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To Increase The Overall Plant Effectiveness (OPE) Of Engine Cylinder Head Production Line.

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ABSTRACT: *In industrial organizations, the manufacturing of the products is the most challenging task. The effectiveness of a manufacturing industry depends on the productivity and performance of the manufacturing equipment. The industries want to keep their overall plant effectiveness close to the world-class level of OPE so that they will remain in the competition in the market. For this purpose, companies must analyze the losses in its productivity and then take measures to minimize these losses. In the same way, the total planned production time is also an important factor in overall plant effectiveness.In industrial organizations, overall equipment effectiveness is the basic tool that is used to determine the losses in the equipment of the industry. The OEE is based on the three parameters like availability, performance, and quality. OEE provides the areas where the improvement should be done to improve overall productivity.*

KEYWORDS: *Overall Plant effectiveness; Total Quality Management; Overall Equipment Effectiveness; Value Addition; Production Planning.*

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I. INTRODUCTION

Technology and the latest manufacturing techniques have brought a very charming change in the manufacturing processes industries. The latest manufacturing methods have enforced the industries to move-on from old techniques to the latest manufacturing techniques. Further on the globalization of the whole world on a platform has created a very competitive environment in the market. The one, who has higher quality in his product, will win the race. Quality means the extent of the excellence of the product. Both it is appropriate to the user's requirement and quality should be in every phase encounter during the manufacturing of the product[1].Manufacturing involves different processes and all of these processes should be up to the mark and should meet the international standards available for the latter described manufacturing. These advancements have encouraged manufacturing firms to adopt an appropriate manufacturing policy to progress their industry performance[2].Likewise; overall equipment effectiveness has developed a chief emphasis on modern manufacturing technology organizations. But, limited empirical knowledge might be castoff to authorize the influence of these stratagems on industry performance. To overcome all the ambiguities, this report intentions to ration the association between Fit Manufacturing (effective manufacturing, active manufacturing, and sustainability) and industry performance through arbitration of overall process performance. Manufacturing is a vital feature in accelerating the economic growth of the country. The newest advancement in globalization and technology upsurges manufacturing systems[3].In most circumstances, the industrial industrialized is attentive to using two more widespread manufacturing methods. These methods are agile industrialized systems and lean industrialized systems. Though, investors such as customers, communities, and strategy makers must be enforcing pressure on industrialized to include social and environmental aspects into the engineering process to guard humanity and the environment from the adverse belongings of the industrial procedure. The aim of all of these manufacturing systems is to increase industrial efficiency by enhancing procedure efficiency and decreasing costs[4-6].More significantly, overall competition has ended it compulsory to develop operative and effective standards in reaction to the global competition to increase overall presentation. Lean and agile industrialization manufacturing has added wider recognition in firms in recent years[7]. Lean is chiefly answerable for excluding non-value-added deeds, while agile is chiefly alarmed with triggering market responses. So, by relating these plans, manufacturing is emerging policies to recover its professional performance. Consequently, the incorporation of these two manufacturing strategies is serious for the existence in the existing market economic situation. Managing OEE in manufacturing is a fundamental strategy for continuous improvement of timely delivery and quality of service to meet customer satisfaction and expectations. Achieving customer satisfaction depends to a large extent on supplier performance, reliability, response to customer needs, and continuous improvement. Handling Overall Equipment Effectiveness is one of the techniques which castoff to guarantee the consistency of manufacturing operations and to gratify clienteles. This is how manufacturers ensure reliability while supporting the competitiveness of both entities in the marketplace and adhering to world-class standards[8, 9, and 10].This article provides an overview of business performance assessments from the perspective of manufacturing and overall equipment efficiency and an in-depth review of enhancing the competence of the manufacturing of the Engine-Head at an automotive manufacturing industry.

