PRODUCTIVITY IMPROVEMENT OF GRID CASTING IN A BATTERY MANUFACTURING COMPANY - A CASE STUDY

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Abstract: *Productivity is the key important factor to every industry as it helps quick response to customer demand as well as optimizes the usages of resources. Utilization of the properly allocated resources leads to better productivity and enhances the efficiency as well as effectiveness. Grid is considered the core of the battery industry. So, focusing on this critical component by improving its productivity is the main concern of the related industry. Improved efficiency bears a positive impact on the costs of goods manufactured, as same output is produced consuming less input or provides same inputs to produce more output. Kaizen events are sometimes referred to as rapid improvement tools. It involves small groups of individuals in the company that are brought together to address a particular area. The present study focuses on improving grid casting productivity and reducing the problems related to low productivity and efficiency in the production arena. Other sections regarding plate preparation are also highlighted for subsequent observation. Capacity study of individual processes and production procedure have also been considered for further improvement.*

Key Words: *Productivity Improvement, Kaizen, Optimization, Resource Utilization.*

INTRODUCTION

In today's increasingly competitive world, it is important to improve continuously, manufacturing or service industry. Manufacturing industry is one of the sectors which can takes turns under all types of economic systems such as free market economy and collectivist economy. All of the products generated is competing to gain demand and satisfaction from customers. Dealing with continuous competition, company not only needs to produce quality products but also excellence in production systems. At the present stage of economic development, one of the main components of successful industrial organizations is planning productivity. Study of the productivity growth is becoming more important against a backdrop of market relations, because it allows company to stay competitive on the market and strengthen the social component in the development of society. The term productivity can be used to examine efficiency and effectiveness of any activity conducted in an economy, business, government or by individuals. Efficiency, effectiveness and productivity can also be evaluated for performance, business in service sector. Increased productivity reduces the cost of work on the production unit or an increase in output and prevent waste. 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. Productivity becomes the dominant issues in the market place where customer demand is high and are willing to pay more for what they required in timely manner.

The main intention is to study the current capacity, analyze it to find areas of improvement, identify the flaws and make an improvement proposal to meet the forecasted increase in demand and improve the productivity in an industry of battery manufacturing production floor. This case study 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 and pattern is different and various industrial engineering technique and tools is implementing in this study in order to investigate and recommend actions. Different organizations within the same industry have different strengths and weaknesses and choose to compete in different ways. Dissimilar production "systems" have altered operating characteristics and each involves a different set of trade-offs. A production system must have a customized design that reflects the priorities and trade-offs inherent in the firm's own competitive situation and strategy.

The research process begins with serious reflection directed toward productivity and identifying a topic or topics worthy of a plate preparation. Considering the incredible demands on tight schedule, no activity is worth doing unless it promises to make the central part of an operators work more successful and satisfying. This study aims to analyze and give suggestions of improvements on the production and

monitoring procedure of grid casting in order to improve the productivity.

