Optimization of Overall Equipment Effectiveness through Lean and Total Productive Maintenance in a Cement Paper Bag Manufacturing Company

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Abstract

One of the most important measures in manufacturing industry is Overall Equipment Effectiveness, commonly termed as OEE, it also indicates the degree to which a manufacturing process is truly productive and serves as a general and inclusive measurement of how well a company's manufacturing operations are performing. Optimization of OEE factors provides significant impact to the organization through efficient operations, cost effectiveness, gaining competitive advantage in the market and to provide sustainable supply of products. Optimization is providing sustainable solutions to the problems identified through root cause analysis through total productive maintenance or lean manufacturing methods or techniques towards the goal of zero to minimal wastage. With the applications of these methods the researcher was able to identify the critical issues and solved the issues affecting the overall equipment effectiveness of the subject company. The researcher was also able to propose a systematic roadmap to implement lean and TPM for the subject company that will ensure and sustain the efficiency and cost effectiveness of the organization.

Keywords:
Overall Equipment Effectiveness, Sustainable, Lean Manufacturing, Total Productive Maintenance

1. INTRODUCTION

One of the most important measures in the manufacturing industry is Overall Equipment Effectiveness, commonly termed as OEE. OEE is the product of three operational factors namely; 1. Availability is a measure of the percentage of hours the equipment is running or available at any given time 2. Quality is the measure of plant effectiveness in producing good and quality products theoretical versus actual and 3. Performance/Rate this is a measure of speed or the equipment effectiveness in terms of theoretical output versus the actual output of the equipment. By optimizing these three (3) factors the firm stands to benefit in terms of increase in capacity, improvement in quality and reduction of operating cost. Rouse (2017), defined OEE as Overall equipment effectiveness is a measure of manufacturing operations performance and productivity, expressed as a percentage. OEE indicates the degree to which a manufacturing process is truly productive and serves as a general and inclusive measurement of how well a company's manufacturing operations are performing. Also, Okpala et al. (2018), explained that OEE is a technique applied for the measurement of major production features which include performance efficiency, rate of quality and availability. It aims at speed increment, and the reduction of defective products, machine stoppages (downtime), and poor quality products by machines, as well as machines and equipment that work below their production capacity.

To increase plant efficiency, OEE focuses on the reduction of the so-called six (6) big losses, namely: 1) Equipment failure; 2) Set-up and adjustments; 3) Idling and minor stoppages; 4) Reduced speed; 5) Defects and rework; and 6) Reduced yield. The six big losses are defined as; Equipment failure where equipment stopped due to unforeseen occurrence or unplanned stoppage means that the equipment stops working according to intended purpose or not meeting equipment expectations. Setup and Adjustments account for any significant periods of time in which equipment is scheduled for production but is not running due to a changeover or other equipment adjustment. A more generalized way to think of Setups & Adjustments is as any planned stop (OEE made easy by Vorne) Idling and minor stoppages, according to Trout (2018), is a minor equipment stoppage that can be resolved by the operators without the help of maintenance technicians. These stoppages can be from minor adjustments, jams, wrong setting and cleaning of the equipment. Reduced speed, also known as slow cycles, is the difference between a machine design or theoretical speed versus actual speed of equipment during operation. Inadequate equipment maintenance or poor equipment condition is one of the factors in reduction of equipment speed as well as quality of materials and operator's competency. Defects and Rework are losses incurred because of failing of machines and equipment to manufacture quality products of established quality parameters or standards set by the company for the goods manufactured. Reduced yield is also related to the defects and rework. The yield is the percentage of good products produced over theoretical quantities of a certain material that can be produced from it.

The subject company of this study is the global leader in the cement manufacturing industry and has a selling capacity of 216,000,000 bags per year. The company uses 2 different materials for bagged cement packaging 1 is WPP or woven propylene plastic and the second is a kraft cement paper bag, which the company produced. The Paper bag plant has a maximum capacity of 90 million bags per year and this is the only packaging plant owned and operated by the subject company making the plant as the sole manufacturer of Kraft cement paper bags in the whole organization. Due to the increasing awareness of environmentalists and government of the hazards associated with the use of plastic sacks and with the local legislations implemented on the certain region of the country with the use of plastics the industry was forecasted to grow by 4% on a yearly basis

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The research study will cover the 2019 data for the downtime records, rejects and key performance indicators. The data used in this study are from monitoring and historical records.

