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Research Article

Process Improvement in a Small Scale Fabrication Industry

Dr. Varsha Karandikar and Hritikesh Nilawar

Vishwakarma Institute of Technology, Savitribai Phule Pune University, Pune

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Abstract

This paper is based on the Industrial Engineering tools & techniques solving the challenges faced by an industry in the given duration. The industry in this case is the manufacturer of children play equipments for park and public places. The paper is focused on the improvements in manufacturing to gain improved productivity. Process optimization is also one of the major attributes leading the produce to profitability. Data collection and implementation is based on the observations from shop floor, making the solution much accurate. The implementation of tools & techniques rewarded the unit in positive way and a drastic improvement was achieved.

Keywords: *Maintenance scheduling, resource optimization, 5s, productivity, kaizen.*

1. Introduction

Production optimization comprises a range of activities related to measuring, analyzing, modeling, prioritizing, and implementing actions to enhance productivity. Product optimization addresses these manufacturing problems:

- Slow production lines
- Long pending work in progress
- Separate workstations overwhelmed with work in progress
- Unnecessary space being utilized for storage
- Multiple errors that require reworking
- Bottlenecks at workstations
- Extended times for delivery
- Inconsistency in productivity
- Convoluted production process and management

With production optimization, a company is in a better position to understand and manage its production processes and bottlenecks. Manufacturers optimize the system for productivity and delivery times. As a result, sales increase, and the company can think about expansion plans for the future.

Production optimization also monitors a range of performance through indicators, while encouraging employees to be responsible for eliminating wasteful practices. Some other benefits are reduced production times, improved productive capacity, and better quality--all at lower production costs.

*Corresponding author's ORCID ID: 0000-0002-7847-6928
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2. Materials and methods

A. Maintenance Scheduling

It is planned work that includes the who, what, when, and where of tasks. Scheduled maintenance helps you schedule the maximum amount of hours available, based on your resources. They are normally organized by priority, with the work orders of the highest priority at the forefront. You can use scheduled maintenance to minimize the number of outside resources and maximize internal labor, which cuts costs and dramatically speeds up all tasks. Scheduled maintenance allows you to implement preventive maintenance jobs when necessary to further minimize potential downtime and increase efficiency.

B. Resource Optimization

Resource optimization is the process of allocating and managing resources in the most efficient way possible. In many organizations, including IT companies and digital agencies, resources can be both human (employees) and electronic (software, computers). In this article, we'll focus on human resource optimization. The purpose of resource optimization is to maximize productivity by reducing the costs of labor and other expenses. Resource optimization techniques can also help you improve performance and meet customer requirements better.

C. 5s Tools

5S is a system for organizing spaces so work can be performed efficiently, effectively, and safely. This

system focuses on putting everything where it belongs and keeping the workplace clean, which makes it easier for people to do their jobs without wasting time or risking injury. 5S began as part of the Toyota Production System (TPS), the manufacturing method begun by leaders at the Toyota Motor Company in the early and mid-20th century. This system, often referred to as Lean manufacturing in the West, aims to increase the value of products or services for customers. This is often accomplished by finding and eliminating waste from production processes.

Lean Production

Lean manufacturing is a production method aimed primarily at reducing times within the production system as well as response times from suppliers and to customers. It is closely related to another concept called Just-in-time manufacturing. JIT manufacturing tries to match production to demand by only supplying goods which have been ordered and focuses on efficiency, productivity (with a commitment to continuous improvement) and reduction of "wastes" for the producer and supplier of goods. Lean manufacturing adopts the just-in-time approach and additionally focuses on reducing cycle, flow and throughput times by further eliminating activities which do not add any value for the customer. Lean manufacturing also involves people who work outside of the manufacturing process, such as in marketing and customer service.

2.1 Preventive Maintenance

Preventive maintenance (or preventative maintenance) is maintenance that is regularly and routinely performed on physical assets to reduce the chances of equipment failure and unplanned machine downtime that can be very costly for maintenance teams and facility managers. Effective preventive maintenance is planned and scheduled based on real-time data insights, often using software like a CMMS. A preventive maintenance task is performed while the equipment is still working to prevent unexpected breakdowns. A preventive maintenance strategy is a commonly used approach that falls between reactive maintenance (or run-to-failure) and predictive maintenance.

