Productivity Improvement in Manufacturing Industry Using Industrial Engineering Tools

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ABSTRACT: *In today's increasingly competitive world, it is important to constantly improve, be it a manufacturing or service industry. Quality with quantity is a main characteristic which helps a company stay in the competition. Technology has taken leaps of development lately and this has brought about an increase in the customer demands. The main aim is to study the current capacity, analyze it to find areas of improvement and make an improvement proposal to meet the forecasted increase in demand. This thesis presents the current performance of outputs and capacity of the plant calculated using continuous data collected in shop floor. In each workstation the processing time is different and the longest time consumption workstation will be identified as a bottleneck workstation. The identified bottleneck station will be analyzed to reduce the processing time which increases production rate.*

Keywords: Productivity, Cause and effect analysis, MTBF, MTTR, Capacity Management

I.   INTRODUCTION

The term productivity can be used to examine efficiency and effectiveness of any activity conducted in an economy, business, government or by individuals. For example, learning or studying methods used by students that include reading and/or writing the content of a topic and revising the topic by saying out aloud or rewriting. Efficiency, effectiveness and productivity can also be evaluated for businesses in service sector. Productivity however, is broadly evaluated mostly through service volume, delivery processes and customer-perceived quality in services offered. In the context of the real world, productivity is mostly examined and evaluated with reference to businesses or an economy. Accordingly, it is essential to study productivity in order to:-

- Understand the processes of a business
- Control the business processes
- Continuously improve processes
- Assess performance of a business
- Determine a business ability to sustain in the long run

Productivity is also confused with terms like efficiency and effectiveness and these terms are wrongly considered synonymous to productivity. Efficiency and effectiveness are two different terms such that efficiency indicates how well the resources are utilized to accomplish a result. Alternatively, effectiveness refers to the degree of accomplishing the objectives.

Productivity becomes the dominant issues in the market place where customers make their buying decisions based on product quality, sometimes they can pay more for what they consider as high quality product.

1.1 Productivity Improvement

Productivity improvement is one of the core strategies towards manufacturing excellence and it also is necessary to achieve good financial and operational performance. It enhances customer satisfaction and reduce time and cost to develop, produce and deliver products and service. Productivity has a positive and significant relationship to performance measurement for process utilization, process output, product costs, and work-in-process inventory levels and on-time delivery. Improvement can be in the form of elimination, correction (repair) of ineffective processing, simplifying the process, optimizing the system, reducing variation, maximizing throughput, reducing cost, improving quality or responsiveness and reducing set-up time.

1.2 Capacity Management

Capacity management is responsible for all aspects of operations' capacity. It is generally responsible for matching the long-term capacity of a process to the demand for its products. It does this through capacity planning, which describes more specific methods for achieving this match.

1.3 Mean Time Between Failure

MTBF is the sum of the operational periods divided by the number of observed failures. If the "Down time" refers to the start of "downtime" and "up time" refers to the start of "uptime".

1.4 Mean Time To Repair

MTTR is a basic measure of the maintainability of repairable items. It represents the average time required to repair a failed component or device. Expressed mathematically, it is the total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time.

1.5 Cause and Effect Analysis

Common use of Ishikawa diagram is product design and quality defect prevention, to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation.

II. PROCESS DESCRIPTION

The brake shoe manufacturing process at brakes & automotive industries is a 14 step process. The web & rim are manufactured from sheet metal and the raw material is shipped to the plant. These raw material is washed to remove any impurities. The web and rim are passed on to the welding station where both the washed raw material are spot welded. Post welding, the welded shoe is allowed to cool down and then moved to the date coding station, where the date coding process takes place.
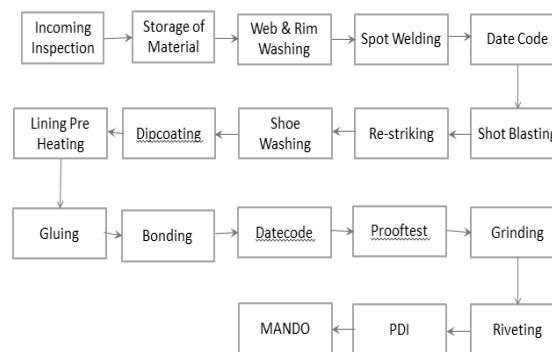

Fig 1 Manufacturing Process

The date coded welded shoe is then shot blasted again to increase the strength of the part. After shot blasting, the part is taken to the re-striking zone, were the welded shoe is re-striked and then it is washed again. Parallel process of lining pre heating keeps going on the pre heating area. While the welded shoe is dip coated and moved to the gluing station where the lining is glued and kept ready for the bonding to take place.

