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Productivity Improvement of Mini Rotary Shear Line Process Using Maynard Operation Sequence Technique (MOST) At ABC Company

Engr. Joel R. Cornejo

Batangas State University, JPLPC-Malvar
Malvar, Batangas, Philippines
Instructor, College of Engineering and Computing Sciences
Corresponding Author E-mail: cornejo.joel@yahoo.com

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Abstract: Productivity improvement through Downtime reduction is essential for a company to remain competitive in the market because it can lead to increasing of output by maximizing utilization of resources. Higher productivity means higher profit. To achieve this, the company and businesses must eliminate delays, idle time and downtime in the operation for the improvement of the current working process. In this research, the Mini Rotary Shear Line (MRS) Process, among the other processes in the production area, is the one that has the most downtime in the operation. Detailed workflow in the MRS Line was captured, and using M.O.S.T., the non-value added activities and the bottleneck of the problem was determined. Major contributor of non-value added activities are ineffective raw material storage, preparation of materials and downtime due to borrowing. These activities lead to downtime and low productivity and it occurs due to improper workload allocation and non-value added activities. Through the analysis of data by the use of M.O.S.T., researcher have proposed a stacker tool and new method to reduce the bottleneck and downtime in the process, and help to allocate workers effectively. Stacker tool is used to eliminate non-value added activities in the process and permit the operator to perform the preparation of next process in advance. Hence, operations in MRS Line Process have been improved; bottleneck operation total completion time was reduced. The downtime was reduced by 19.61% and lastly, the productivity increases by 9.18% in the section.
Keywords: Maynard Operation Sequence Technique, Downtime, Non-Value Added Activities, Productivity.

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Introduction

In today's increasingly competitive world, it is important to continuously improve the process of manufacturing or service industry. Due to strong competition in modern manufacturing and service, continuous improvement becomes more critical and one of the most widely tackled issues is how to maximize the overall efficiency and utilization of the resources in the production.

This research aimed to reduce the downtime of the mini rotary shear line process at the production of ABC Company. This line was observed and concluded that the productivity in the sections depends on machine utilization. The longer the time the machine is used in the process, the more the output they produce. To increase the overall productivity on this type of process, the proponent focused on reducing cycle time of manual activities that causes downtime in the process. Downtime reduction is one of the core strategies towards manufacturing excellence and it is also necessary to maximize efficiency of the resources.

Through observations and interviews with the associates on the production, it was found out that Mini Rotary Shear Line has highest occurrence of bottleneck and non-value added activities are coming from the manual activities in this area that leads to downtime. One of the most convenient way exposed non-value added activities and activities that need for improvement is with the use of Maynard Operation Sequence technique. One of the major problems identified by MOST is bottlenecks on alignment sections that lead to downtime in the operation. The process also includes non-value added activities and unequal distribution of manpower that causes of failure on meeting monthly target.

Reduction of downtime has a positive and significant relationship to performance measurement for process utilization, process, product costs, and work-in-process inventory levels and on-time delivery. Also, improving process in a company will develop very productive workers whom might be able to meet unexpected demand by having current employees work overtime, instead of scrambling to hire temporary workers, contractors or adding more full-time employees. Another objective of this study is to standardize the manufacturing process of Mini Rotary Shear line process wherein cycle time of the manual activities will be reduced and non-value added activities will be eliminated or simplified to reduce human effort by proper design of tools and process. The result of this study will serve as their basis for further improvement of the company.

Problem Statement

This study focuses on reducing the downtime that occurs at the operation of Mini Rotary Shear Line Process at ABC Company. The main cause of downtime was identified through Maynard Operation Sequence Technique and also with the help of different quality tools. The proponent aimed to reduce identified downtime to improve productivity

Specifically, this study sought to answer the following question:

1. What is the current status of Mini Rotary Shear Line process in terms of:
1.1 Process;
1.2 Productivity;
1.3 Downtime?
2. What is the possible problem of Mini Rotary Shear Line process?
3. What technique can be used to improve productivity and process?
4. What material is needed to improve the production of mini rotary shear line process?
5. What is the assessment of current and proposed solution?

