ENHANCEMENT OF PRODUCTIVITY BY OVERALL EQUIPMENT EFFECTIVENESS PERFORMANCE TIME REDUCTION IN FOOD INDUSTRIES

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ABSTRACT: Productivity is an important factor in the manufacturing industry is productivity. Nowadays, the critical issue in current operation at most industries is a low productivity because of uncertain poor performance in operation such as performance of quality and operation stop or delay without any notices due to lack performance of machines or equipment. Therefore, the objective of this paper is to identify the root causes which effect to poor performance of quality and operation by applying Overall Equipment Effectiveness (OEE). Ultimately, propose appropriate action to be taken by the respective company to increase the productivity and output in production line. To cater appropriate performance measures, this study used a descriptive quantitative method with an Overall Equipment Effectiveness (OEE) as measuring tool based on Performance, Availability and Quality percentage. Based on the results found that Performance with 71.6% is the main contribution to the low productivity. Therefore, to identify a root cause of the poor performance as one of OEE's components by using the Ishikawa diagram, as well as to make any suggestions for improvement using the Why-why analysis. Thus, according to the results of OEE's factors (Performance, Availability, and Quality) at the current level were determined the causes for improvement proposed based on six big losses. Finally, the results of OEE able as a measurement reference to propose suggestion for improvement.

KEYWORDS: *Productivity; Efficiency; Performance; Equipment; Improvement*

1.0 INTRODUCTION

Markets and trends are making industries increasingly competitive today. In order to achieve the highest level of competitiveness, overall productivity within an industry must always be increased. Performance targets such as cost, quality, flexibility, and speed will reveal the dynamic expectations of the market in the word of production output. Farokhi et al. [1] mentioned that the challenges of defining goals, which may result in unintentionally biased choices when deciding on performance goals. In this study, the OEE method was used to increase productivity. OEE concentrates on six major losses such as idling and minor stops, reduced speed, equipment failure, process failure, defects in a process, and reduced yield [2]. All these losses are under the factors of performance, availability, and quality. By understanding the losses, OEE aims to help manufacturers improve their performance. OEE is a measure that reduces apparently complicated production issues. Since the OEE method is applied in a machine, there is no limit on the amount that managers and engineers can profit from it. The OEE is a significant indication that measures the performance of all the equipment to its full yield potential, identifying production bottlenecks and establishing new objectives for improvement [3]. As stated by Tsarouhas [4], the OEE method provides an important point of view and helps manufacturers to come up with a good solution to enhance performance and productivity.

Productivity measurements are crucial for the kind of industry. Changing efficiency fulfils the customer and reduces the time and cost of producing, creating, and conveying items. Many industries are now alert of how problems in their production line will impact productivity and efficiency in their manufacturing. Besides, manufacturing industries are more focusing on improving the production line through OEE's productivity output must be sufficient in order to compete in the market, as high productivity is directly related to processes control and equipment efficiency. Besides that, the major daily problems that encountered by many manufacturing industries are small stops and increased speed. These problems have a great impact on the OEE's performance in productivity and delivery time. The objective in this study is to identify the factor which cause poor OEE's result occurred in the production line through practicing the performance measures of OEE on production assembly in manufacturing industries. Finally, to propose the appropriate improvement for enhancing productivity in production line. Thus, the novelty in this study is to reverse application of OEEs' factors in order to monitor the performance of production line to achieve desire target of productivity and output.

2.0 LITERATURE REVIEW

2.1 Productivity

Productivity is an average measure of production efficiency. It can be formulated as the output to input ratio, or output per unit of input, used in the production process. when the productivity measurement takes into consideration all inputs and outputs. In addition, Satbir and Sandep [5] stated in their study that productivity has become an adaptable word, as everyone talks about it. The meaning of "productivity" is different for people who are characterised as human applications to deliver with little input because the benefits of production are circulated among the largest number of individuals. In the study by Moktadir et al. [6], efficiency can be used to measure the amount in certain outputs that can be separated from a given output. Productivity measurements are essential for the industry.

