-100%
			Hazardous	Above 100%

Good	Air quality satisfactory and air pollution poses little or no risk
Moderate	Air quality acceptable; chance of moderate health concern
Unhealthy for sensitive group	Certain groups of people particularly sensitive to the harmful effects of certain air pollutants
Unhealthy	Everyone may begin to experience health effects
Very unhealthy	Triggers health alert, everyone may experience serious health effects
Hazardous	Triggers health warnings of emergency conditions

Figure 7: Air Quality Index color coding

Safety Performance Indicator

- First of all, the user need to choose the types of Safety Indicators that they want to evaluate. Then, they need to select appropriate answer to several question provided. The concept is the same as audit process at the process plant area.

- Then, the evaluation will be done. Percentage of score and percentage will be calculated.

- User can save the result and proceed with other indicator.

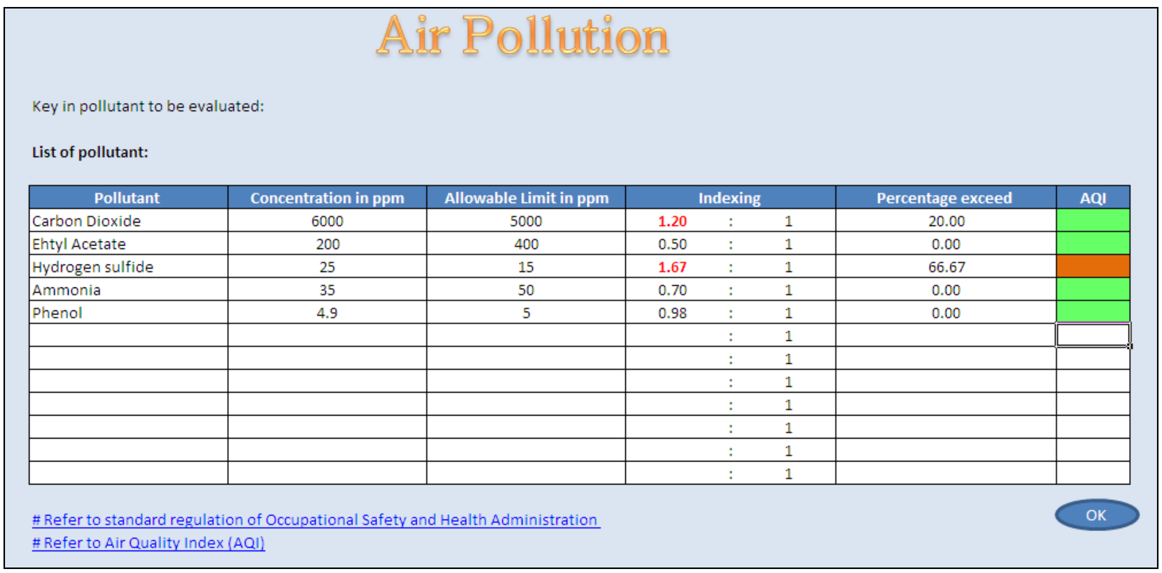
Productivity Performance Indicator

- User need to key in several data based on their plant operation.
- Result will be evaluated and calculation is done based on the formula provided. No specific range for this kind of data.

Result and Discussion: Application to a case study

The tool has been applied to a dummy case study to evaluate the performance of the plant operation at current condition. The results are as follow:

Environmental Performance Indicator (Air Pollution)


Air Pollution

Key in pollutant to be evaluated:

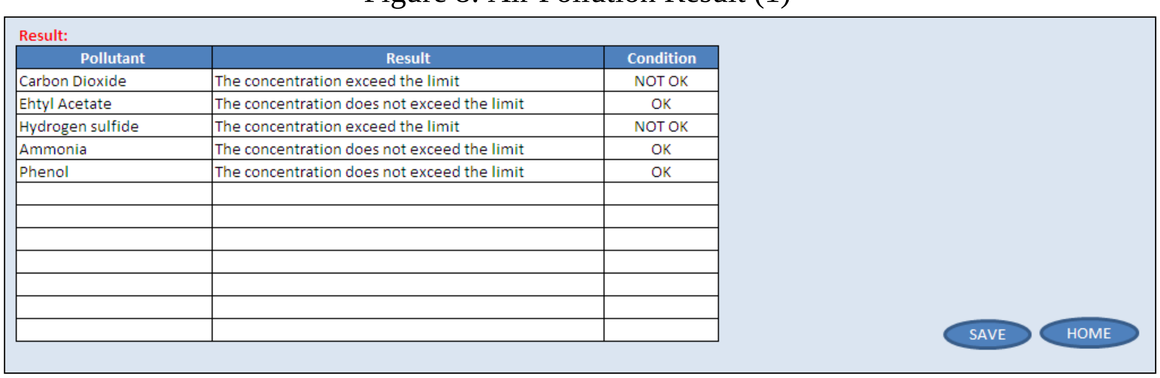
List of pollutant:

Pollutant	Concentration in ppm	Allowable Limit in ppm	Indexing			Percentage exceed	AQI
Carbon Dioxide	6000	5000	1.20	:	1	20.00	
Ehtyl Acetate	200	400	0.50	:	1	0.00	
Hydrogen sulfide	25	15	1.67	:	1	66.67	
Ammonia	35	50	0.70	:	1	0.00	
Phenol	4.9	5	0.98	:	1	0.00	
				:	1		
				:	1		
				:	1		
				:	1		
				:	1		
				:	1		
				:	1		

Refer to standard regulation of Occupational Safety and Health Administration
Refer to Air Quality Index (AQI)

OK

Figure 8: Air Pollution Result (1)


Result:

Pollutant	Result	Condition
Carbon Dioxide	The concentration exceed the limit	NOT OK
Ehtyl Acetate	The concentration does not exceed the limit	OK
Hydrogen sulfide	The concentration exceed the limit	NOT OK
Ammonia	The concentration does not exceed the limit	OK
Phenol	The concentration does not exceed the limit	OK

SAVE HOME

Figure 9: Air Pollution Result (2)

The pollutants that are being discharge from the plant are:

1. Carbon dioxide
2. Ammonia
3. Ethyl Acetate
4. Phenol
5. Hydrogen sulfide

After the user key in the concentration of pollutant produced at their plant, it shows that some of the pollutants exceed the allowable limit based on the standard regulation from Occupational Safety and Health Administration. Indexing system is used to calculate the exceed percentage of the pollutant concentration.

Example:

Carbon dioxide concentration = 6000 ppm

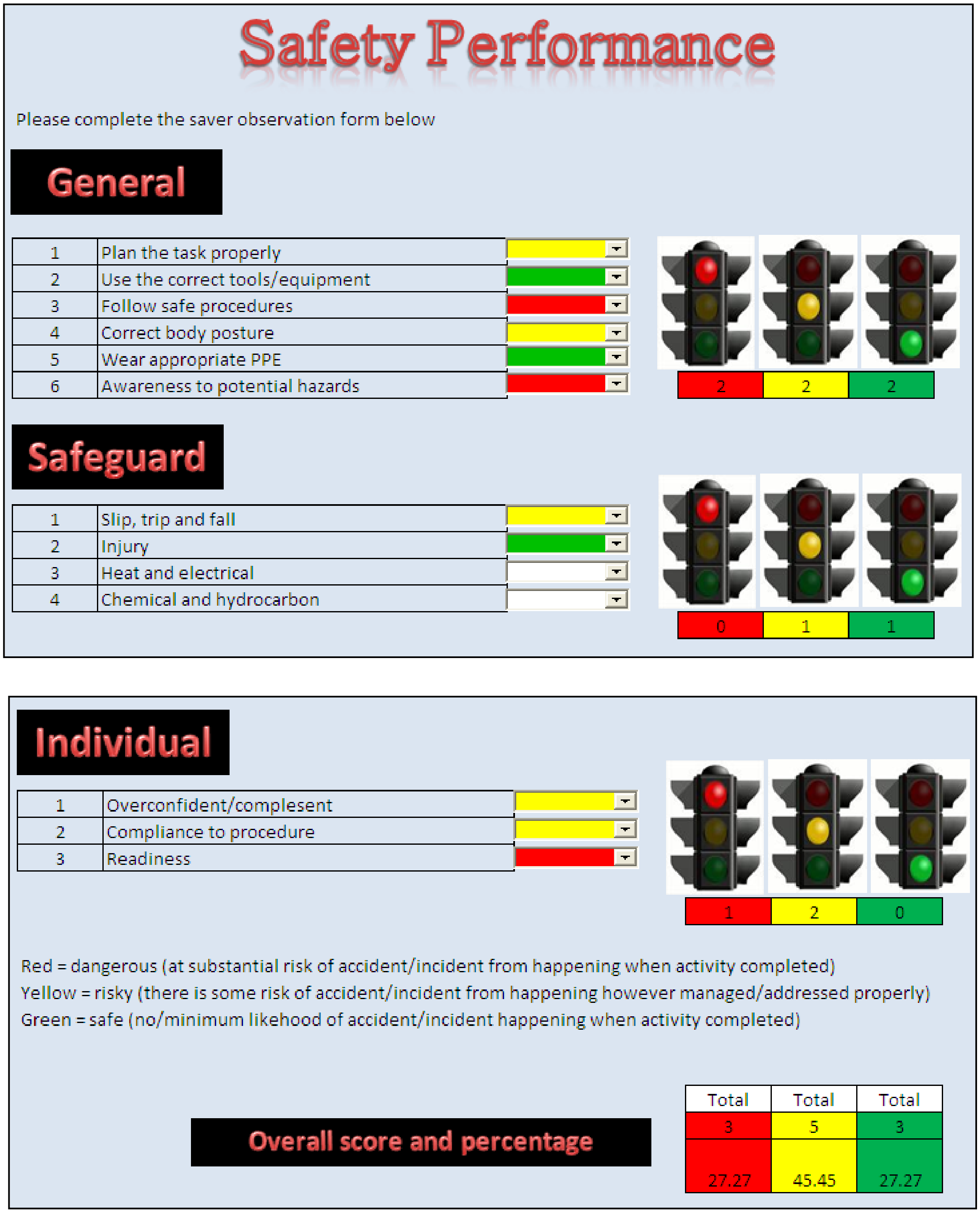
Allowable limit = 5000 ppm

Indexing = 6000/5000 = 1.2

Percentage exceed = (1.2-1)/1 x 100% = 20%

Air Quality Index color coding will appear as the result according to the exceed percentage of the pollutant (*Refer to Figure 7*). The following table will display the result of the evaluation and shows the condition of the current situation. For pollutant that exceeds the allowable limit, the 'NOT OK' condition will be displayed. That situation will notify the plant operator that the concentration of the pollutant discharged is at alarming level. For water and sound pollution, the same procedure applied.

Safety Performance Indicator (Safety Status)



Safety Performance

Please complete the saver observation form below

General

1	Plan the task properly
2	Use the correct tools/equipment
3	Follow safe procedures
4	Correct body posture
5	Wear appropriate PPE
6	Awareness to potential hazards

2	2	2

Safeguard

1	Slip, trip and fall
2	Injury
3	Heat and electrical
4	Chemical and hydrocarbon

0	1	1

Individual

1	Overconfident/complesent
2	Compliance to procedure
3	Readiness

1	2	0

Red = dangerous (at substantial risk of accident/incident from happening when activity completed)
Yellow = risky (there is some risk of accident/incident from happening however managed/addressed properly)
Green = safe (no/minimum likehood of accident/incident happening when activity completed)

Overall score and percentage

Total	Total	Total
3	5	3
27.27	45.45	27.27

Figure 10: Safety Performance Result

Result:

For safety performance indicator, under safety status element, the user need to complete the audit based questionnaire before the evaluation will be done. Under safety status element, most of the questionnaire will be based on behavioral safety in achieving HSE excellence.

There are 3 categories that the user need to complete namely; general, safeguard and individual. All the questionnaires will be completed with 3 general colors coding; red, yellow and green.