Related Literature

According to the research study of Jain *et al.,* (2016) entitled Optimization of Labor Productivity Using MOST Technique, it states that the most practical approach productivity improvement is to attack the work process itself by review and redesign the operations and apply automation. IE techniques are used by the proponent for evaluating the existing manufacturing situation and identifying the potential for increased productivity. Using Basic Most, Time Study, and Basic Most Analysis, discovered that a lot of sub operation

contributes a lot of idle time in the process. Their research also attempts to show the application of the Basic MOST for time study of casting processes at bathroom appliances industry and shows the comparison with the time standard established using Stopwatch method. Statistical t-test is used to show the significance level between stopwatch method and MOST results. The result of the research shows that 2.72 % was decreased in the time takes place after successful implementation of MOST on casting process at assembly line of the product. Also the labor improvement also takes place from 4 workers to 1 worker, so this shows that the MOST is successfully implemented.

Karad *et al.,* (2015) conducted a research study entitled Productivity Improvement By Maynard Operation Sequence Technique. This study aims to reduce or eliminate the idle and downtime of operations in addition to improvement of the current working methods. This study is conducted through application of MOST in the rear floor assembly section to determine and analyse the process activities using descriptive workflow data block for the value adding, value engineering and methods engineering analysis. Thus through the process redesign and process flow analysis, material handling and workflow are improved. In conclusion, it is evident that to sustain in this competitive industry, a company needs to reduce or eliminate the idle and/or downtime, improve the working methods, standardize the time as well as enhance the overall capacity planning and in this respect the MOST can play a vital role. The result shows that by modifying the methods, it is possible to bring the competitive advantages in terms of satisfying the customer demand, well balancing the process flow as well as ensuring the economic benefits.

In the case study conducted by Mishra *et al.,* (2014) entitled Application of Maynard Operation Sequence Technique (M.O.S.T) at Tata Motors and Adithya Automotive Application Pvt Ltd. Lucknow for Enhancement of Productivity, this study stated that all the jobs are just combinations of 19 basic motions that are used to perform any task. This study also stated that to achieve productivity of the highest order, the consumption of all the resources via Men, Material, Machine, Money and Methodology have to be utilized at maximum efficiency.

The researcher broke each job down into its individual motions, analysed these to determine which were essential. With unnecessary motion eliminated, following a mechanical routine became far more productive. In their research, it was found that M.O.S.T Study at TATA MOTORS LTD, Lko was much accurate and efficient to measure work and it was being validated by shop owner. It results in total decrease of 32.2% in total process time. It is also found that Work content calculation by M.O.S.T Study has a clear difference from work content of Time Study.

In the case study conducted by Rahman M., (2018), entitled Implementation of Maynard Operation Sequence Technique (Most) To Improve Productivity and Workflow the researcher tried best to find a possible solution for existing problem in the selected garment sewing section by applying MOST technique. It states that, the Maynard operation sequence technique plays a vital role to identify and eliminate bottleneck workstation and to make a competitive industrial environment. MOST also helps to improve the productivity of a manufacturing company by reducing non-value added activities.

By implementing MOST, it is possible to proper utilization of total available time and to save money. It was found in this study that before implementation of MOST technique in selected garment industry to complete a basic T–shirt time consumed 139 seconds but, after

implementation of MOST bottleneck time reduced and 109 seconds is needed to complete the same T–shirt. After identifying bottleneck and improving the method of working motion time reduced 40 seconds. In measuring the production rate, the Takt time of the selected sewing line is estimated by dividing the total available time with the customer demand. The Takt (cycle time per work station) time and productivity as per demand are shown to be improved.