The welded is shoe is bonded with the lining and this part is again taken to a date coding machine. The finished shoe date coded again before being put to a shear test. Once the shoe passes the test, it is then passed on to the grinding station where the grinding process takes place. The grinded brake shoe is paired with another brake shoe with the help of the riveting process which takes place in the riveting station. These finished products are then accumulated and stored. Based on the daily demand, the products are shipped to Mando india.

III. PROBLEM DEFINITION

Now a days, many company want to improve their output and productivity to achieve their yearly target by eliminating some causes and production time that affect profit for company. In flow line production the product moves to one workstation due to time restriction. Once it's get stuck due to accumulation in certain

workstation, it exceeds the cycle time in that station. Faster station is limited by slowest station. Thus, decreasing the rate of productivity. As the demand are not met by the company, productivity improvements techniques are used to identify the bottleneck process in production line and eliminate them to achieve the goal of the company.

IV.   DATA COLLECTION

The purpose of data collection is to provide a basis for analysis, in other words, to turn data into information that is used by, and useful to, decision-makers. However, before data can be collected, a data collection plan needs to be developed. The data is collected to identify the bottleneck station in manufacturing plant and to analyze and eliminate them. The collected data is of direct observation in shop floor using stop watch by continuous assessment of each machine. Data collected is shown in (table 1) below.

V.   METHODOLOGY

A productivity improvement technique is the methodology chosen to carry out to increase the production of brake shoe manufacturing.A framework of the work to be carried is given as follows
- ✓ From the direct continuous observation data collected the capacity has been calculated.
- ✓ Identification of bottleneck process.
- ✓ Analyzing bottleneck process.
- ✓ Reducing cycle time.
- ✓ Reducing takt time.
- ✓ Calculating overall machine efficiency.
- ✓ Reducing tool change over time.

Table 1 Data collection

Process	Activities		1	2	3	4	5	6	7	8	9	10	Total time(secs)	No.Of Components	AvgCycle time	Capacity
													BRAKES PLANT - CYCLE TIME ANALYSIS			
Washing	Loading		179.4	160.0	166.0	165.0	161.0						831.4	357	7	4114
	Washing		260.0	260.0	257.0	255.0	258.0						1290.0			
	Unloading		94.5	69.0	60.0	63.0	65.0						351.5			
	Total Time		533.9	489.0	483.0	483.0	484.0						2472.9			
Welding	Total Time		12.1	10.8	10.4	10.1	10.6	10.2	10.1	13.3	10.4	10.5	108.6	10	11	2618
	Time b/w Changing the job		1.0	1.3	1.3	1.3	6.0	1.3	1.3	1.3	1.4	1.4	17.5			
	Time b/w welding		1.3	1.5	1.4	1.5	1.2	1.3	1.5	1.5	1.4	1.3	13.9			
Welding date Code	Between Each shoe		2.2	3.8	3.0	3.6	2.5	3.7	2.5	11.3	2.1	5.3	39.9	10	4	7200
	Coding time		1.1	1.0	0.9	1.1	0.8	0.9	0.9	0.9	1.0	1.0	9.5			
Shot Blasting	Loading		23.0	26.0	18.0	20.0	20.4						107.4	428	8	3600
	Shot Blasting		732.0	600.0	596.0	629.0	540.0						3097.0			
	Unloading		47.0	44.0	47.7	29.0	49.0						216.7			
	Total Time		802.0	670.0	661.7	678.0	609.4						3421.1			
Restriking	Between Each shoe		5.0	3.0	3.0	3.0	2.0	2.5	2.5	7.0	3.0	2.0	33.0	10	3	9600
	Striking Time		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	9.9			
Dip Coating	Loading in Jigs		200.0	197.0	190.0	187.0	193.0						967.0	280	5	5760
	Loading for Dipping		15.0	13.0	12.5	13.6	13.2						67.3			
	Dipping		6.0	5.9	6.0	6.0	6.2						30.1			
	Drying		52.0	50.0	48.5	46.0	55.0						251.5			
	Unloading		40.0	28.0	25.0	30.0	28.0						151.0			
	Total Time		313.0	293.9	282.0	282.6	295.4						1466.9			
Glue	FL-47	For set of 12 items	25.0	21.0	24.3	24.8	23.9	24.3	46.9	25.1	21.7	26.5	263.5	120	2	14400
		B/w each Product	2.9	1.9	2.1	2.0	4.0	1.8	1.9	2.0	2.3	2.0	22.8			
	FL 48	For set of 12 items	44.0	39.3	36.4	43.6	45.5	34.5	35.9	40.0	42.0	39.0	400.2	120	3	9600
		B/w each Product	3.9	2.7	2.7	2.9	2.6	3.0	6.3	3.4	9.7	2.7	39.9			
Clamping	Operator 1		23.1	17.3	41.7	23.7	27.1	29.6	20.6	23.5	31.5	26.5	264.6	10	26	1107
	Operator 2		21.4	17.2	33.6	28.1	24.7	27.8	18.2	23.9	26.2	28.5	249.5		25	1152
Date Code	Inspection		225(33)	206(35)	165(27)	180(30)	170(29)						946.0	154	6	4800
	Coding time		170.5	160.0	140.0	120.0	126.0						716.5			
Grinding(Set of two)	Machine 1	Total time	10.5	11.2	17.0	13.8	11.8	11.7	10.0	12.1	11.2	9.7	119.0	20	6	4800
		Grinding time	8.9	6.8	6.1	6.7	6.9	7.1	6.9	7.0	7.1	7.0	70.5			
	Machine 2	Total time	17.0	16.9	14.8	17.2	15.6	17.2	16.1	17.4	18.0	14.6	164.9		9	3200
		Grinding time	9.0	8.9	8.7	9.0	9.1	9.0	9.0	8.9	8.8	8.9	89.2			
Proof Test	Testing		10.6	15.0	16.8	12.7	18.5	17.0	15.8	11.8	12.6	16.1	146.9	10	15	1920
Riveting	Operator 1		20.9	25.3	17.7	19.6	17.6	27.3	17.4	17.1	17.9	26.1	206.8	10	21	1371
	Operator 2		23.0	14.5	30.5	19.8	20.1	14.7	34.1	24.9	19.2	20.5	221.2		22	1309
PreDespatch Inspection			7.92	9.2	7.6	8.5	8.4	8.4	10.3	7.1	8.6	7.5	83.5	10	8	3600