Red = dangerous (at substantial risk of accident/incident from happening when activity completed
Yellow = risky (there is some risk of accident/incident from happening however managed/addressed properly)
Green = safe (no/minimum like hood of accident/incident happening when activity completed)

For overall score and percentage,

% Red color = (3/11) x 100% = 27.27%

% Yellow color = (5/11) x 100% = 45.45%

% Green color = (3/11) x 100% = 27.27%

Discussion:

From the result obtained, we can say that the percentage of high risk activity (red color) happen is quite low. Therefore, the plant is still in good condition. But the percentage of risky activity (yellow color) should be reduced and at the same time, increased the safer environment percentage (green color). There are quite a number of ways that can be implemented in order to improve safety performance of the plant. For example, the safety team can:

	Increase and develop training/awareness module for Slip,Trip & Fall, Exposure to Injury, Specific Critical Procedures and Personal Protective Equipment.
	Training
	Training, promotion
	Training
	Awareness in toolbox meeting
	Coaching
	Promote RMS through cards, personal coaching
	Contractor safety officer training (syllabus by PPM)
	Include/enhance safety induction
	Increase Awareness

	Enhancement of Audit Program
	Housekeeping
	Include in specific form (especially shoes, body harness)
	Tools audit
	PTW audit report - to share

	Develop a specific task observation
	Develop specific hazard list
	Develop simplified work instruction
	Form site map/shortcut to all procedures
	Specific observation form
	Review PPE specification

	Intensive Promotion and Communication
	Incentive (token) for good behavior observed
	Monthly handout
	Wisdom words in morning prayer (doa)
	Promotion (monthly, different theme)
	Stickers/leaflet/brochure/infoSAVER/banner
	Free disposable PPE items i.e. ear plug, glove (token)

For other elements in Safety Performance Indicator which are the management performance and operational performance, the same procedure are applied.