The proportion of actual production planned with respect to time depicts an imperative part of gathering production goals and deciding the victory or catastrophe of industrial projects. It is defined that the effectiveness of manufacturing enterprises reliant on the accessibility and efficiency of their manufacturing facilities[11]. It is showed that ferocious global rivalry demands from the companies to expand and enhance their output in order to win the race[12].This would be imaginable if manufacturing damages were recognized and removed. The arcade wants industrialists to supply their merchandise at the lowermost rate, so it is essential to containing the crucial essentials of efficiency in the systematic process of effective processing. The main achievement of this report is bounded around the measurement of the overall equipment effectiveness and overall plant effectiveness of the engine head production line of Millat Tractor[13-15].We will find the effectiveness of all equipment which will lead us to the calculation of overall plant effectiveness. The values which are pre-requisites for calculations are the costs of labor, treating time, power consumption, quality, and all overheads. These factors are carefully monitored and control to enhance the efficiency of the production line. The proportion of value auxiliary by each device in the production line is considered and then castoffs to define OPE of the plant. The method is also castoff to define OPE of the similar plant working in another place anywhere the budgets of various components in the production line is varying[16].This relative learning will help to categorize the area of additional enhancement in the mandate to be able to compete.

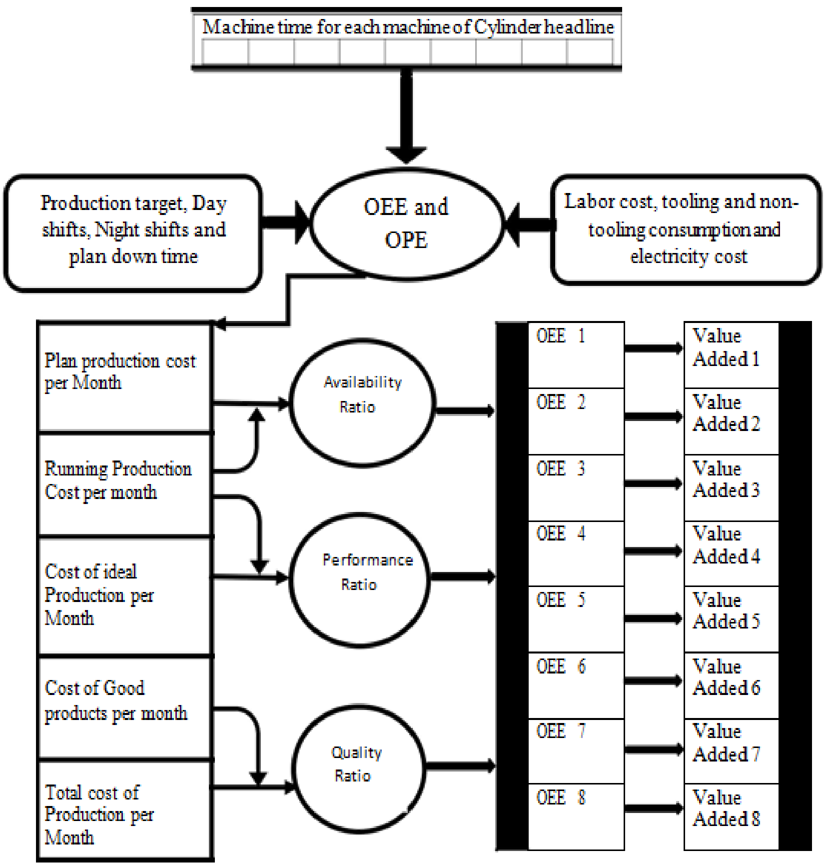


Figure 1: Architecture of technique employ for calculating OEE and OPE.

II. SYSTEM DEVELOPMENT &IMPLEMENTATION

The sequence of operations is performed for the manufacturing of a cylinder head. So, for calculations of OEE, a system matrix has been established. The first part of this system evaluates electricity cost, labor cost, tooling consumption cost, and non-tooling consumption cost. This system with help of these parameters evaluates running productions and planned productions per month, which are used to measure OEE and OPE[17]. For each machine of a plant, we can calculate the availability ratio by dividing the running production cost per month to planned production cost per month. Calculate ideal machining time per part and product cost after each operation is parameters to evaluate the performance of each machine of a plant[18]. To calculate the Performance ratio of each machine, evaluate by a ratio of cost of the products produced per month to running production cost per month as shown in figure 2. Calculate ideal machining time per part and product cost after each operation is parameters to evaluate the performance of each machine of a plant. Parameters to evaluate Quality of plants are good products, the cost ofproduct and overhead costs.