The plant OEE target for year 2020 is 90% versus 89.86% actual attainment in 2019. The production line recorded a total downtime of 229.4 hrs and 58,000 pcs of bags for the year 2019. With the rate of the machine of 171 bags per minute, 229.4 hrs of downtime is equal to 2,353,644 pcs of bags in opportunity losses and that is equivalent to 3,530,466 pesos net loss at 1.5 pesos per piece of bags income. In effect of this equipment inefficiency the line produces 58,000 pcs of rejected bags that is equivalent to 394,000 pesos in product wastages. The plant did not explore opportunities to improve the OEE of the plant using different methodologies given with the target provided by the top management. This is one of the reasons why this topic is proposed, to develop solutions that will improve the OEE of the plant that will reduce cost of operations, ensure the stability of supply of packaging material to the cement plants and mitigate the impact in case the supplier of plastic packaging fails to deliver.
There are numerous studies in manufacturing industry for the optimization of OEE factors such as lean manufacturing practices in manufacturing industry. However, previous studies did not explore the opportunities of lean manufacturing and total productive maintenance and its impact on the operations of the cement paper bag manufacturing industry.
It is in this light that the study will aim to the following objectives:

1) To determine the significant factors affecting unattained target OEE of 90% at the current production level of only 21M bags.
2) To identify the areas of improvement in significantly increasing OEE to 95% at the target production level of 90M bags.
3) To recommend a strategic roadmap of improving and sustaining the OEE level of 95% toward maximum capacity utilization and operations cost-effectiveness.

Following will be the significance of this study: 1) to improve the over-all equipment effectiveness of the plant as well as cost-reduction of operations & maintenance, less downtime, avoidance of catastrophic failure and minimal wastages. 2) to gain strategic competitiveness in the market and 3) to contribute to the environment conservation by providing renewable, sustainable, and greener packaging solutions to the customers and end-users.

This research study will cover the 2019 data for the downtime records, rejects and key performance indicators. The data used in this study are from monitoring and historical records that were provided by the plant in accordance to the corporate policy on data confidentiality and protection.

2. REVIEW OF RELATED LITERATURE

Lean manufacturing practices in a manufacturing industry requires hard work, perfection, patience and strong will to thrive. The output of this implementation cannot be seen overnight. JM Kafuku et.al (2019) said that lean manufacturing requires the essential practice such as product design, human resources, process and equipment, concurrent engineering practice, manufacturing planning and control, and supplier and customer relationship are considered in order to improve the process. Wiktorsson, M., et al., (2018) stated that the importance of lean practice in industries lies in the ability to improve the production line through identification of waste, non-value-added activities, and establish flow of values activities to customers.

Hooi et. al., (2017), defined TPM as a production-driven improvement methodology that is designed to optimize equipment reliability and ensure efficient plant utilization with employee involvement and empowerment and as a team-based asset management strategy that emphasizes co-operation between operations and maintenance departments with a goal of zero defects, zero breakdowns and manufacturing industry's Availability, performance rate, quality rate and overall equipment effectiveness (OEE).Hence, the main goal of TPM is to maximize equipment effectiveness and OEE is used as a measure (Fam, S. et. al., 2018).

The use of lean manufacturing and total productive maintenance in cement bag manufacturing has not been adopted yet despite various benefits that may be achieved. The researchers have observed that despite the benefits of these methods, there were no cement bag manufacturing companies whether it is plastic or kraft paper that initiated the study and combined lean manufacturing and total productive maintenance in a single research. This research will fill the gaps of the previous research.

3. METHODOLOGY

The primary goal of the study is to increase overall equipment effectiveness (OEE). Focusing on the three elements of availability (A), quality (Q) and performance (P) to improve the current level of 89.86% to the desired level of 95%.The focus is to identify the root causes affecting the 3 OEE elements and develop solutions to minimize wastes and improve efficiency and quality accordingly.

The Input-Process-Output (IPO) approach is adopted by the study in achieving each of the 3 objectives discussed earlier and are summarized in the following table:

Table 1. Summary table

	INPUT	PROCESS	OUTPUT
Objective 1: To determine the significant factors and root causes of unattained OEE target	Interview Observation Downtime data Rejection data	Pareto Analysis Process Review SWOT	Top contributors explaining the gap in OEE; Identified areas of improvement
Objective 2: To develop solution approaches / alternatives for OEE improvement	Top causes accounting for the OEE gap	Validation of Causes - Gemba Walk Root Cause Analysis - Tree diagram, - 5W1H Lean Tools - TPM - Poka Yoke	Solutions to attain 95% OEE; Incremental improvement contribution by causal factor; Decision Matrix (Eisenhower)
Objective 3: To recommend an implementation roadmap in improving and sustaining OEE at 95% level	Lean solutions; A x Q x P factors to improve; Reviewed SOPs	Work standardization; System; SOP re-visit / procedural review	New A x Q x P targets toward 95% OEE; Standardized Work; Performance Management System; PDCA Roadmap (Kaizen)

To determine the significant factors and root causes of unattained OEE target interview to the key personnel of the plant to obtain data such as rejection, downtime, and pain points in the operation. Observation to validate the data obtained. After the date was gathered and validated, Pareto analysis done to identify the areas for improvement and the top contributors affecting the unattained OEE. SWOT analysis done to determine the internal organization factors that have both direct and indirect impact to the OEE attainment of the subject company.