Materials and Methods

Design of the research refers to the overall strategy that the proponent used in collecting and analysing measures of the use of variables in the research problem and also served as blueprint of research project. It is also a way to systematically study and solve the research problems (Kothari, 2004). The researcher aimed of reducing downtime with the use of Maynard Operation Sequence Technique concept to improve productivity on the mini rotary shear line process. Based on the objective that the researcher had, it is concluded that the applied research design is the most suited design in conducting the study to achieve the best result.

Figure 1 shows the conceptual paradigm that includes input, process and output of the study. First, the input includes the current status of Mini Rotary Shear Line process in terms of productivity, process and downtime. This helped the researcher to know what problems the process is facing and the interventions to be applied. Second is the process where it includes the methodologies used by the researcher to uncover bottlenecks and areas that need for improvement. Through the use of flow process chart and fishbone diagram bottlenecks and issues in the line are identified and with the use of Maynard Operation Sequence Technique it was analysed and validated as a true root cause of downtime and non-value added activities which lead to low productivity.

The proposed stacker tool and modified process are also presented in the process section that is used as remedies to the problem the Mini Shear Line encountered. Lastly, as for the result of the study, it was presented in the output section that downtime rate was reduced and productivity improved through the use of stacker tool which also helps the company optimize the performance of their production line in mini rotary shear line process.

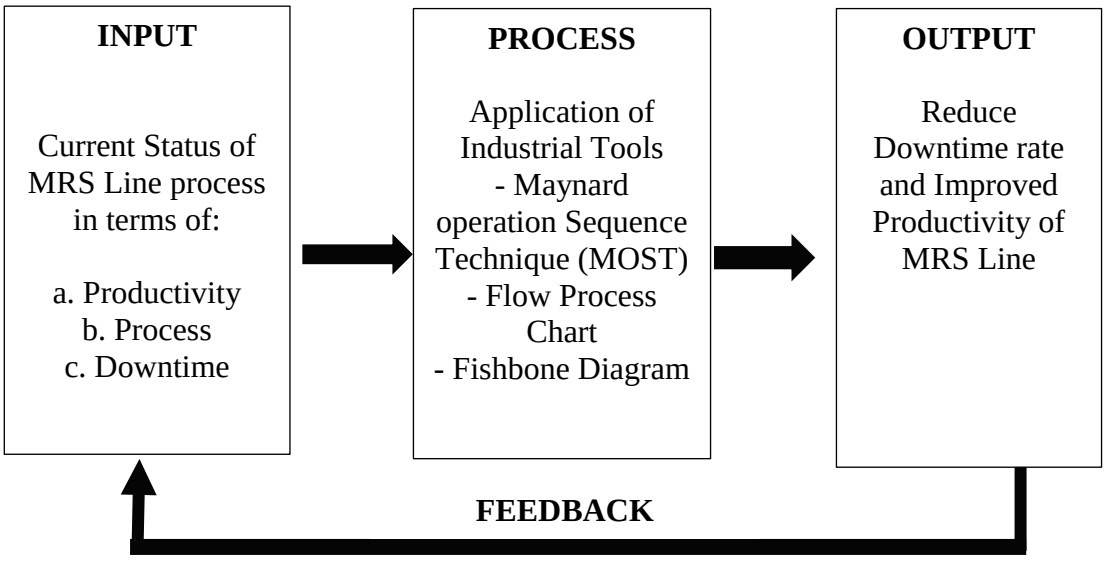

Figure 1. Conceptual Paradigm

Results and Discussion

1. Current Status

To obtain specified objectives for the study and to completely analyse all necessary data, the researcher used the most suitable technique to represent more factual basis for the study. The succeeding information presents the current status of Mini-Shear Line process in terms of process, productivity and downtime.

1.1 Process. In determining the currents status of the mini rotary shear line in terms of process, the researcher used flowchart. A process flowchart shows in pictorial form how a process is performed from start to finish, usually in sequential step order. This type of chart can be used for training, to document a current process or to examine the efficiency of a process. Using a flowchart to examine a process is helpful when you are seeking bottlenecks or duplication of effort (Frederick Van, 2014). In order to come up with the possible solution the researcher use flowchart to evaluate and analyse overall system.