2.2 Understanding of OEE

Overall Equipment Effectiveness (OEE) is the application of the concept to enhance and monitor the measurement of production. OEE classifies the time ratio of production that is productive. As explained by Joseph and Jayamohan [7], a 100% OEE score means that only Perfect Parts without Stop Time are produced as quickly as possible.

According to Mjimer et al. [8], OEE rate can be calculated by using the availability rate, the quality rate and the performance rate. which include the Six Big Losses namely idling and minor stops, reduced speed, equipment failure, process failure, defects in the process, and reduced yield. The structure of the Six Big Losses allows manufacturers to investigate with extraordinary specificity levels for their efficiency issue [9].

In order to calculate the OEE, performance efficiency, availability ratio, and quality rates must be calculated first [10]. The OEE score equation is as shown in Equation 1:

$$\text{OEE} = \text{Performance} \times \text{Availability} \times \text{Quality} \tag{1}$$

(i) Performance

OEE is a quantitative metric, to find the main cause of the line's performance, it is necessary to analyse its OEE [10]. Although productivity is a conceptual term, it is a very specific principle that should be remembered in connection with the ratio between output and input. In addition, Wickramasinghe and Vathsala [11] mentioned that performance supports the claim that manufacturing production implementation can be achieved only over time. Carlo et al. [9] expressed that the performance factor has big losses including idling and minor stops as well as reduced speed. In order to calculate the actual performance value of a machine, speed losses are needed. Joseph and Jayamohan [12] mentioned in his survey that Overall OEE metrics are used to investigate the performance of a Kerala cattle feed production plant.

(ii) Availability

According to Roessler and Abele [13], when effective practises and maintenance management are used, equipment is more reliable and has a longer time available, which significantly lowers costs and losses in the production processes. In detail, the availability factor methods, the total time system does not function due to breakdowns, setup, adjustment, and other interruptions [7]. For example, planned and scheduled maintenance, operator training, process improvement projects, machine operator maintenance (e.g. cleaning the equipment), official manufacturing breaks, etc. The maximum installation length of the equipment after any assumption of arranged manufacturing activities is called availability time. As identified by Bengtsson [14], stated that insufficient attention to detail (waiting), equipment breakdown, or defective goods can cause main losses. The two major losses (Unplanned stops and Planned stops) help measure the actual value for a machine's availability in a manufacturing sector which are equipment failure, and setup and changeover [15].

(iii) Quality

Bahria et al. [16] identified that the performance of manufacturing systems largely depends on the integration of maintenance, production and quality. Carlo et al. [9] mentioned that quality shows the defective percentage of manufacturing to the total manufacturing volume. Besides, the key feature to clarify is that the idea of quality of product includes only defects happening at the specified stage of the process, normally on a machine or manufacturing line [17]. This is generally known as the first pass yield. In order to better represent the quality measurement of the machining process, useful steps will be taken in machine quality inspection by technologically advanced control systems. Severe economic delays in a factory are due to energy waste or recycling costs. These are based on defects in the process and reduced yield.

3.0 OEE AS A PERFORMANCE MEASURES

This section is intended to provide a clear explanation of the methodology analysis used throughout the duration of this study. This study was conducted using the Overall Equipment Effectiveness (OEE) method as a section of manufacturing company to focus the current use. A visit to the food industry was undertaken to gather data collection and information observations. The data were then used for the analysis of the OEE method and the analysis was discussed in this study as well as the proposed improvement for the food industry. In addition, performance losses were also identified from this research and the solution was suggested. From the above findings, the OEE technique was used in this project to achieve and evaluate the good performance of the industry. Project planning is based on the food industry issue.

OEE is a great practice method of determining the efficiency and effectiveness of the manufacturing process. Calculated as the result of three factors, Availability, Performance and Quality, it indicates a percentage of the scheduled production time that is truly productive with initial capitals. In addition, OEE is a way to monitor and improve production line efficiency. As be informed, OEE is categorized into three factors, these factors help to improve the efficiency and define the basic productivity losses of the productivity in the production line. OEE allows continuous improvement of interaction, which eventually will enhance production performance. As a conclusion, the OEE method is more beneficial in the industry especially in food industry, and it will gain good productivity.