Upon revealing the top contributors for the unattained OEE, Root cause analysis was done to uncover the true causes of the problem and to develop solutions to attain 95% OEE that will have an incremental improvement contribution by causal factor; Decision Matrix (Eisenhower) was also done to see what solutions will cause an immediate impact and easiest solution to implement. Poka-yoke and standardization implementation helped the workers not to commit mistakes and eliminate the possibility of human error that leads to product defects and downtimes.

Correction of the problem identified alone will not help the organization to maintain the performance. By revisiting the current practice of the organization, procedural review and assessment continuous improvement is needed to ensure success of the organization. With the aid of Kaizen this will ensure the continuity of the implementation of the identified solutions to the problems affecting the OEE and consistently attain organizational goals. Kiran D.R (2020) stated that Kaizen or continuous improvement emphasizes continuous improvement as compared against innovation, which is a one-time improvement.

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4. RESULTS AND DISCUSSION

4.1. RESULTS

4.1.1 Cement Paper Bag Manufacturing Process

The Cement paper bag manufacturing plant handles the procurement of raw materials, scheduling, and manufacturing, glue mixing, warehousing of finished goods, logistics of product to the cement plant, and maintenance of manufacturing equipment.

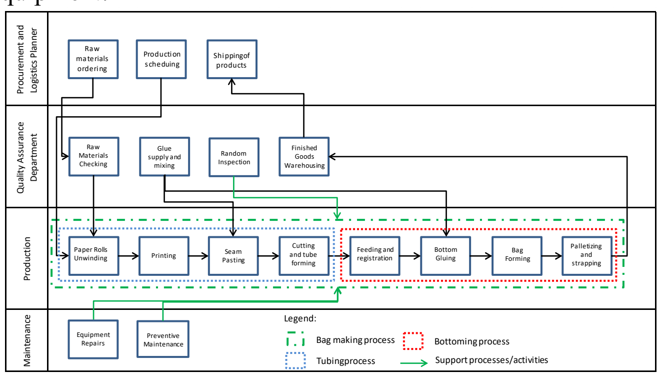

Figure 1. Bag Manufacturing Process Flow

Cement Paper Bag manufacturing consists of two major processes, these are; Tubing and Bottoming. The tubing process includes the unwinding of paper rolls, printing of bag design, seam pasting gluing or binding of two papers, cutting and tube forming while Bottoming process consists of feeding and registration, bottom gluing, bag forming, and palletizing.

4.1.2 Process review

During the Gemba walk, I was able to witness the actual conduct of troubleshooting and adjustments on the equipment. The process is as shown in the figure below;

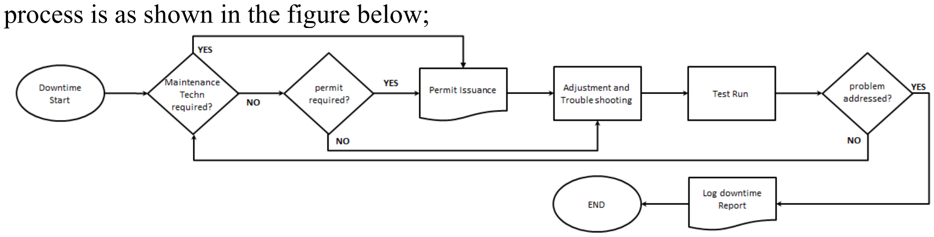

Figure 2. Existing Process on troubleshooting

During downtime the operator may execute the adjustments and or troubleshooting if a work permit is not required, if the work is associated with health and safety risks, workers should secure a work permit before commencement of the tasks. After the adjustments, the operator will run the equipment to test if the problem was addressed, if not the need to stop the equipment again to perform troubleshooting. During this test run phase, the equipment will produce rejects as it cannot eliminate the products inside the machine or even recover.

4.1.3 Pareto Analysis

Pareto diagram was used to identify the significant downtime, rejects, and focus of improvement. This specifies the 80% of consequences or effects come from 20% of the causes. However, this method does not show the true cause(s) of the failure. Pareto is a method to show only where the focus of analysis.

4.1.3.1. Pareto Analysis on Machine Downtime

Figure 3 showed the results of the Pareto analysis of machine-related downtime The top contributors accounting for 80% of the total machine downtime are: 1) Cut-off timing belt; 2) Malfunction of stack loader conveyor; and 3) Ink pump malfunction, the root causes of which were analyzed using the 5W&1H approach.