2.2 Shadow Board

A shadow board is a type of tool board for organizing a set of tools; the board defines where particular tools should be placed when they are not in use. Shadow boards have the outlines of a work station's tools marked on them, allowing operators to identify quickly which tools are in use or missing. The boards are commonly located near the work station where the tools are used. Shadow boards are often used in the manufacturing environment to improve a facility's lean six sigma capabilities. Shadow boards reduce time spent looking for tools and also reduce losses. They improve work station safety because tools are replaced safely after use, rather than becoming potential hazards.

2.3 Kaizen

Kaizen is an approach to creating continuous improvement based on the idea that small, ongoing positive changes can reap significant improvements. Typically, it is based on cooperation and commitment and stands in contrast to approaches that use radical or top-down changes to achieve transformation. Kaizen is core to lean manufacturing and the Toyota Way. It was developed in the manufacturing sector to lower defects, eliminate waste, boost productivity, encourage worker purpose and accountability and promote innovation.

3. Results and Discussion

3.1 Solution

3.1.1 Preventive Maintenance Schedule

Table-1: Maintenance Schedule

MAINTENANCE SCHEDULE

DAY/TIME	09-10AM	10-11AM	11AM-12PM	12-1PM	1-1:30PM	1:30-2:30PM	2:30-3:30PM	3:30-4:30PM	4:30-5:30PM
MONDAY	11		12	7,8	Lunch	13	1	2	3
TUESDAY	14	20	15	7,8		16	4	5	6
WEDNESDAY	17	7,8	18				19	7,8	
THURSDAY	11		12	9,10		13	1	2	3
FRIDAY	14	20	15	9,10		16	4	5	6
SATURDAY	17	9,10	18				19	9,10	
SUNDAY	Holiday								

1	COMPRESSOR	11	DRILL MACHINE (1)
2	DRYER	12	DRILL MACHINE (2)
3	GRID BLASTING	13	PIPE BENDING-1 (3)
4	POWDER COATING GUN	14	PIPE BENDING-2 (4)
5	POWDER COATING CABIN	15	PIPE BENDING-3 (5)
6	POWDER COATING COMPRESSOR	16	PIPE BENDING-4 (6)
7	CHOP SAW	17	SHEET METAL BENDING (7)
8	ANGLE GRINDER	18	SHEET METAL CUTTING (8)
9	MIG WELDING	19	PUNCHING MACHINE (9)
10	ARC WELDING	20	Laser Cutting (10)

3.1.2 New Equipment Requirements

Table-2: New Requirements

Sr. No.	New Machine Requirements	Quantity Required	Remark
1	Angle Grinders	15	Every worker will have personal grinder
2	Hand Drill Machine	3	Reduce the workload of industrial drill machines
3	Powder Coating Gun with electronic panel	1	Output will increase by 2 times
4	Chop Saw Machine	2	Enhancement in production
5	Arc Welding	3	Enhancement in production
6	CNC Lathe	1	New products can be introduced
7	Manual Lathe	1	New products can be introduced