Data were collected for OEE analysis such as shift length per day, short break and meal break per day, down time, ideal time, total and rejected carton. Next, the planned production time for employees to do their jobs was the scheduled time. Maximum work per shift was calculated minus the break provided by the company to get the planned production time. Thus, the total working time can be measured. The operating time was unplanned due to unforeseen downtime in the production line and the estimated production time minus downtime was measured as the operating time. In order to obtain a good carton, the overall product will be reduced by the rejected product. To get availability value, operating time was divided by planned production time. The performance can be measured by the total carton divided by operation time, and then the value divided again by the ideal run rate. Finally, the quality can be calculated based on a good carton divided by the total carton.

4.0 RESULTS AND DISCUSSION

The section explained issues involved in this research. After all the information collection was described, data analysis was carried out along with the enhancement suggestion that can be made by the company.

4.1 Define Issues

The first step in this survey is to recognize the issues in the company with the intention to address them. The definition of problems also served as the basis for analysis. The definition of the problem was explained based on the critical issue of the company. The company has performance issues to address. The performance factor in the food industry should be enhanced to maintain higher productivity. In addition, performance losses such as minor stoppage and reduced speed play a crucial role in the production of soybean drinks to improve the performance factor. Applying the performance losses of the Overall Equipment Effectiveness (OEE) can reduce the idle time, improve speed, manpower, method of processing soybean drink, etc. that occur in the production.

4.2 Data Collection and Analysis

The data gathered from food industry are the primary data. It is important to note that the primary data collected are input, output and defect. The production of this food industry runs eight hours a day. There are two breaks in that company which are short breaks and meal breaks. For short breaks, they allocate 15 minutes and 1 hour is for lunch. This research focused only on the main assemblies which are filtering process, soy water filling process, foil cover process, capping and labelling process and packaging process with the processing time per carton as shown in Figure 1.

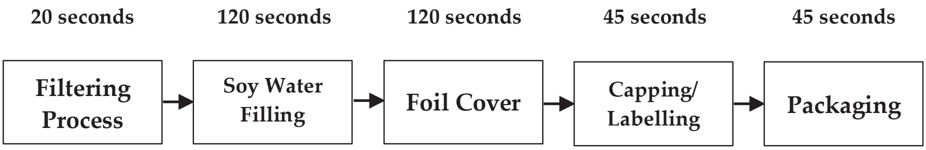

Figure 1: Main assemblies of production

The highest bottlenecks in production can be identified by the cycle time of each process in the main assembly. The calculation shows the ideal run rate and the actual run rate of production per day as in Table 1. It was determined that 0.5 cartons can be produced per minute.

Table 1: Production data for OEE analysis

Production Data				
Shift Length	8	Hours	480	Minutes
Short Breaks	1	Breaks	15	Minutes Each
Meal Break	1	Breaks	60	Minutes Each
Down Time	0	Minutes		
Ideal Run Rate	0.5	CPM (Carton Per Minute)		
Total Carton	144	Carton		
Reject Carton	1	Carton		

$$\text{Shift Length} - (\text{Short Breaks} + \text{Meal Breaks}) = \text{Prod. Shift Length} \quad (2)$$

$$\text{Prod. Shift Length/ Highest Bottleneck} = \text{Carton/ day} \quad (3)$$

4.3 OEE Analysis

Table 2 shows the experiment setup for OEE analysis which are the planned production time, operating time and good carton.