Table 1.1 depicts that the current process flow at Mini Rotary Shear line process start with locating of coil and checking its properties in terms of size and initial inspection of secondary coil if its free from any damage or any issue regarding on secondary coil.

Table 1.1. Existing Current Flow of Mini Rotary Shear Line Process

Activity no.	ELEMENTAL DESCRIPTION	Operation	Transportation	Inspection	Delay	Storage
1	Locate coil and inspect	○	⇨	■	D	▽
2	Place hook on coil	●	⇨	□	D	▽
3	Place coil to coil-car	○	➡	□	D	▽
4	Insert to un-coiler	●	⇨	□	D	▽
5	Unroll coil tip to shear line	●	⇨	□	D	▽
6	Encode coil size and start machine	●	⇨	□	D	▽
7	Cut metal sheets (Scrap + 1 actual size)	●	⇨	□	D	▽
8	Measure metal sheets	○	⇨	■	D	▽
9	Scrapping the measured metal sheets	○	⇨	□	D	▼
10	Continue the machine in cutting	●	⇨	□	D	▽
11	Metal sheet to packaging area via conveyor	○	➡	□	D	▽
12	Stacking the metal sheets	○	⇨	□	D	▼
13	Package metal sheets	●	⇨	□	D	▽
14	Signaling the forklift operator	●	⇨	□	D	▽
15	Store to finished goods area	○	➡	□	D	▽

It can be explained that the process on Mini Rotary Shear line operations perform on single line in sequence and dependable to the type of coil to be used and number of items to produce. The smaller the number of items to be produced the higher the idle time, and the larger the number of products to produce the smaller the idle time or delay in the process.

Signaling the forklift operator is considered as delay because of waiting it results in non-value added activities and it will vary from the distance of where the forklift will come from. Another delay is the packaging area. This is due to the reason of different number of items to produce, different types of secondary coil to use and different sizes of product need different type of packaging method. Inspection is mainly performing at the first operation on process.

1.2 Productivity: The currents status of the process in terms of productivity shown in Table 1.2 was the data gathered by the proponent during the study and presented it in tabular form. For complete calculation with Work Productivity.

Table 1.2 shows the highest productivity in the four (4) months included for current status of Mini Rotary Shear Line is in the month of April 2017 with the productivity percentage of 85.45%%. The month with second highest productivity is the month of July 2017 with a productivity percentage of 79.53%. It was followed by the month of June wherein it has 78.34% of productivity. The lowest productivity in four months included for the study of current productivity is in May having productivity of 73.37%.

Table 1.2. Current Productivity Status of Mini Rotary Shear Line Process

Month	Output in kg(s)	Target output in kg (s)	Productivity	Percentage of output needed to meet monthly quota
April	1965431	2300000	85.45%	14.55%
May	1687500	2300000	73.37%	26.63%
June	1801852	2300000	78.34%	21.66%
July	1829248	2300000	79.53%	20.47%

1.3 Downtime: The current condition of Mini Rotary Shear Line process in terms of Downtime is obtained through the actual observation and downtime calculation worksheet with the use of stopwatch for the month of June and July 2017. Downtime calculation worksheet was used in summarizing the uptime, downtime and details of each issue. In the study of Raoul Wallenbergplein, (2018) this downtime worksheet was used to monitor status transitions and how does maintenance affect the uptime.

Table 1.3.1 reveals the current average downtime and uptime in the process of mini rotary shear line process from the two (2) months of observation of proponent. The month of June has higher downtime compared to July with 20.19% average percentage of total downtime. July has 19.31% of average total downtime and uptime average percentage rate of 80.69% of the time.