.The product of these parameters can generate a percentage which is known as %OEE. After finding % OEE for each machine in plant and value added % by each machine. By adding these two factors the result is formed in percentage which is % OPE. For analysis and development of OEE accurate record of machining time should be maintained. For the help of a machine operator, a sheet is formed which records all the parameters required for measuring OEE and OPE as shown in figure 1. The parameters measured to conclude OPE are machining time per part, labor cost per hour in Rs, production target per shift, day shifts per month, night shifts per month, planned downtime per shift, electricity cost per month in Rs, tooling and non-tooling cost in Rs, cost or raw casting in Rs, rejected part per month, rework cost per month in Rs, production target per month, planned production time in minutes, run time in minutes, planned production cost per month, running production cost per month, the single product cost in Rs, cost of good products in Rs, the total cost of production in Rs, AVAILABILITY, PERFORMANCE, QUALITY, Overall Equipment Effectiveness, value added to the finished product in Rs, percentage value addition to the product at each machine and Overall Plant Effectiveness (OPE) which are the data required for table 1 & 2 and also mandatory for our evaluation.

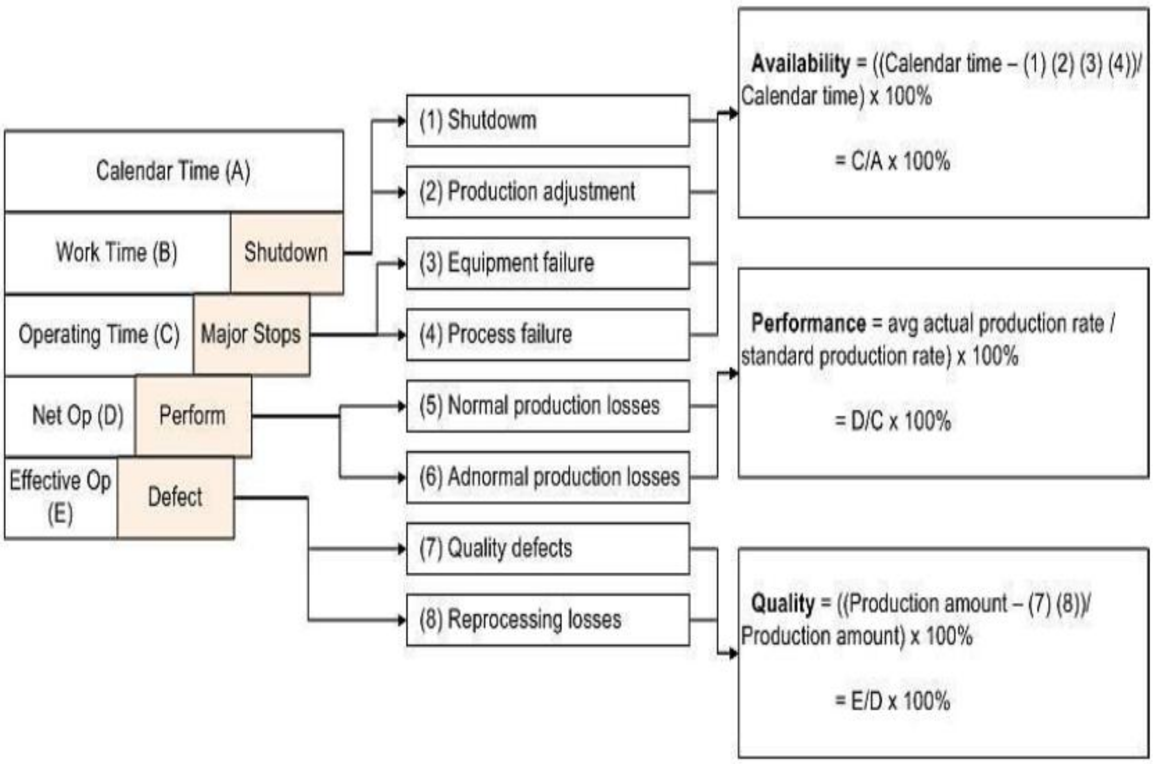


Figure 2: Flowchart and Schematic of Calculation Methodology

Table 1: System display for OEE and OPE under normal operationsand conditions.