Table 2: Production data for OEE detail analysis

Support Variable	Calculation	Result	
Planned Production Time	Shift Length - Breaks	405	Minutes
Operating Time	Planned Production Time - Down Time	405	Minutes
Good Carton	Total Carton -Reject Carton	144	Carton

The Overall Equipment Efficiency (OEE) results were compared with the World Class Standard in the data analysis are shown in Table 3. The availability of production was observed to be 100%. It shows that the downtime losses were well organised. Also, the performance of the production was found to be 71.60%. It was noted that there were some losses due to small stops and slow cycles. The quality factor was found to be comparable to the world standard for manufacturing processes which was 99.31%. By comparing these values with those of the world class standard, production performance was found to be far below the world standard. These values pointed to the fact that production did not operate efficiently. Based on the OEE's results, this attempts to find the root of the problem by using a specific set of steps, with related methods, to locate the main cause of the problem, so that it can determine what happened, determine why it happened, and find out what to do to minimize the chance that it would occur again.

Table 3: OEE result comparison with world class standard

OEE Factor	Calculation	OEE%	World Class
Availability	Operating Time / Planned Production Time	100%	90%
Performance	(Total Carton / Operation Time) / Ideal Run Rate	71.60%	95.00%
Quality	Good Carton / Total Carton	99.31%	99.90%
Overall OEE	Availability x Performance x Quality	71.11%	85.00%

4.4 Root Cause Identification

In this study, the study employed an Ishikawa diagram and the Why-why analysis for poor performance in the food industry.

(i) Ishikawa Diagram

Ishikawa or also known as the fishbone diagram will help to separate ideas into practical segments as shown in Figure 2. The analysis of the fishbone diagram was used in detail based on the 4M factor, namely material, method, machine and man. This diagram will stimulate the idea of the root cause of the problem. In the first place, machine is the main reason for poor performance. This occurs because of the small stoppage. Second, the method is the root cause of poor performance due to the slow process of the production in the workplace. Finally, manpower plays an important role in poor production performance in the food industry. The company has a shortage of manpower due to it being a small company. There was a lack of knowledge in production control skills and poor teamwork among employees.

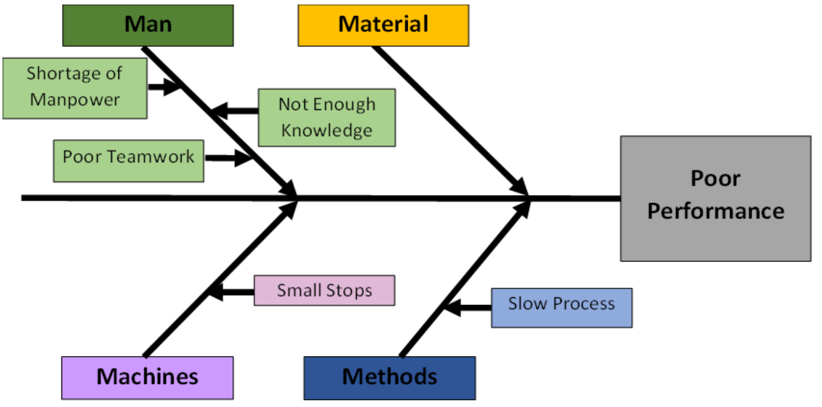

Figure 2: Cause and Effect Diagram

(i) Why-why Analysis

In order to determine what was really behind the low performance, a why-why analysis was used. The analysis is a method of analysis that identifies the problem's root cause. A Why-why problem that addressed its root cause was identified. Table 4 shows the Why-why analysis for poor performance in the food industry.

The primary root cause of the 4M factors was identified from the Why-why analysis result of poor performance as shown above. It is necessary to propose an improvement to the company following an analysis of the important issues to be considered. This is to ensure that the most serious issues are reduced by solving the problem in the production line. Here, problem-solving means reducing the cost of minor issues and saving time or shortening the process time. However, Karamouz et al. [17] identified the problem-solving for improvement by using method similar to OEE, it permits analysing and managing equipment effectiveness as a function of three remains factors: availability, performance, and quality aspects to set improvement priorities. But, in addition, it uses resource losses due to inefficiencies and deviations of the machine or equipment in the original OEE formulation. Similarly, Cheah and Prakash [18] stated that commonly used basic tools and techniques to support OEE improvements include the Gantt chart, Pareto chart, cause-and-effect analysis, brainstorming, control chart, and continuous improvement. Thus, the resources losses had been identified to cater the root causes related to machine or equipment efficiency.