Productivity Performance indicator

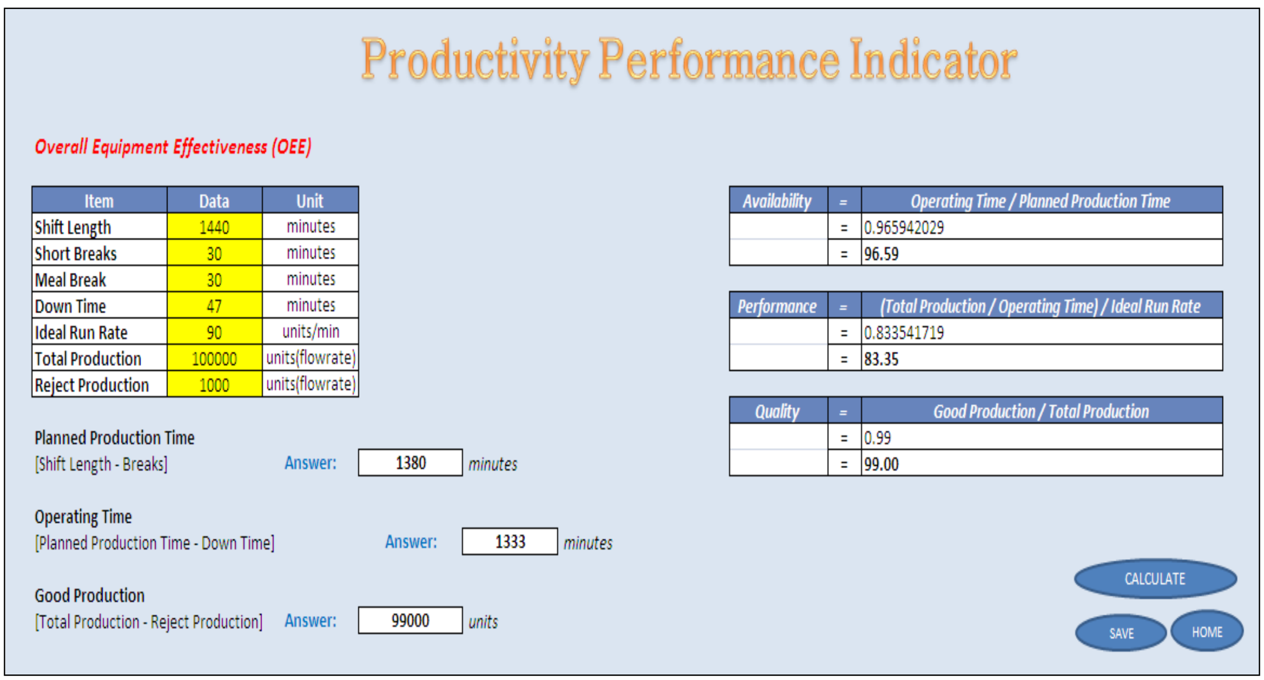


Figure 11: Productivity Performance Result (1)

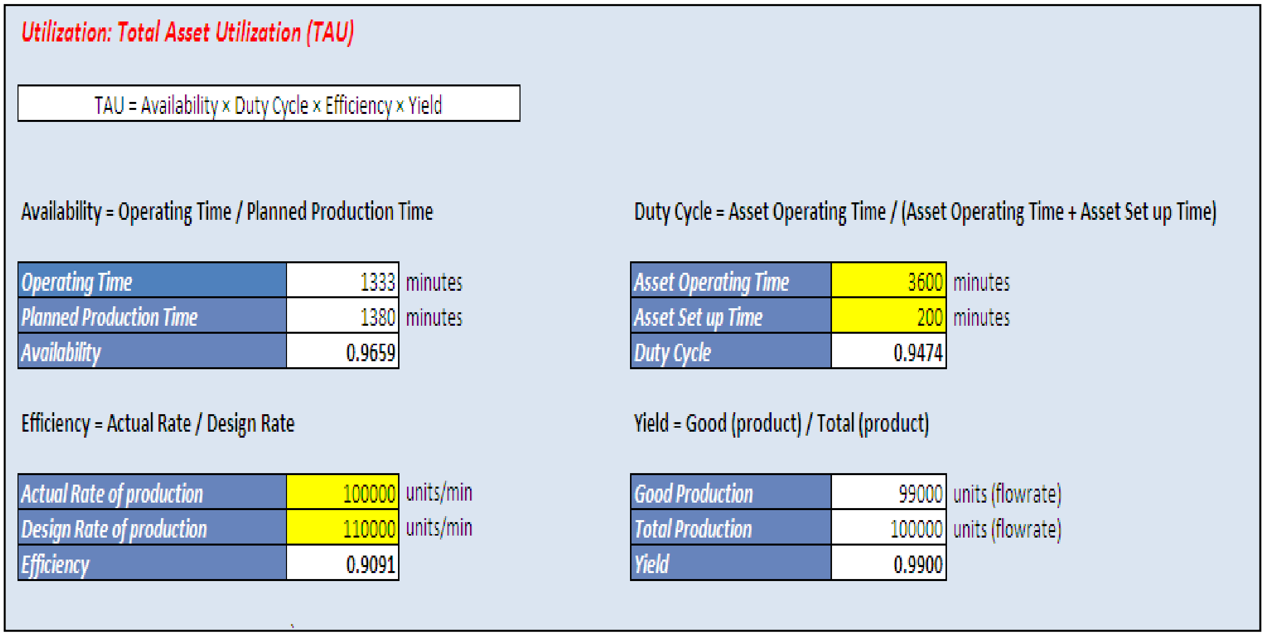


Figure 12: Productivity Performance Result (2)