Sr.No:	Description	OP-756	OP-1656	OP-3104	OP-1681	OP-1711	OP-1702	OP-1624	OP-3343	OP-1125
A	*Machining Time per Part in seconds*	189.6	132	443.2	751	2278.8	1095.6	146.4	2625	61.8
B	*Labor Cost per Hour in Rs*	170	170	170	170	170	170	170	170	170
C	*Production Target Per Shift*	90	90	90	90	90	90	90	90	90
D	*Day Shifts per month*	22	22	22	22	22	22	22	22	22
E	*Night Shifts per month*	0	0	0	0	0	0	0	0	0
F	*Planned Down Time per Shift*	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
G	*Electricity Cost per Month in Rs*	9980	4461	13659	18760	26511	19051	3451	27893	3548
H	*Tooling and Non-Tooling Cost (Rs)*	13451	11457	21567	27598	41264	28513	6743	47598	10432
I	*Cost of Raw Casting (Rs)*	7500	7500	7500	7500	7500	7500	7500	7500	7500
J	*Rejected Part per month*	0	0	2	1	2	0	0	2	1
K	*Rework Cost Per month in R*	0	0	0	300	300	0	0	300	0
L	*Production Target Per month*	1980	1980	1980	1980	1980	1980	1980	1980	1980
M	*Planned Production Time in minutes*	390	390	390	390	390	390	390	390	390
N	*Run Time in minutes*	360	360	360	360	360	360	360	360	360
O	*Planned Production Cost per month*	1105	1105	1105	1105	1105	1105	1105	1105	1105
P	*Running Production Cost per month*	1020	1020	1020	1020	1020	1020	1020	1020	1020
Q	*Single Product Cost in Rs*	7508.95	7506.23	7520.93	7535.46	7607.61	7551.74	7506.91	7623.98	7502.92
R	*Cost of Good Products in Rs*	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7
S	*Total Cost of Production in Rs*	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7	1.5×10^7
T	*Availability %*	92.3077	92.3077	92.3077	92.3077	92.3077	92.3077	92.3077	92.3077	92.3077
U	*Performance %*	79	55	73.01	87.37	91.875	75.901	61	97.03	40.87
V	*Quality %*	100	100	99.899	99.9475	99.897	100	100	99.89	99.94
W	*Overall Equipment Effectiveness (OEE)*	72.9231	50.7692	67.3258	80.6069	84.7203	70..0625	56.3077	89.4711	37.7126
X	*ValueAddedtotheFinishedProduct(Rs)*	122.371	122.371	122.371	122.371	122.371	122.371	122.371	122.371	122.371
Y	*%ValueAdditiontoProductat eachM/C*	7.31649	5.0938	17.1028	28.9806	18.2103	21.7863	5.6494	27.0921	2.3848
Z	*Overall PlantEffectiveness(OPE)*	76.194%								