Table 4: Why-why analysis for finding

Findings	Why 1	Why 2	Why 3	Why 4	Root Cause
Machine	Small stops	Labelling machine frequently stops	Labelling not stick properly	N/A	Careless by worker
					Lack of worker's skill
Method	Slow process	Not organised properly	Poor layout	N/A	No appropriate distance machine
Man	Poor teamwork	Poor communication	Lack of interaction among team	Lack of ideas	No specific trainer
	Shortage of manpower	Absence for work	Attitude Problem	No motivation training	
	Not enough knowledge	Lack of skills	Not enough of training	N/A	

4.5 Proposal Improvement

(i) Provide Discipline Talks

The first root cause was carelessness by employees which caused small stops to occur in production. For example, employees need to use a dryer to stick the labels on the bottles for the labelling process, but the issue is that employees neglect to do so on the job. In this case, management can provide disciplinary talks to employees at the company. Disciplinary talks promote good behaviours and make employees aware of the good work they have done. It is a much more effective style of management which creates a stronger link between management and staff. Practicing discipline demonstrates that management appreciates the worker and motivates them to change without resorting to strategies of terror. While it is never easy to discipline workers, it helps to create a more productive and efficient workplace.

(ii) Redesign Layout for Soybean Production

The second root cause of the method was that there was no appropriate distance machine in production. The production layout in the food industry was poor and not static. This may result in lower worker performance and the company's work can suffer as well. For this reason, it is possible to suggest a redesign of layout for the soybean production. Several factors including the available space need to be taken into account when designing the layout. In addition, other factors should include accessibility to different production requirements and the roles played by different employees in production.

(iii) Provide Professional Trainer

Finally, no specific trainer in the company is the root cause of man. There is poor teamwork among employees in the production of Soybean, and they do not have enough knowledge of the handling machine as well as the process. The production also has a shortage of manpower due to an employee attitude problem and does not have motivational training regarding their attitude problem. In this situation, management can provide workers with proper training by a professional trainer. By training, employees will be a better worker after this, and they know how to handle the machine and process. Then the workers may also avoid their carelessness in production.

5.0 CONCLUSION

In conclude, it is advantageous to incorporate Overall Equipment Efficiency (OEE) in every organization. The OEE method is used to achieve higher productivity. By understanding the losses, OEE aims to help manufacturers improve their performance. OEE is a measure that reduces seemingly complicated production issues and functional information that can help to make the right decisions to increase efficiency and reduce operating costs. The low of the current OEE% (71.11%) compared with the world class (85%) can give a signal to the company for increasing the OEE's rates to achieve desire productivity rates.

The first objective is achieved at the end of this study which is practice the performance of OEE on production assembly in manufacturing industries. In addition, the Ishikawa diagram and Why-Why analysis tools have been used to identify the root causes of poor OEE's result. Then, the method helps to identify the root causes of the problems of production. The first root cause at workplace is the carelessness by employees, because of their carelessness small stops occur in production. Second, the root cause of the method is that there is no appropriate distance machine in production. Lastly, no specific trainer in the company is the root cause of man. Therefore, the analysis of the study can be carried out and the problems can be resolved.

Finally, the second objective is to propose the OEE method of productivity enhancement that can be achieved by the industry. The proposed improvement is based on the analysis of the data and the root cause identified. The first improvement proposed is that management can provide disciplinary talks to employees at the company. Secondly, suggest a re-layout for Soybean production. When, due to a better layout the employee's productivity rises, the employee's salary and thus the company's income increases at the same time. Last improvement is the management can provide workers with proper training by a professional instructor. By training, employees will be a better worker after this, and they know how to handle the machine and process. The proposed improvement shall be submitted to the company for consideration in the resolution of the company's problems. In this study can conclude that the results of OEE can be a reference to identify the root causes for proposing improvement.

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