Table 1.3.1. June and July 2017 Downtime and Uptime

Month	Average Percentage Total Downtime	Average Percentage Total Uptime
June	20.19%	79.81
July	19.31%	80.69

Table 1.3.2 reveals the sources of downtime, waiting for forklift contributes the most of the downtime in the process with 20.59% this is due to the fact that they have only one transportation machine which is forklift. It was followed by locating of coil with (29.49%) due to the fact that raw materials are not organized. Arranging materials for packaging has 20.59% while other factors has 8.82%, this downtime are coming from uncontrollable factors like machine overheating and other internal issues.

Table 1.3.2. Sources of Downtime

Remarks of Downtime	Frequency
Arranging materials for Packaging	20.59%
Locating coil	29.49%
Waiting for forklift	41.18%
Other Factors	8.82%

2. The Problem

The cause and effect diagram below was created with the goal of identifying and grouping the causes which generate a problem. Although it was developed as quality control tool, this technique was used to uncover bottlenecks and identify why a certain process has delays. This made Fishbone diagram become a very useful instrument in risk identification stage. Also, the method is used to simulate the dynamic of the process analysed (Ciocoiu and Ilie, 2010).

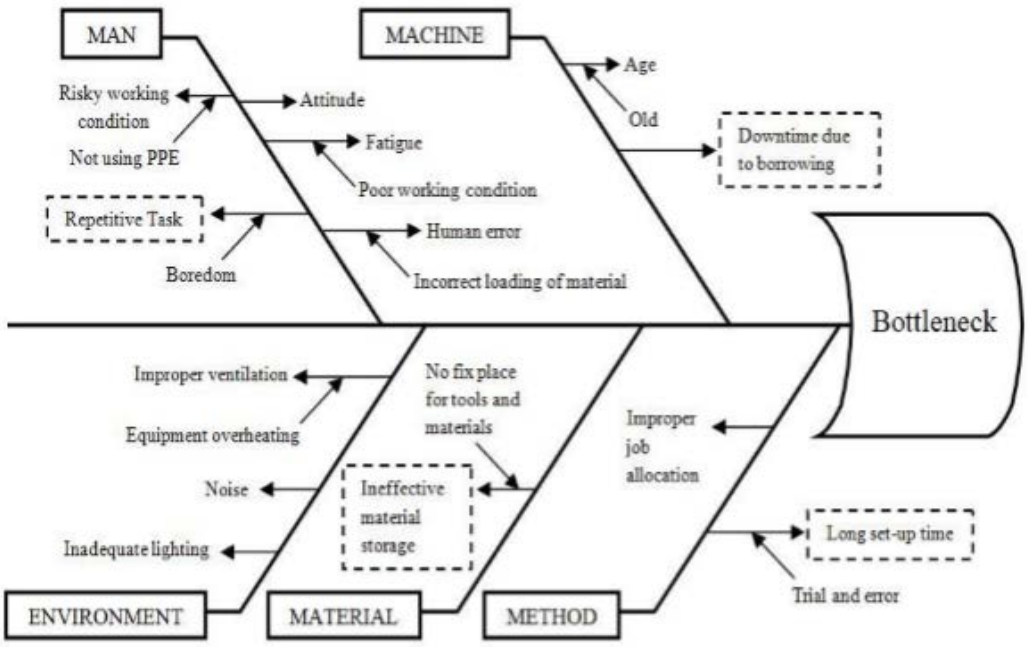

Figure 2. Fishbone Diagram

Figure 2 shows the fishbone diagram from mini rotary shear line process which shows the most probable causes of bottleneck.

Machine: Old machines need higher time of maintenance because of failure to operate and unexpected shutdown can happen.

Manpower: Short time processes have repetition that can cause boredom.

Operators are not following safety instructions like using the Personal Protective Equipment (PPE).

Environment: Section improper ventilation, noise and inadequate lighting could affect the productivity of workers and machine.
Method: The process of improper job allocation happened because operator does not have specific assign of workload.
Material: The bottlenecks in this division are caused by ineffective material Storage for the reason that placing secondary coil has no rule to follow; it is just placed in free space.