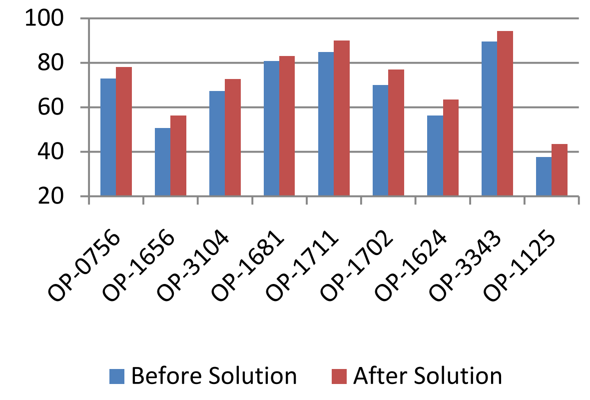
As we know that OEE is the multiplication of availability, performance, and quality as shown in figure 1. All of these three factors should be highest to get the highest values of OEE. All tactic and processes are done to enhance these factors to get the highest or greater values of OEE which in turn increase the value of OPE[18]. If one machine's availability is less but quality and performance is good, we must work over its availability more so that its OEE can increase. This will eventually result in increasing the overall plant effectiveness of the whole production line. OP 1624 quality is 100 % but its OEE is not 100% just because of the reason that it's available and performance is not 100%. OP 756 availability, quality, and performance are 100%, 79%, and 92%. So we must work on the performance of that machine so that the OEE of that machine increases. It is necessary to note that all machines are connected by the aid of the conveyor belt. If one machine had completed its task and the other one had not, the first one had to wait for the second one to complete its task, so in this way, the bottleneck is created, we have to reduce the time of performing the task of that machine which is taking more time and the reason of the creation of the bottleneck. The stopgap or bottleneck is provisional and typically not a foremost problem. An example of a temporary blockage is accomplished by the worker taking a few days off[19]. There are long-standing bottlenecks that must be expressively sluggish down production meaningfully. So, we have to look that both the bottleneck is long term or short term and then according to that solution is suggested. It is also noted that by reducing or removing the bottleneck, the Overall plant effectiveness is increased 4 percent our main task is to increase the OPE by reducing the time to perform the task and by reducing the value addition as shown in table 2. Each data is assigned a column in the table assigned as alphabetic. Every data was found as the aid of some formulation and some technical data found out by the particular method. The scheme then computes the manufacturing objective per month, strategic manufacture time, and run-time[19]. The standards of the period are rummage-sale by the arrangement to compute calculated manufacture cost per month and consecutively manufacture rate per month. The arrangement then computes the rates of semi-finished merchandise at the finish of each process. These principles are rummage-sale to regulate the whole price of quality yields per month and the total cost of entire parts created both good and rejected per month. Each machine or operation has specific value for each data, and some have to be enhanced and some have to be minimizing to enhance the overall plant effectiveness[20]. The time for the operation and cost to make the part should be lower in order overall equipment effective which while eventually increase the overall plant effectiveness. However, it is noted that we have performed different methods and techniques to increase OEE[20]. Like the machines which are taking more time, the analysis is done to decrease the time by either place one additional machine there or either enhancing its efficiency to work inappropriate time.

III. SOLUTION OF BOTTLENECK PROBLEMS FOR IMPROVED OEE AND OPE

Through the examination of the production line process, it is documented that while the operating OP 1681 is working effectively, the solo operation of the OP 1711 is deprived by looking the first column of table 1. Consequently, OP 1711 has a bottleneck and delays the working time. The total number of parts that are finished depends on the working, performance, quality, and availability of all the machines in the production line. If the problem is identified, a restatement of each machine can be enhanced to increase the efficacy of the plant. Under normal circumstances, the factory has only one shift, as depicted in the E column of table 1 and 2 in which , no night shift is performed, so it is endorsed that OP 1711 and OP 3343 shouldbe given overtime after several days. Ifessential, it is also suggested that OP 1702 should also work overtime to overcome deprive or lagging for the other machine's operation. Energy costs and tools non-tool expenses are the thoughtful use of representation devices and tools[21]. This is accepted as an influence data for the arrangement, and an arrangement is revealed to show the enhancement of usability, performance, and quality enhancement criteria, which will increase the OEE and OPE values. Calculations are made afterward these endorsements, and it must be understood that the value of the OPE will upsurge significantly[22-23].