5.1 Data Analysis

From the data collected it was found that there was few bottleneck stations. Data analysis was made in-order to eliminate bottleneck station and to improve takt time. Data analysis is shown in table 2.

Activity	AvgCycle time	Capacity(100%)	Capacity(80%)
Washing	7	4114	3291
Welding	11	2618	2095
Welding Date code	4	7200	5760
Shot Blasting	8	3600	2880
Restriking	3	9600	7680
Dip Coating	5	5760	4608
FL-47A	2	14400	11520
FL-48	3	9600	7680
Clamping1	26	1108	886
Clamping2	25	1152	922
Date Code	6	4800	3840
Grinding1	6	4800	3840
Grinding2	9	3200	2560
Proof Test	15	1920	1536
Riveting1	21	1371	1097
Riveting2	22	1309	1047
Predespatch Inspecti	8	3600	2880

Table 2 Data Analysis

VI. QUALITY ANALYSIS

From the data of rejection rate some quality losses are identified

| Quality loss	Work station	Quality loss	Work Station
Glimb cut	PressShop, restriking	Operations missing	Riveting
Miss welding	Welding	Opposite side	Riveting
over melting/under melt	Welding	End cutting	Riveting
Line mark, plating	Riverting	Lining radius mismatch	Grinding
Welding impression	Welding	Lining shift	Bonding
Welding gap	Welding	Lining crack	Bonding
Web bend	Press shop	Lining damage	Gluing
Symmetric move	Welding	Less & overglue	Gluing
Web shift	Welding	Gimb burr	PDI
rust	Dip coating		

Table 3 Quality losses
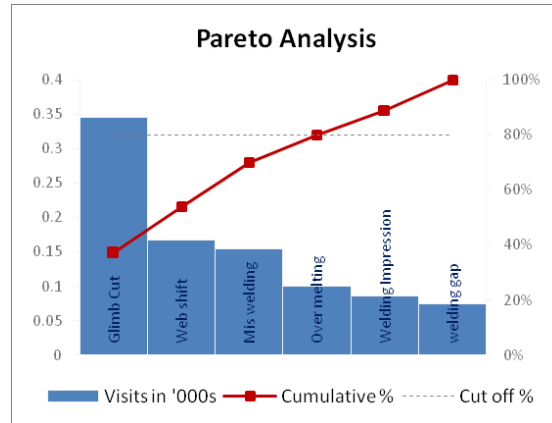
Fig 2 Pareto Anaysis

Based on pareto analysis few major losses was identified. Cause and effect diagram was drawn in order to minimize or eliminate losses which effect the production rate.