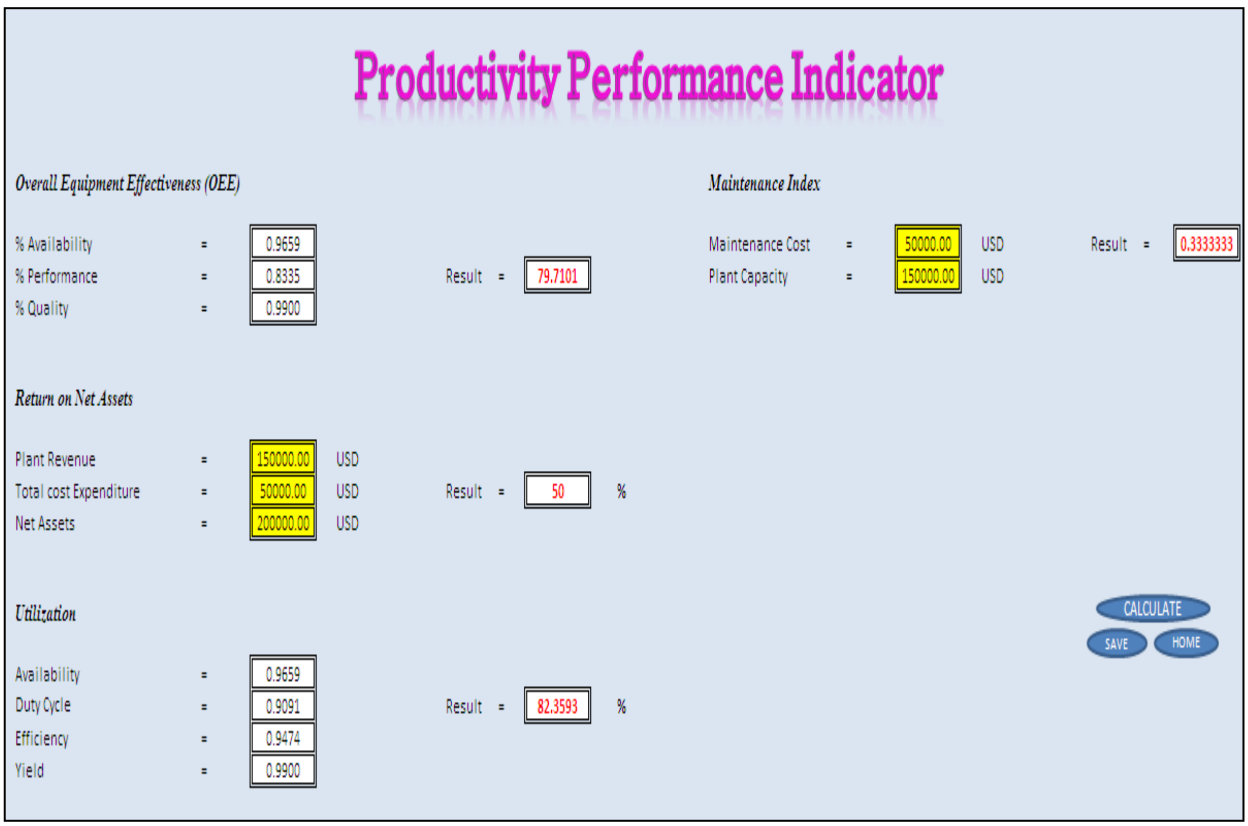


Figure 13: Productivity Performance Result (3)

For productivity performance, the elements that are calculated include:

1. Overall Equipment Effectiveness (OEE)
2. Return on Net Assets
3. Utilization
4. Maintenance Index

For Overall Equipment Effectiveness, the calculation can be referred to Figure 11. The user need to key in some information based on their plant operation and then the tool will automatically calculate the result. The information that the user need to key in include:

- Shift Length
- Short Breaks
- Meal Break
- Down Time
- Ideal Run Rate
- Total Production
- Reject Production

Based on the information inserted by the user, the tool will calculate the planned production time, operating time and good production before it can calculate the percentage of availability, performance and quality in order to calculate the overall equipment effectiveness.

Example:

OEE = Availability x Performance x Quality

Based on the calculation,

% Availability = 96.59

% Performance = 83.35

% Quality = 99.00

Therefore, the OEE = 0.9659 x 0.8335 x 0.99

= **79.7103**

Discussion:

The result shows that the equipment effectiveness is quite high. This means that the equipment is still in good condition and can produced high capacity of the product produced by the plant.

For Utilization calculation, the information that needs to be inserted in by the user is:

- Asset Operating Time
- Asset Set up Time
- Actual Rate of production
- Design Rate of production

The tool will then calculate the availability, efficiency, duty cycle and yield for the calculation of the utilization.