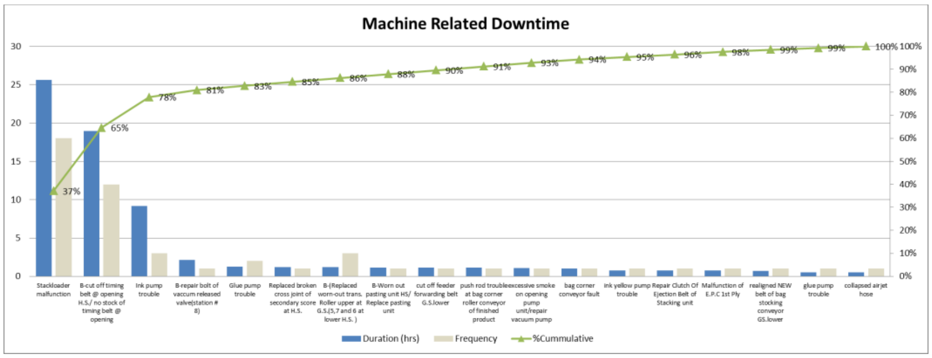

Figure 3. Pareto diagram of machine downtime

4.1.3.2 Pareto Analysis on Rejects

Rejects shown in figure 4 are the factors affecting the Quality performance of the organization. Displaying the highest rejects was cut print followed by tube problem, deformed pocket, and the inverted pocket was accounted as the major contributors of total quality rejects.

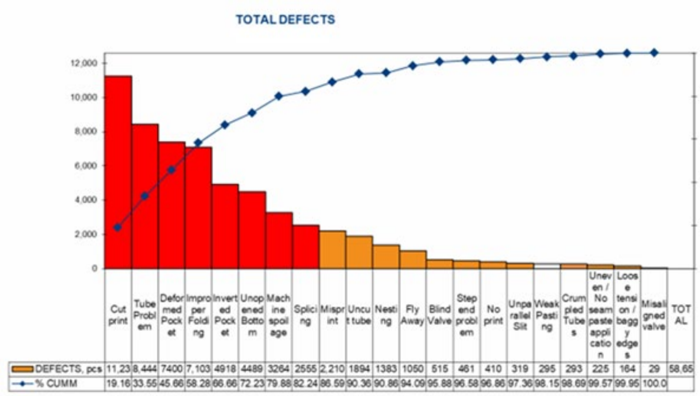

Figure 4. Pareto diagram of rejects

4.1.4 SWOT Analysis

Using SWOT analysis, it shows that the troubleshooting skills of production personnel need improvement the same with their technical capabilities to understand and handle complex equipment problem. While there was already an identified subject matter experts (SMEs) for the cement paper bag manufacturing operation.

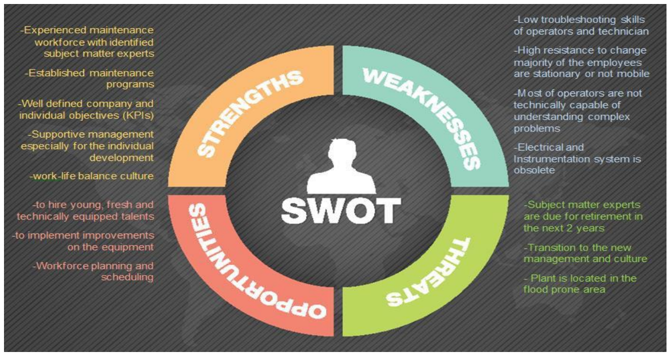

Figure 5. SWOT analysis of the internal environment

4.4.5 Validation of Causes

The results of the Pareto analysis were verified through observation of the process and personnel in the production area. During the time of observations, it was observed that the rejects have mostly come from 2 process areas; these areas are Tubing and Bottoming machine. Also, the lack of communication from personnel produces a high number of rejects mentioned by one of the operators during my interview as well as the lack of technical competencies of the operators.

4.4.6.1 Root Cause Analysis

Problem-solving is a mechanism in identifying problems, opportunities for improvement, and determining the right actions to take and to control risks associated with unattained OEE. This will enable the organization to focus on the true causes rather than the symptoms.

4.4.6.1.1 RCA for Machine Downtime

In figure 6, 5 why 1 H approach was used to uncover the root cause for machine-related downtimes. This shows that the failure of machine-related downtime was through the lack of technical expertise of machine operators and their involvement in maintenance repairs and the need for an established minimum and maximum inventory level for the materials.