3.1.3 Shadow Board and Toolkits

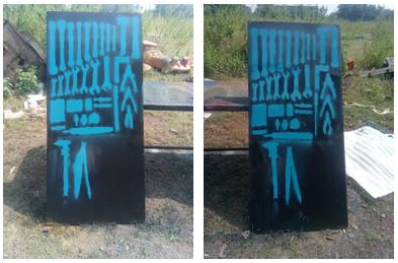

Figure-1: Shadow Board

Table-3: Toolkit

Tool Kit Requirement			
Sr. no.	**Fitters**	**Welders**	**Helpers/Packers**
1	Ruler	Helmet	Cutters
2	Try Square	Welding Gloves	Industrial Scales
3	Out Caliper	Welding Pliers	Dispensers
4	In Caliper	Welding Magnet	Tapes
5	Divider	Chipping hammer	Adhesives
6	Straight Scriber	Speed Square	Strapping Equipement
7	Center Punch	Metal brush	Staple guns
8	Screw Drivers	Angle Grinder	Stretch Wrap
9	Flat Chisel	Sheet Metal Gauge	
10	Hammer	Soapstone	
11	Hacksaw	Metal file	
12	Safety Goggles	C-Clamp	
13	Anvil	Welding boots	
14	Switch Block	Welding sleeves	
15	V-Block	Safety Glasses	
16	Spirit Level	Nozzle Gel	
17	Allen key set		
Approx. cost*	3235	8280	1500

3.1.4 Fixture Design

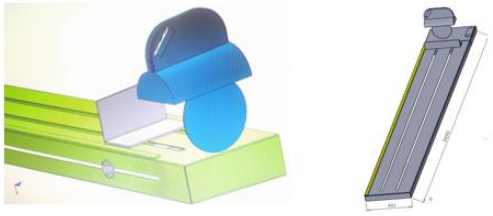

Figure-2: Fixture for Chop Saw

3.2 Result

3.2.1 Improvement in Breakdown

Table-4: Reduction in number of breakdown

Replay International Pvt. Ltd.				
Breakdown Data For Machines				
Sr. No.	Machine Name	Breakdowns/fortnight	After implementation	% improvement
1	Compressor	-	-	
2	Dryer	-	-	
3	Grid Blasting	-	-	
4	Powder Coating Gun	3	1	66.66666667
5	Powder Coating Cabin	1	0	100
6	Powder Coating Compressor	1	0	100
7	Chop Saw	5	2	60
8	Angle Grinder	5	1	80
9	Mig Welding	1	0	100
10	Arc Welding	3	0	100
11	DRILL MACHINE (1)	2	0	100
12	DRILL MACHINE (2)	1	0	100
13	PIPE BENDING-1 (3)	3	0	100
14	PIPE BENDING-2 (4)	2	1	50
15	PIPE BENDING-3 (5)	3	0	100
16	PIPE BENDING-4 (6)	1	0	100
17	SHEET METAL BENDING (7)	2	1	50
18	SHEET METAL CUTTING (8)	2	0	100
19	PUNCHING MACHINE (9)	2	0	100
20	Laser Cutting (10)	1	0	100

3.2.2 Improvement in Finding Tool

Table-5: Reduction in tool finding time

	BEFORE	AFTER	% IMPROVEMENT
TIME TAKEN	50 (3000 SEC)	88 (SEC)	97.06
WORKERS DISTURBED	54	0	100
WORKSTATION TRAVELLED	46	5	89.13

Sr. no.	Required Tool	Time taken (in sec)	No. of workers disturbed	Workstations travelled
1	Spanner (big)	7	0	0
2	Spanner (small)	10	0	0
3	Screw driver	8	0	1
4	Plier	15	0	1
5	Hammer	5	0	0
6	Measuring tape	5	0	0
7	Spirit level	3	0	0
8	Centre punch	10	0	1
9	Safety glasses	3	0	0
10	Divider	6	0	1
11	Allen key	7	0	0
12	Hacksaw	5	0	1
13	Tri square	4	0	0
	Total	88	0	5

3.2.3 Expected improvement in cutting time

Table-6: Reduction in cutting time

Observation	1	2	3	4	5	6	7	8	9	10
Time required (min:sec)	6:04	5:53	6:15	5:19	5:03	6:10	6:12	5:45	5:56	6:23
Expected time required	2:00	1:30	2:00	1:30	2:00	1:30	2:00	1:30	1:30	2:00
% Improvement	67.03	74.50	68.00	71.79	60.40	75.68	67.74	73.91	74.72	68.67

Conclusion

- By implementing maintenance schedule there was significant improvement in number of breakdowns
- Adding new machines to the unit will enhance the throughput positively
- Appending the shadow board has improved production time as tool finding time is decreased by nearly 97% than the earlier
- Fixture developed will show 60-75% improvement in time required for cutting on chop saw

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