Example:

TAU = Availability × Duty Cycle × Efficiency × Yield

Based on the calculation,

Availability = 0.9659

Duty Cycle = 0.9474

Efficiency = 0.9091

Yield = 0.99

Therefore, the Utilization = 0.9659 x 0.9474 x 0.9091 x 0.99

= **82.3593 %**

Discussion:

The result shows that the company fully utilized the asset in their operation. This indicates that the company is good in turning their asset into sales. 82.3593% utilization of asset is good enough for a plant operation to achieved good production and finally leads to high profit gain.

For Return on Net Asset calculation, information needed is plant revenue, total cost expenditure and net asset.

Example:

Return on Net Assets (RONA) = (**Plant Revenue - Costs**) / **Net Assets**

Plant revenue = USD 150 000

Total cost expenditure = USD 50 000

Net asset = USD 200 000

Therefore, the RONA = $\frac{USD150000 - USD50000}{USD200000}$ x 100%

= **50%**

Discussion:

RONA is basically an indicator of how profitable a company is relative to its total assets. RONA gives an idea as to how efficient management is at using its assets to generate earnings. The plant manages to gain 50% of return on net asset. The higher gain of the return of net asset, the better the performance of the company.

For Maintenance Index, the information that needs to be inserted by the user is maintenance cost and plant capacity. Plant capacity referred to the revenue that the plant available to produced.

Example:

$$\textbf{MI} = \frac{\textbf{Maintenance Cost}}{\textbf{Plant Capacity}}$$

Maintenance cost = USD 50 000

Plant Capacity = USD 150 000

Therefore, maintenance index = $\frac{USD50000}{USD150000}$ = **0.3333**

Discussion:

Maintenance index is a measure of maintenance cost. Lower index indicates that the company spent less money on the maintenance services. This situation is good and could help the company to gain high profit.

CHAPTER 5

CONCLUSION

As a conclusion, plant performance indicators definitely help an organization to define and measure progress toward organizational goals as it is used as a performance management tool. Utilizing Plant Performance Indicator (PPI) Tool in plant is hopefully can help the organization to evaluate overall plant performance generally in order to monitor the plant from time to time. The application of the tool on small-scaled case study definitely shows that the tool is applicable for industrial purposes.

RECOMMENDATIONS

There are some recommendations that could be implemented in order to improve the performance of the Plant Performance Indicator. The recommendations are as follow:

1. Provide user with different kind of standard regulation of Occupational Safety and Health Administration suitable for their usage. For example, for the company that operates in Malaysia, standard regulation provided by Department of Environment (DOE) should be used so that the discharged pollutant will comply with the DOE limit.
2. Include detailed analysis on each performance indicator for accurate result. For example the result on the implication that the company would face based on the result obtained.
3. Design service process should be focus on simplicity coordination and collaboration between different functions so that the tool is classified as “user friendly” tool. For example, there can be a link between the applications so that the data that the user need to key in is self-generated in the PPI tool.

4. Another element that can be included in the tool will be Financial and Man-power Development. In financial part, we can discuss more on the operating profit and revenue versus operating and maintenance cost. For man-power development, it should discuss more on numbers of training and types of training that the company should conducted in order to produce competence workers. The company can refer to the guide book by Malaysian Industrial Development Authority in developing man-power and training facilities in their industry.

5. In Safety Performance Indicator, it will be beneficial to the company's evaluation if the element such as Total Recordable Case Frequency (TRCF) and Loss Time Injury Frequency (LTIF) is included in the evaluation. TRCF is the number of injuries of contractors and staff requiring medical treatment or time off work, for every million hours worked while LTI is the number of lost time injury accidents per million man-hours worked. The purpose of including these elements is to build a safety culture where all employees and contractors must aim for "Goal Zero" – operating with zero fatalities and significant incidents.

$$\text{TRCF} = \frac{\text{No of recordable cases x } 10^6}{\text{Total man-hours worked}}$$

$$\text{LTIF} = \frac{\text{No of LTI's x } 10^6}{\text{Man-hours worked}}$$

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