LITERATURE REVIEW

For over 150 years, the lead acid battery technology has developed and become one of the main portable sources of electric power with wide application in man's everyday life (transport vehicles, telecommunications, information technologies, etc.). It has won a dominating position in energy storage and load-levelling applications (reserve electric power supply and remote area energy systems). The lead acid battery is a complex dynamic system. This 'living' organism exists due to the simultaneous operation of two electrochemical systems: the lead system (Pb/PbSO4 and PbO2/ PbSO4) and the water system (H2O/H2 and H2O/O2). The latter is thermodynamically supported, but kinetically suppressed. These two systems are in continuous competition with each other, the lead system playing the dominating role, which makes the lead acid battery functional and useful to mankind. [1].19th-century illustration of Planté's original lead-acid cell up to this point, all existing batteries would be permanently drained when all their chemical reactions were spent. In 1859, Gaston Planté invented the lead–acid battery, the first-ever battery that could be recharged by passing a reverse current through it. Planté's first model consisted of two lead sheets separated by rubber strips and rolled into a spiral. In 1881, Camille Alphonse Faure invented an improved version that consisted of a lead grid lattice into which a lead oxide paste was pressed, forming a plate. Multiple plates could be stacked for greater performance. This design was easier to mass-produce. The basic principle has not changed since 1859. In the early 1930s, a gel electrolyte (instead of a liquid) produced by adding silica to a charged cell was used in the LT battery of portable vacuum-tube radios. In the 1970s, "sealed" versions became common (commonly known as a "gel cell" or "SLA"), allowing the battery to be used in different positions without failure or leakage. Today cells are classified as "primary" if they produce a current only until their chemical reactants are exhausted, and "secondary" if the chemical reactions can be reversed by recharging the cell. The lead-acid cell was the first "secondary" cell.[2,3].The process of making changes in a company, is usually slow, regarding the layout, the machines or the organization. Therefore, it is important that all the choices which is made, strives towards the same goal, this is where the manufacturing strategy plays its part. By clearly stating a manufacturing strategy, it is possible to make the right choices, at the right time [4].Productivity data are used to investigate the impact of product and labor market regulations on economic performance. It also allows analysts to determine capacity utilization, which in turn allows one to gauge the position of economies in the business cycle and to forecast economic growth. If it continuously measured, it is possible to show the effects of changes in the production, and which choices have the desired effect [5].One of the most important things for measure production is the productivity. Productivity is, according to Hannula, defined as how well a company uses its resources, which can be expressed by the formula, where the output is the output from the system and the input is all the resources that has been used [6].To standardize a work method, is to specify which operations and in which order they should be performed to complete a work task. Effect of standardized work is a reduction of the variance in both quality and operation time. There are several factors that needs to be considered to achieve a standard, these factors are: all the operations required to complete a task, all safety procedures needed in each operation, a visual representation of where each operation takes place, the timing for each operation, and proper method of doing that. By using standardized work and constantly improving it, the productivity will be improved, which also leads to reduced costs [7]. Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership. Kaizen is a system that involves every employee - from upper management to the cleaning crew. It is continuous. In most cases these are not ideas for major changes [8]. Maintenance is an important factor in quality assurance, which is another basis for the successful competitive edge. Beyond just preventing break downs, it is necessary to keep equipment's operating within specifications (i.e. process capability) that will produce high level of quality [9]. 5S is an approach which helps to identify the problems that cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement [10]. Work Study is the systematic examination of the methods of carrying out activities such as to improve the effective use of resources and to set up standards of performance for the activities carried out [11]. The performance appraisal is the process of assessing employee performance by way of comparing present performance with already established standards which have been already communicated to employees, subsequently providing feedback to employees about their performance level for the purpose of improving their performance as needed by the organization. It is the process of evaluating the performance and qualifications of the employees in terms of the requirements of the job for which he is employed, for purposes of administration including placement, selection for promotions, providing financial rewards and other actions which require differential treatment among the members of a group as distinguished from actions affecting all

members equally. Performance appraisal includes all formal procedures used to evaluated personalities and contributions and potentials of group members in a working organization. [12, 13].

CURRENT STATE MAPPING

Actual monthly production data is collected from the work floor. Data, analysis, identify pattern is also done to understand the current scenario. All grid types are considered same to reduce the complicacy of calculation. This is done under the assumption of considering after analyzing and identifying all the production quantity for various grid type is almost same. Production data was collected, analyzed on different issues to compare & study the pattern to identify the current & critical scenario. Shift & Machine wise production quantity is summarized & graphical representation is along with that for easy observation as well as for better understanding. Loss Time was collected for each machine in six categories the way it reported in Grid Casting Activity Report. Here Shift wise, categorized & Machine wise loss time was classified & calculated. Graphical representation is also provided for better visual understanding. Efficiency of overall grid casting is also cumulated & updated instantly to pursue & take necessary actions to improve. Machine capacity study was done under current circumstances which are compared to other monthly production data & used to estimate the overall production capacity & production quantity. Reasons are accumulated for the low productivity of Grid castings on FBD sheet. Overall comparisons are done in the Overview sheet. In this the Capacity portion the total capacity of grid casting is calculated considering the average production found by machine capacity study. This is tentative & may vary with the actual production capacity. That's why secondary verification is done with the factory actual data.

OVERVIEW OF CURRENT STATE

The following data are the accumulated data from the production floor to access the current condition. Production capacity, Machine utilization, Loss time & actual production scenario is represented here. All data provided here are the primary data collected directly from the ongoing process so that the actual scenario could be estimated clearly and the flaws could be identified.