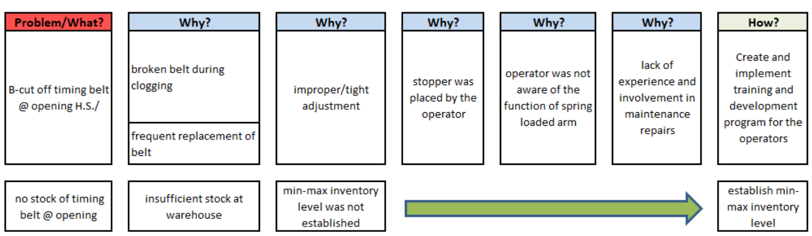

Figure 6. Root cause analysis for belt cut-off downtime

4.4.6.1.2 Stack Loader Downtime Root Cause Analysis

In figure 7, RCA was done for the Stack loader downtime. The root causes identified for the downtime are; 1) Low educational attainment mindset; 2) references cannot be found in the manual; 3) No system or system is no longer relevant to capture the downtime description and action taken and; 4) Departmental/Production only mindset.

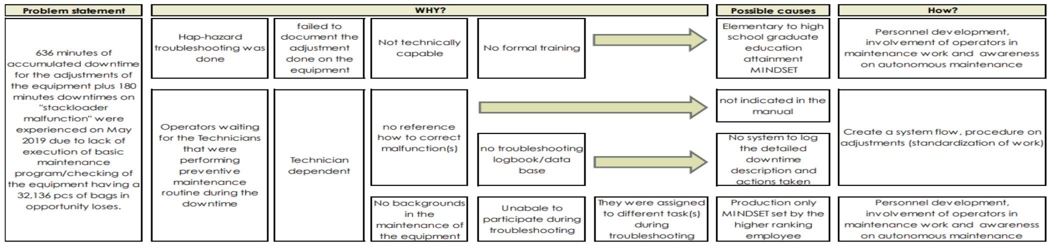

Figure 7. Root cause analysis for stack loader downtime

4.4.6.1.3 Ink Pump Malfunction RCA

Using the 5W 1H approach, the root cause of the problem originated from the removed the strainer installed in the tank and the plastic twine seal enter the system and damaged the pump motor. This type of malfunction is preventable if only the personnel have technical knowledge on the basic function of the equipment protection installed in the equipment. This can be address by simply involving the personnel to the improvement done by the other section and by increasing the competency of the personnel through trainings.

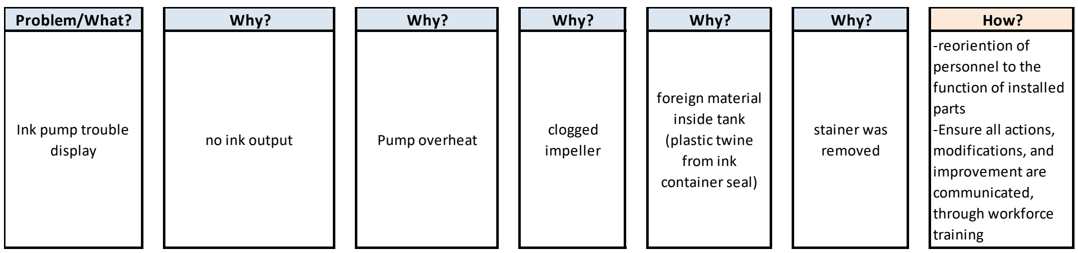

Figure 8. RCA for Ink Pump

4.4.6.1.4 Root Cause Analysis for Rejects

In figure 9, tree diagram was used to identify the root causes of high rejects. Although the rejects classification was plotted in the Pareto diagram to see the top 80% affecting the quality, there are numerous factors affecting the high number of rejects such as; the production scheduling that stuck with the traditional 5 days operations another is there is no data base where troubles and corrections were logged to serve as guide to the operators.

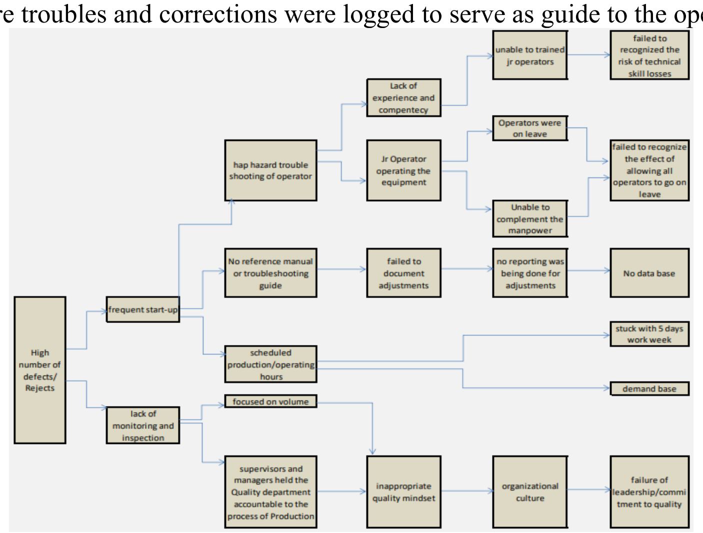

Figure 9. Root cause analysis for rejects using the tree diagram

4.2 DISCUSSION

4.2.2 RCA for Machine Downtime

To address this performance gap, a gap analysis was done to identify the technical and behavioral gaps to come up with a strong learning and development plan tailor-fit according to the needs of each plant workforce.