Table 2 shows if the identified problem causes are the true cause of having bottleneck. It was presented to show how the probable cause was validated and what techniques are used in proving that it is true cause of bottleneck. Downtime due to borrowing causes non-value added activities and waiting, and was validated through the concept of M.O.S.T. Another factor that cause the bottleneck is the long set-up time. Different metal sheet types have different set-up time resulting in trial and error of the worker. It was also validated through the concept of M.O.S.T. Ineffective material storage was proven through the concept of M.O.S.T. This is due to the reason of ineffective way of organizing secondary coil.

Table 2. Validation of Root Cause Analysis

Probable Cause	Root Cause	Validation Method	Findings	Conclusion
Downtime due to borrowing	Lack of equipment	M.O.S.T	Causing non-value added activities	True cause
Long set-up time	Different metal sheet types have different set-up time	M.O.S.T	Workers are doing trial and error and causes bottleneck	True cause
Ineffective material storage	Material storage is not organized	M.O.S.T	Ineffective way of organizing causing downtime	True cause

3. The Improved Process

Downtime due to bottleneck in the process is the emerging issue on the Mini Rotary Shear line. The downtime occurs at the rate of 19.75 percent of the time based from the observation and analysis of the proponent. In finding the best remedy to the main issue on the process, Maynard Operation Sequence Technique was used to identify the section which has highest occurrence of bottleneck and uncover the area that needs improvement. Identifying bottlenecks is critical for improving efficiency in the production because it allows one to determine the area where accumulation occurs. According to Wang *et al.*, (2005), bottleneck can be found in the longest average waiting time in the process. Maynard Operation Sequence Technique has system family with different usage depending on the frequency on performing the activity and length of total operation.

In determining the effectiveness of the proposed method and tool, the proponent collected data while implementing the said proposal. And to better visualize the effect on production, it was compared to the current practices, the results were follows:

3.1. Productivity: Figure 3.1 shows the proposed method and tool was implemented at the month of August and September 2017 and it was observed by the proponent and evaluated with work productivity calculator. It clearly shows that the productivity on the month of

August was improved by 9.65% also the month of September with increased of 9.18% compared to the month of July which indicates that the proposed method improved the productivity of the process.

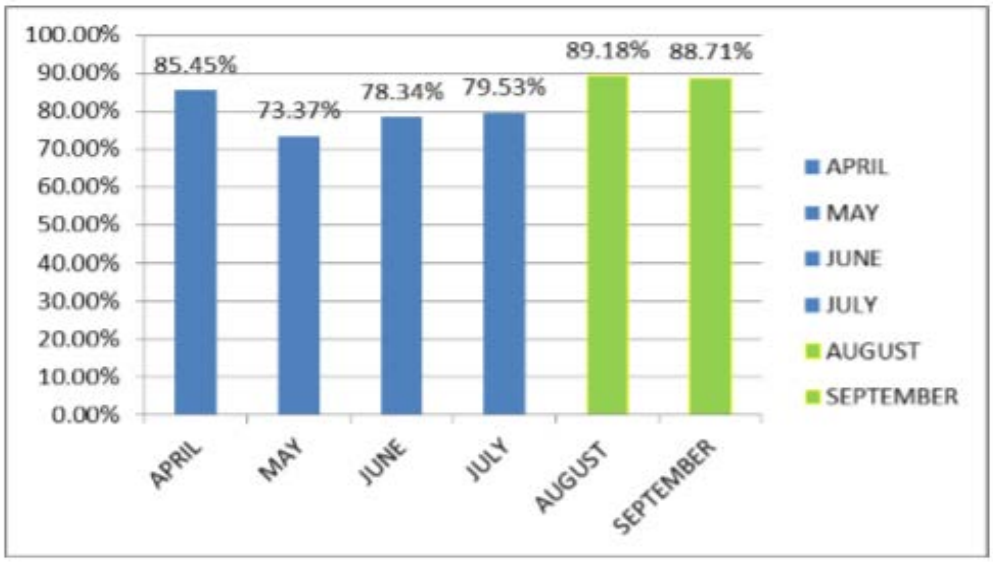

Figure 3.1. Productivity of Mini Rotary Shear Line Operation

3.2. Downtime: Figure 3.2 depicts the average downtime for the month of June, July, August and September 2017. The implemented tool and method was observed at the month of August which has the average downtime of 6.435 minutes and the month of September with 5.9175 minutes both per 225 minutes of operation.