Table 1: Capacity of the Grid casting Production floor

Production Data			Production/ Machine				Total Capacity (Grid Casting)
			Min	Prd/Hr	Prd/Shift	Wt/AlW	
Time	480	Min/shift	14	1680	13440	10080	1874880
Shift	3	Shift/ day					
Days	31	Days/month					
Machine	2	Each Shift					
Avg Prod	14	Mc/ min					
Allowance	15	Min/Hr					

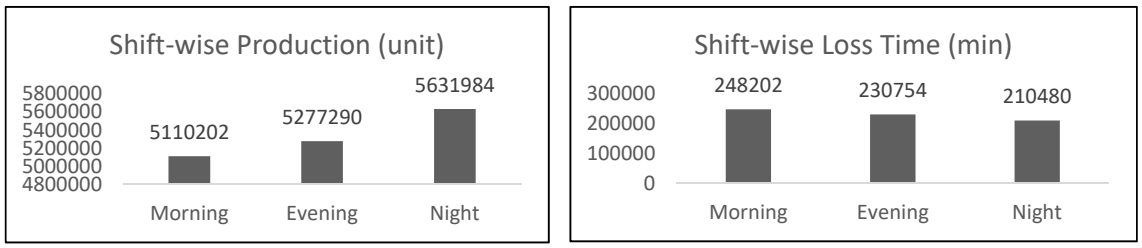

Figure 1: Shift wise production and Loss Time

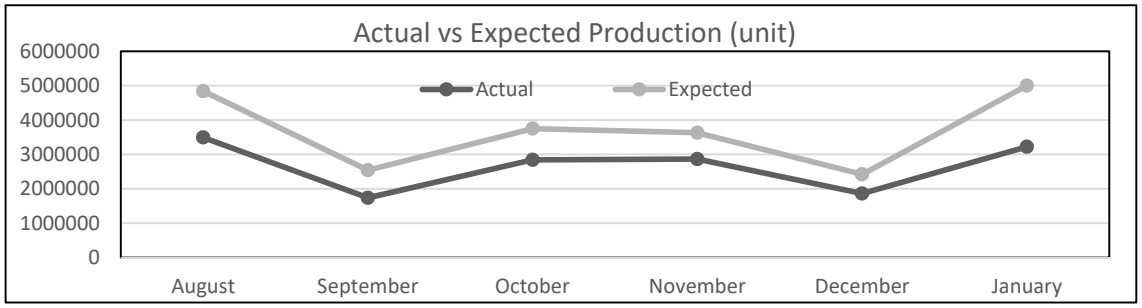

Figure 2: Actual Vs Expected Production (unit)