4.2.2.1 GAP ANALYSIS

There are 3 major factors in the competency of the operators; 1) Operation of the equipment; 2) Preventive Maintenance of the equipment and; 3) Quality aspects. By performing gap analysis on the operator's performance of these factors can validate one of the root causes and can use to design training or intervention needed to address the performance gap.
The immediate superior and the employee is responsible for performing the gap analysis and ensuring the required level for each competency is according to the business' needs. After both assessments were done, operators and immediate superior will discuss and justify the assessment to come up with the final assessment rating and the intervention needed if there is a gap identified with the agreement of both parties.
After the gap has been established, training master plan for all the personnel must be developed to ensure that the personnel is technically equipped.

4.2.2.2 Subject Matter Experts

With the internal SMEs previously identified in SWOT analysis, this will not incur additional cost to the plant. SMEs will facilitate in-house training; this will give the personnel easy and accessible training as well as good motivation and something to look forward to.
Subject Matter Experts or SMEs of the plant were already available. These persons were trained in the factory of the Original Equipment Manufacturer (OEM) for the operations, maintenance, and troubleshooting of the equipment.
The company employs them for more than 20 years as operators and now as maintenance technicians.
By increasing the competency of the operators it will decrease the numbers of occurrences of the downtime and the plant will benefit from it by having a decrease in downtime by 46.62 hours or 5.6% in terms of Availability of the equipment.

4.2.2.2 POKA YOKE AND STANDARDIZATION

SMEs can provide documented procedures to standardize work with a combination of poka-yoke. Documented work procedure will ensure the sequence or chronological order of work to avoid mistake, while poka-yoke will ensure the correct material is useful and properly placed. By creating pins and groove, anyone in the operations can place the material without a mistake. Doing this to all of the processes of operations will take so much time however, applying this method to the critical processes of the plant will create an immediate impact.

4.2.2.3 MONTE CARLO SIMULATION

To address the second root cause of the problem, the stock-out of the necessary material due to an unestablished minimum and maximum inventory level. Monte Carlo Simulation was done. This is to establish minimum and maximum inventory level and the reorder point to avoid stock out. During an interview with the warehouse custodian, the limitation for the specific part to be stored is 17 pcs at a maximum. Monte Carlo simulation used to determine the parameters for the inventory management of the plant. After performing the simulation, the optimal values for the inventory of the specific part identified. The values are the following; 1) maximum inventory level is 17 pcs 2) Reorder point is 7 pcs and 3) Order quantity is 12 to avoid stock out.

4.2.2.4 Ink Pump Downtime RCA

An ink pump is stand-alone equipment that is critical to the printing process; the pump will automatically fill the printing tank of printing equipment, while the operators manually fill the ink tank to ensure a steady supply to the printing tank. Strainers were put in the tank to prevent foreign materials to go through the pump to ensure the expected volume is delivered. By addressing this problem and preventing the recurrence the equipment availability will increase by 0.6%

4.2.2.5 Solutions to Stack loader Downtime

4.2.2.5.1 Decision matrix

In table 2 is the decision matrix to the subject organization's decision-maker on what actions to take or prioritize that will give the highest impact to the operations

Table 2. Decision matrix for solution identified in RCA of machine downtime

Decision Table			
Impact	HIGH	1. Create a data base where downtime can be logged and accessible to all personnel 2. Cross-training of production personnel to maintenance department 3. Create work instructions for identified tasks(s) 4. Create troubleshooting guide 5. Conduct regular workforce training using subject matter experts to update and enhance the workforce skills	Change the mindset of production personnel to a departmental mindset to plant KPI by: 1. Exposure of operators to Operations meanings 2. Inclusion of downtimes to individual KPIs Embrace quality as everyone's responsibility
	LOW	1. Train all the personnel to Autonomous maintenance	
		EASY	HARD
		Implementation	

The identified actions in the decision matrix above were evaluated with the help of the organization's department heads. The company resources were also assessed to make the decision reliable and accurate based on the current status of the subject organization. The solutions with readily available resources were put in the EASY quadrant while actions need further resources and time was put in the HARD quadrant.