It clearly shows that the production in workstations was improved and downtime was reduced after the execution of new method and tools with almost 37.274 minutes and it also shows the effectiveness of the proposal.

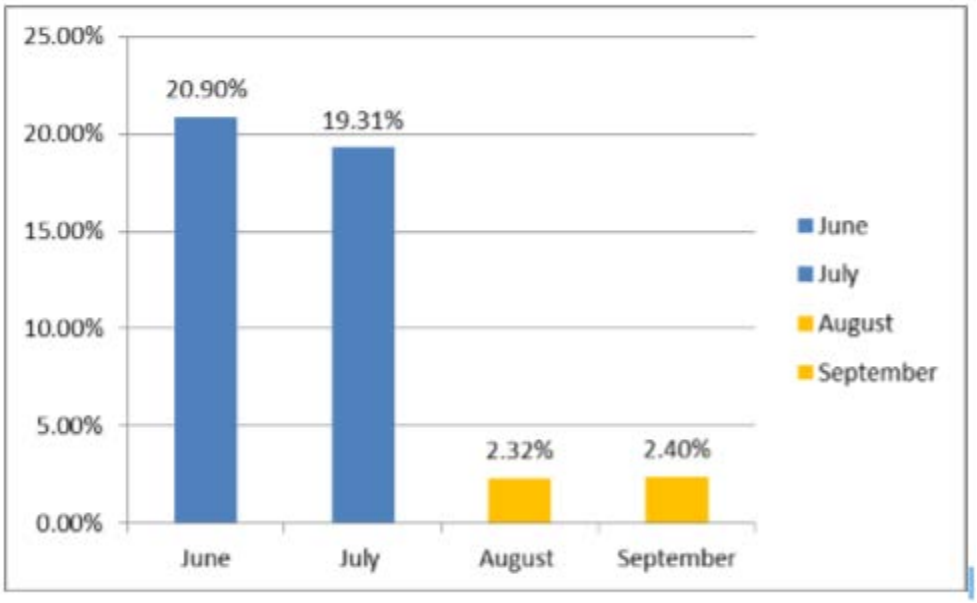

Figure 3.2. Average Downtime from June-September

4. Material Used for Improvement

After the bottleneck and non-value added activities are identified, the researcher came up of using Stacker and Aligner Tool in the packaging of Mini Rotary Shear Line process. This tool can align the metal sheets with only one operator needed compared to the present that needs two operators. The stacker tool will help to improve utilization of manpower.

Installation of Stacker Tool

This tool aims to make stacker of metal sheets safety, easily and to eliminate NonValue Added Activities on the process of aligning the metal sheets. Unnecessary motions like repetition is a kind of waste and can cause fatigue to the worker must be eliminated in order to improve productivity. One of the most important use of this tool is it can also help other sub-activities on process to eliminate downtime in the process.

Figure 4 shows the diagram of complete positioning of stacker with the pallet inside. The mini rotary shear line process has sensor to detect if the metal sheet while transporting thru conveyor are in the middle, this function was taken advantage by the researcher in making the design. It was purposely in a little clearance of exact because from the interviews of researcher, those misaligned metal sheets have discrepancy due to machine error on cutting. Therefore, this can also help in quality inspection and improvement.