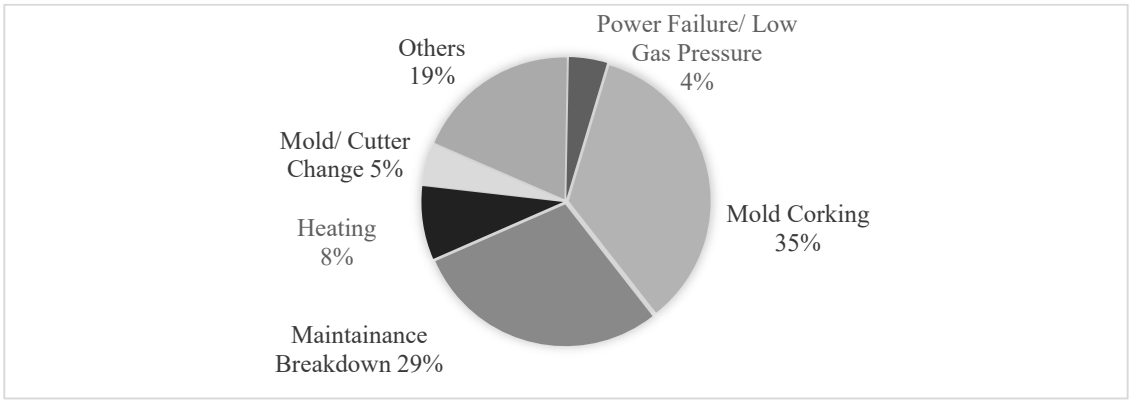

Figure 3: Cumulative percentage of Loss Times

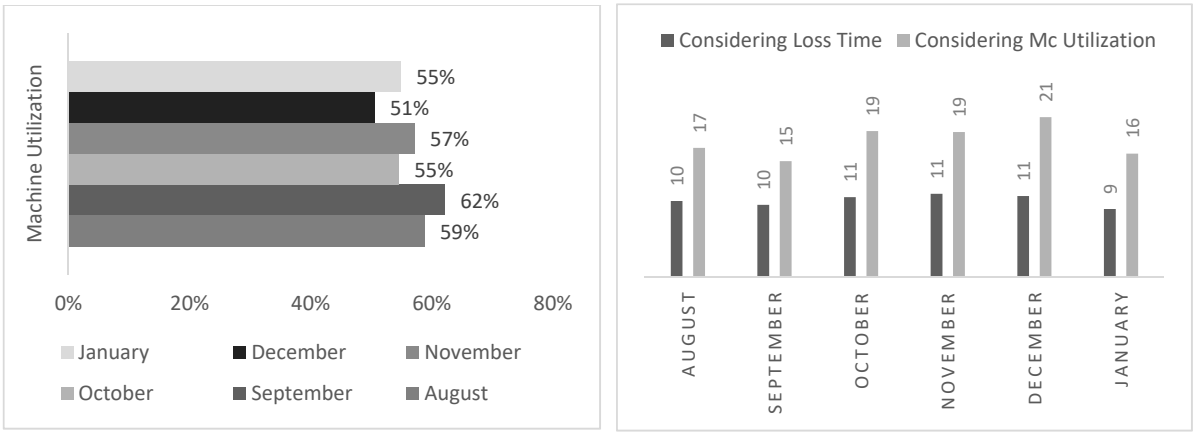

Figure 4: Machine Utilization & Productivity considering Loss time as well as Machine Utilization

FUTURE STATE MAPPING

Based on the collected data mentioning the time span the future state was developed. Production condition, production quantity & the area of small and medium improvements was identified considering existing capacity of grid production. Compared the actual & existing scenario observations are made. Made those as suggestions which are under consideration and verifying with the existing procedure.

All detailed work done are enclosed here and the detailed calculations are attached at the groceries. According to the data and observation, suggestions are made for monitoring production floor, tracking work, productivity & preventive maintenance work shows the estimation of capacity considering the average production found in the previous study. Where the other parameters and considerations remains same. Afterwards, the comparison is also shown in here.

Table 2: Estimated capacity calculation

Production Data			Production/ Machine				Total Capacity (Grid Casting)
			Min	Prd/Hr	Prd/Shift	Wt/AlW	
Time	480	Min/shift	15	1800	14400	10800	9039600
Shift	3	Shift/ day					
Days	31	Days/month					
Machine	9	Each Shift					
Avg Prod	15	Mc/ min					
Allowance	15	Min/Hr					

Existing capacity: 7066817 units; obtained by the average output/min using 6 months' production data
Estimated Capacity: 9039600 units; considering m/c utilization time and proper monitoring on each shift
1972783 units can be increased with improved productivity and proper m/c utilization, i.e., around 28% capacity improvement

Table 3: Production Scenario Comparison after implementing of Hourly Monitoring

	Previous	Current	Difference
Production (Pcs)	156900	174800	17900
Productivity/ min	8	9	1
Efficiency	65%	72%	7%
Loss time (min/ day)	491	422	69
Utilization (min/ day)	949	1018	69