4.2.2.5.2 System Improvement

A flow diagram was created to capture reports and a systematic approach to troubleshooting.

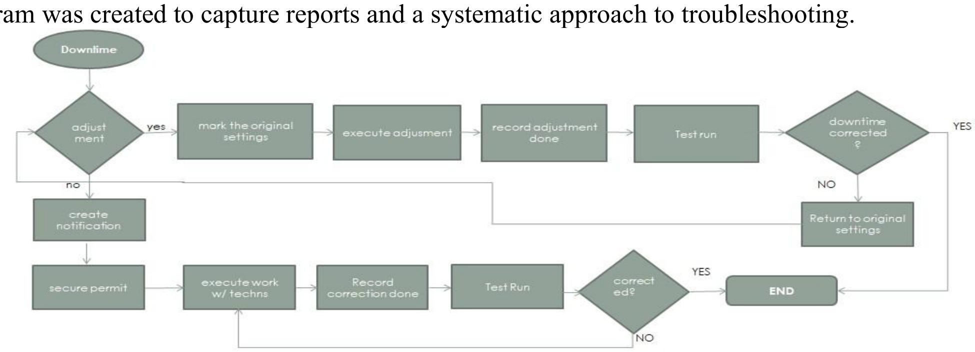

Figure 10. System proposal to address haphazard troubleshooting

With this flowchart or work procedure, the operators will be able to capture all the necessary information done by any worker during the troubleshooting. This will shorten the downtime by more than 50%, avoiding the same corrections done that did not work during the span of downtime; this will capture as well the effective solution to the specific equipment trouble and serve as a "knowledge database" for the operations an increase in operating time of 46.62 hours or 2.5% equivalent in equipment Availability.

4.2.3 Rejects tree diagram

One of the root causes identified is that the schedule is in 5 days workweek at 16 hrs per day of operations. A frequent stoppage produces rejects. With adjustments on the work schedule from 5 day workweek at 8 hours per shift to 4 days work week at 10 hours per shift it gives the subject company an increase of 30 minutes additional operating time per week or equivalent to 5,400 pcs of bags and spare capacity of 40%.

By implementing a compressed work schedule, the plant also eliminated 20% of start-up rejects or 0.14% in quality performance and an additional savings of another 20% for the electricity consumption for the administrative operations. Rudy Hung et. al, 2004, stated that Saving labor costs by a few percent or more by simply rearranging work hours, which involves no or very little expenses, is quite an attractive proposition. With the improvement on both quality and addressing the factors affecting the availability of the equipment, the performance rate of the equipment is also set to improve from the current rate of 99.45 to 100%.

4.2.4 Strategic Roadmap

In figure 11 is the recommendation of implementation of lean manufacturing and total productive maintenance or a strategic roadmap to improve and sustain the OEE level of 95% and towards maximum capacity utilization and operations cost- effectiveness consistent with IPO process and Kaizen or continual improvement. At the pre-implementation/INPUT stage this stage is also known as the goal and foundation setting.

The success of an organization relies much on top management that is why the need to identify and appoint lean implementation is highly needed at this stage. This will give a systematic approach and mitigate the cost implications of the improvement to address the known risks.

The implementation or Process stage is where all the plans are executed. At this stage budget and work force, allocations are already on a full scale. Training is done to enhance organizational knowledge and competencies towards the goals of achieving high efficiency at a minimal cost. Soft launch of identified improvement plans is implemented at this stage.

Monitoring of targets set by the organization and adjustments on targets or strategy was developed in case of unattained organizational goals. Monitoring through a balanced scorecard, key performance indicators, and or key results area was also done. Analysis of data gathered was also implemented to make necessary adjustments.

In the output or post-implementation stage, documentation of best practices and standardization of work is the key to ensure business continuity and sustaining what has been achieved by the organization. While maintaining the success, the lean implementation team should challenge the existing best practices to ensure continual improvement.