6.2 Cause and effect Diagram

List of major losses are listed below
Lining shift
Symmetrical move
Web shift
Over/under melting
Glimb cut

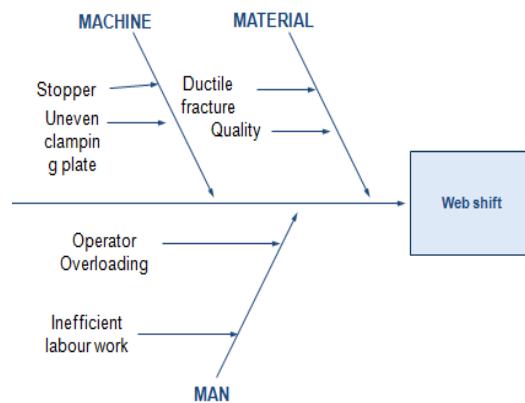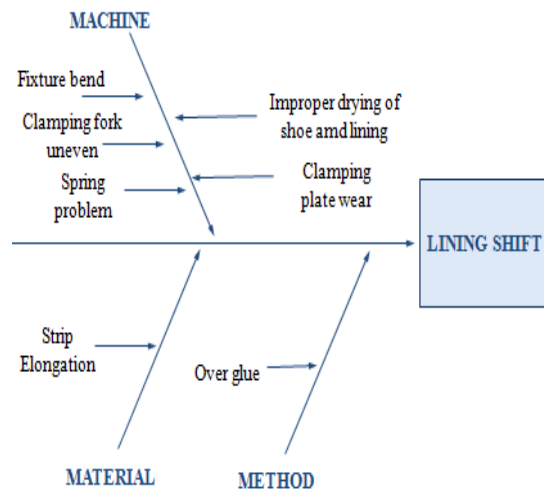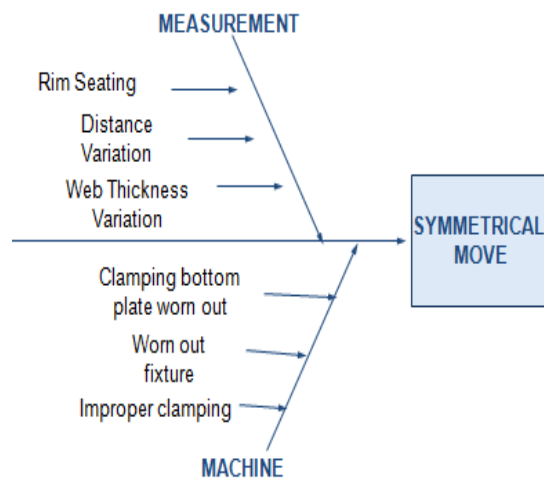**Fig 3 Web Shift**

Fig 4 Lining Shift
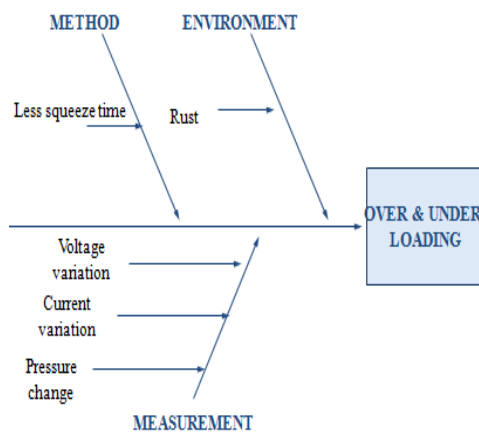

Fig 5. Symmetrical Move
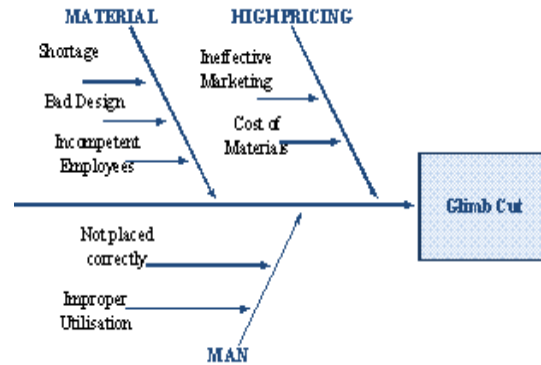
Fig 6. Over & Under melting

Fig 7. Glimb Cut

6.3 Counter Measures

- Proper Utilisation of raw material
- Tightning the bolt
- Pressure variation shuld be limited,avoid rust
- avoid forming rust such as avoid contact to environment
- Precheck for rust & avoid rust formation
- Bolt tightning, Match with the Stopper
- Concentration Improvement
- poka yoke,Train the Operator for proper Operation
- poka yoke
- Avoid waiting time & Inventory
- Avoid Interruptions,maintenance
- Avoid Interruptions
- Raw material Inspection, Proper setting
- check for meeting the specifications
- Improve Operator effectiveness
- Raw material Inspection
- Raw material Inspection
- Improve Operator effectiveness
- Grind the tool

VII.   CONCLUSION

From the collected data it has been identified that the production time is less than the takt time for the case study organization hence in order to meet the demand it is important to implement the suitable industrial engineering tools. By implementing, it can reduce the cycle time and work-in-progress. Reduction of waste can also improve productivity. Improving quality at the source will not affect any station, but reduces scrap and rework. Manufacturing defect less product will help to meet the demand. After collection of data the bottleneck

station was identified. Cause and effect diagram was used to identify the causes which reduces the production rate and the remedial measures has been noted to reduce the causes.

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