Table 4: Improved scenario of Grid Casting production

Sl	Date	Shift	Target	Production		Daviation		Productivity		Efficiency		Losstime		Utilization	
				Shift	Day	Shift	Day	Shift	Day	Shift	Day	Shift	Day	Shift	Day
1	10/2/2016	Morning	11500	9400	27400	2100	7100	10	10	82%	79%	135	395	345	1045
		Eveneing		9350		2150		10		81%		120		360	
		Night		8650		2850		9		75%		140		340	
2	11/2/2016	Morning	11500	6350	24800	5150	9700	7	9	55%	72%	240	410	240	1030
		Eveneing		8450		3050		9		73%		110		370	
		Night		10000		1500		10		87%		60		420	
3	12/2/2016	Morning	11500	6900	26150	4600	8350	7	9	60%	76%	195	360	285	1080
		Eveneing		9650		1850		10		84%		90		390	
		Night		9600		1900		10		83%		75		405	
4	13/2/2016	Morning	11500	6400	19550	5100	14950	7	7	56%	57%	225	620	255	820
		Eveneing		3750		7750		4		33%		320		160	
		Night		9400		2100		10		82%		75		405	
5	14/2/2016	Morning	11500	6000	25350	5500	9150	6	9	52%	73%	265	415	215	1025
		Eveneing		9650		1850		10		84%		90		390	
		Night		9700		1800		10		84%		60		420	
6	15/2/2016	Morning	11500	8650	27400	2850	7100	9	10	75%	79%	110	320	370	1120
		Eveneing		9400		2100		10		82%		135		345	
		Night		9350		2150		10		81%		75		405	
7	16/2/2016	Morning	11500	8850	24150	2650	10350	9	8	77%	70%	130	435	350	1005
		Eveneing		9350		2150		10		81%		75		405	
		Night		5950		5550		6		52%		230		250	
Grand Total			**80500**		**174800**		**66700**		**9**		**72%**		**422**		**1018**

RESULTS AND DISCUSSIONS

Current capacity of the grid casting production floor considering the parameters on the left column of the Table 1. We calculated the shift wise production and loss time what showed in Figure 1 and this helps us to get the expected output considering the current capacity which is shown in Figure 2 along with the actual output. Here we found the deviation of production and thus we tracked all the reason behind it. Loss time is identified individually and shown in Figure 3 where we can visualize its impact clearly. Machine Utilization & Productivity considering Loss time and machine utilization is shown in Figure 4 where we can see the capacity usages throughout the time period of analysis. In Table 2 considering the same parameters of table 1 and the capacity we found the estimated capacity of production floor. To enhance that production rate must be improved to atleast15 grids/ min which will lead to a capacity escalation to 1972783grids/ each month. However, it

is not possible to calculate how much exactly for such bound. Besides, there are significant other fact which can't be neglected in the findings. Chasing this capacity applying proper monitoring we found the changes and improvement which are shown in the Table 3. In Table 4 we see the improved scenario of a week-long Data where we can see the significant changes.

From the beginning the goals included, optimizing the resource utilization of the work floor in the production line utilization was measured to about below 12%. We know higher productivity leads to sustainable growth. Since none of the improvements have been tested in the system directly, the exact effect of them is not known yet. But by having breaks in shifts and making sure that the external part of the calculations is done in time, it would be possible to increase the utilization of the machine and resource 7~8 % and productivity about 21 % which may cause an overall improvement by 28 %. It is found that 35% of total loss time is consumed by corking and 29% machine breakdown as well as contributing 19% to other issues. It has been clearly seen that 14% overall deviation in expected production considering average production/ Hour (each machine output/ min) and machine utilization time. The average overall efficiency was found around 56%.

CONCLUSIONS

This paper focuses on finding and solving the problems that exists in the production floor of grid casting unit. The problems derive mostly from the lack of standardization and the lack of measurements. In order to have standardized work methods, the staffing needs to be the same in both shift teams. For the Grid casting department to reach its full potential, it is important that the rest of the supportive departments also start working with standardization. As from the machine utilization time we get that the capacity is much higher than what we are getting in production. If the standardized work division and worksheets are used; it should be possible to improve the current scenario from an average of 12 grids/ min to 15 grids/ minutes, leading to a total production increase to 28 %. However, the production increase is only possible if there is a viable production plan and the needed components are available. After the standardization changes, the largest losses remaining are, mold corking related issues. It remains the key obstacle which hinder the productive time. Both the suggestions and observation are remaining as a guideline to follow but it should be a benefit if applied as a standardize change, however, the effect is not measurable while the changes are not implemented. Therefore, this improvement is not included in the results. In order to minimize the remaining losses, it is necessary to find out the other underlying reasons by measuring and documenting the occurring breakdowns. That will lead to further possible improvements in the grid casting and related production area.

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