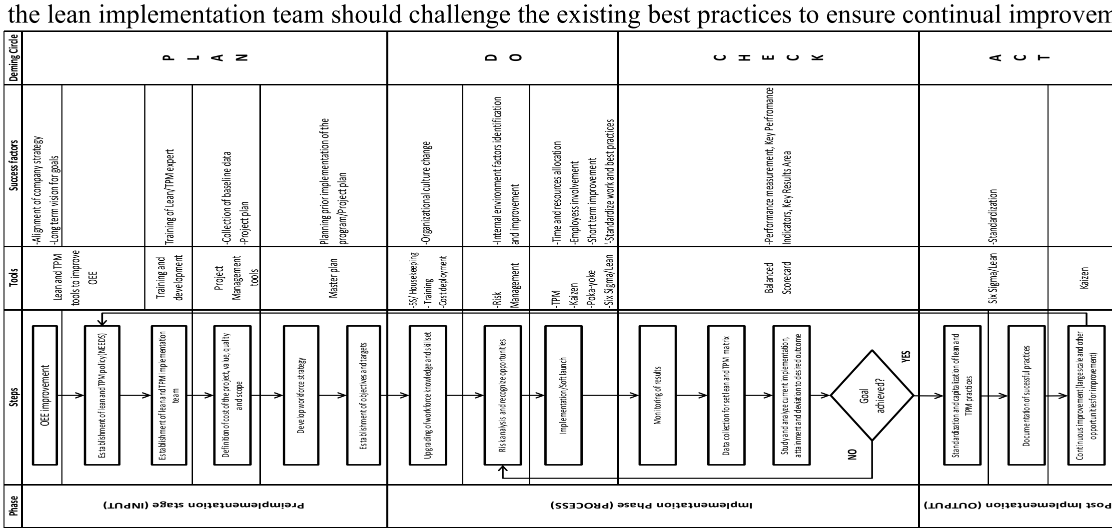

Figure11. Strategic roadmap for TPM and Lean Implementation

4.2.5 COST-BENEFIT ANALYSIS

4.2.5.1 BENEFITS

The amount of losses at 89.90% OEE as defined in the 1st part of this paper is 3,530,466 Php to account for the losses at 95% OEE a ratio and proportion computation must be done, using Ratio and proportion the formula is shown below;

$$\frac{The\ total\ amount\ of\ losses\ at\ 89.90\%\ OEE}{OEE\ deviation} = \frac{New\ Losses\ (amount)\ at\ 95\%\ OEE}{New\ OEE\ deviation}$$

Where;
The total amount of losses at 89.9% OEE= 3,5540,466 Php
OEE deviation = 100%-89.9% = 10.1%
New Losses at 95% OEE = X?
New OEE deviation=100%-95% = 5%
Solving for the new losses;

$$\frac{3{,}530{,}466}{10.1\%} = \frac{Losses\ (amount)}{5\%}$$

$$Losses\ at\ 95\%\ OEE = \frac{3{,}530{,}466\ (5\%)}{10.1\%}$$

$$Losses\ at\ 95\%\ OEE\ = 1{,}747{,}755\ Php$$

To compute for the benefits, the benefits is the difference from the losses from 89.90% OEE and losses from 95% OEE

$$Benefits = 3{,}5540{,}466\ Php - 1{,}747{,}755\ Php$$

$$Benefits = 1{,}782{,}711\ Php$$

4.2.5.2 Benefit/Cost Ratio

In any project or changes benefits to cost ratio is very important. This will define if the project will produce more than the current benefits or more beneficial than the existing set-up, the benefit to cost ratio should be greater than 1 to produce a favorable advantage to the company. Below is the computation of the Benefit/Cost Ratio for this project

$$B/C = \frac{\text{Benefits from the project}}{\text{Project Costs}}$$

Where;
Benefits from the project=1,782,711 Php
Project cost= 1,204,000.00 Php

$$B/C = \frac{1{,}782{,}711.00}{1{,}204{,}000.00} = 1.48$$

The benefit to cost ratio is 1.48, meaning that the project is favorable to the company.

5. CONCLUSION

With the application of lean tools, problems were able to identify and corrected to attain the target performance of 95%. Throughout the process, it was highlighted the weakness of the organization in technical skills. Although the equipment availability (A), quality of the product (Q), and performance rate (P) are directly attributed to the performance of the equipment or the so-called six (6) big losses, people factor most often neglected in the unattained equipment also play a bigger role in these performances. People management is one of the key factors in the success of the organization.
The use of lean tools such as standardization and poka-yoke will enable the workforce to enhance their skills while preventing committing mistakes. Autonomous maintenance will enable the workforce to enhance their skills in the operations of the equipment and basic maintenance of the equipment. With the proper guidance of Lean/TPM champions, this will enable the company to maintain the OEE target.

Kaizen or continuous improvement is a suitable method to improve the organization performance of the subject organization. The subject company may benefit from the implementation of this method such as elimination or minimization of wastes, improved equipment availability, and performance. The difficulty of this method improved the leadership skills of the line managers and teamwork amongst employees including OEE.

6. RECOMMENDATION

Many adaptations, tests and experiments can be made through this paper for future research. For future work, a deeper analysis of the operations, systems, internal or organizational environment, and root cause analysis methods in solving complex problems are suggested to further enhance this study, the impact to the environment and impact to the operations of cement bag manufacturing companies.

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