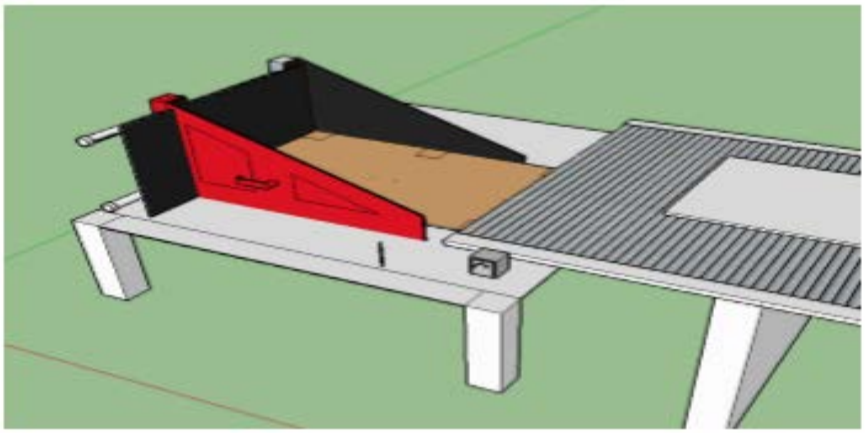

Figure 4. Schematic Diagram of Complete Positioning of Stacker

5. Assessment of Before and After

The researcher also aimed to minimize or eliminate the bottlenecks encountered at the process of the line; the following are the proposed Countermeasures to the Bottlenecks in Mini Rotary Shear Line process.

5.1. Downtime due to borrowing: The root cause of this bottleneck is lack of equipment, it can be solved through the use of proposed tool in alignment of metal sheets, the workload of assigned operator and cycle time required was reduced, this help aids the problem by while the stacker tool replaces the operators job, preparation and promptness of forklift can be ensure before the alignment was done and packaging was done.

5.2. Long Set-up Time: The root cause of this problem is that different types of secondary coil have different operation of set-up time to reduce the bottleneck of set up time for different type of secondary coil, the researcher applied sorting of the raw materials. Another is through the modifying of method where the capacity of un-coiler was determined so that in can place one-three secondary coil depends on its weight and width. This reduces the

operations of involving locating coil, transportation to coil car and coil-car to un-coiler to the secondary coil to be processed in the mini rotary shear line section.

5.3. Ineffective Material Storage: The probable cause of this problem is that material storage are not organized and standardized. This problem can be solve through sorting of secondary coil from width and date of delivery of orders. From this proposed method, the operator can solve the bottleneck cause by ineffective material storage. Finding of the secondary coil which cause delays are minimized. Also inspection, transportation and material handling are made easily for the associates to perform their workload.

Conclusions

After conducting the study, the researcher have drawn the following conclusions:

1. The utilization of resources in the MRS Line process are not maximized and not reaching the monthly target. This is due to the fact that there are processes that needs improvement to increase the productivity and reduced the downtime in the section.
2. It was found out that the major cause of Bottlenecks encountered at the MRS Line process are long set-up time, ineffective material storage, and downtime due to borrowing.
3. Upon using accurate work measurement technique which is Maynard Operation Sequence Technique, problems and areas need to improve are identified. The implementation of stacker tool to solve the problem identified by MOST can have a huge significant effect on the production line in terms of productivity, process and downtime rate.
4. The benefit of using the stacker tool is that was design to avoid scratches on metal sheets. This tool eliminates the unnecessary motion which is waiting in the workstation of alignment of metal sheets and leads to have one operator to perform other sub activities. It also helps for equally distribution of workload as well as reduction of downtime in the process.
5. The assessment shows that by adding some working tools and modifying the methods, it is possible to bring the competitive advantages in terms of maximizing utilization of resources, well balancing the process flow as well as increasing of output by cycle time reduction. Thus, the incorporation of the MOST to estimate the standard times for various elemental tasks involved in different manual operations, inclusion of simple tools to perform a task in shorter time with minimum effort from operators and manoeuvring the distribution of activities in different workstations to balance workload can substantially improve the productivity of an industry from the current level. In future, a research study with the application of the MOST can be explored from a wider perspective through implementation in a single or mixed model assembly lines having large number of work stations.

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