Table 2. System display for OPE after solving bottleneck problems

Sr.No:	Description	OP-756	OP-1656	OP-3104	OP-1681	OP-1711	OP-1702	OP-1624	OP-3343	OP-1125
A	*Machining Time per Part in seconds*	189.6	132	443.2	751	2278.8	1095.6	146.4	2625	61.8
B	*Labor Cost per Hour in Rs*	170	170	170	170	170	170	170	170	170
C	*Production Target Per Shift*	95	95	95	95	95	95	95	95	95
D	*Day Shifts per month*	22	22	22	22	22	22	22	22	22
E	*Night Shifts per month*	0	0	0	0	0	0	0	0	0
F	*Planned Down Time per Shift*	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
G	*Electricity Cost per Month in Rs*	10231	5261	15359	19468	27317	20019	4137	28373	4107
H	*Tooling and Non-Tooling Cost (Rs)*	14754	12407	22569	27598	42213	29537	7079	48079	11051
I	*Cost of Raw Casting (Rs)*	7500	7500	7500	7500	7500	7500	7500	7500	7500
J	*Rejected Part per month*	0	0	2	1	2	0	0	2	1
K	*Rework Cost Per month in Rs*	0	0	0	300	300	0	0	300	0
L	*Production Target Per month*	2090	2090	2090	2090	2090	2090	2090	2090	2090
M	*Planned Production Time in minutes*	390	390	390	390	396.3	398	390	398	390
N	*Run Time in minutes*	366	366	366	366	388.7	390	366	390	366
O	*Planned Production Cost per month*	1105	1105	1105	1105	1122.85	1127.67	1105	1127.6	1105
P	*Running Production Cost per month*	1037	1037	1037	1307	1101.32	1105	1037	1105	1037
Q	*Single Product Cost in Rs*	7508.95	7506.23	7520.93	7535.46	7607.61	7551.74	7506.91	7623.98	7502.92
R	*Cost of Good Products in Rs*	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7
S	*Total Cost of Production in Rs*	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7	1.6×10^7
T	*Availability %*	94.0121	94.0121	94.9012	95.1793	98.1213	98.9541	94.0121	97.1213	94.658
U	*Performance %*	82.9624	59.9081	76.63	87.37	91.875	77.78	67.49	97.0	45.8
V	*Quality %*	100	100	99.9043	99.95	99.9024	100	100	99.9	99.9
W	*Overall Equipment Effectiveness (OEE)*	77.9947	56.32	72.6533	83.1168	90.061	76.966	63.4499	94.1419	43.39
X	*ValueAddedtotheFinishedProduct(Rs)*	122.371	122.371	122.371	122.371	122.371	122.371	122.371	122.371	122.371
Y	*%ValueAdditiontoProductateachM/C*	7.31649	5.0938	17.1028	28.9806	18.2103	21.7863	5.6494	27.0921	2.3848
Z	*Overall PlantEffectiveness(OPE)*					81.113%				



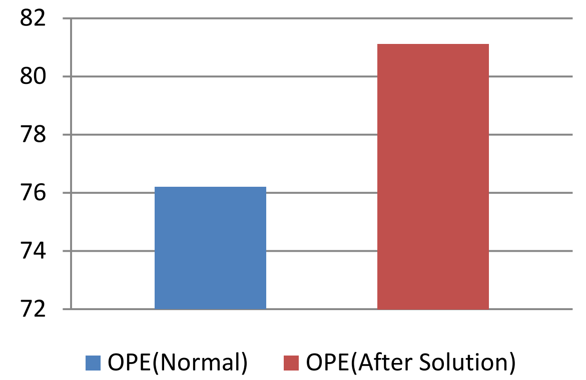


Figure 3: The improvement in OEE ofeachplant in production line.Figure 4: Upsurge in the OPE after employing bottleneck solution.

IV. CONCLUSIONS

The scheme is to find the OEE for each apparatus of the plant and the overall plant effectiveness (OPE) of the cylinder head production line. It is observed that OP 3343 takes longer machine operation time compared to OP 1624 and similarly the plant OP 1711 takes much more time than its previous plant OP 1681. As the amount of completed fragments depends upon the performance of these machines so the problematic solution was fixed by applying the overtime 14 hours per month to OP 3343, OP 1711, and OP 1702. By doing so this will result in the production of more parts of the cylinder headlines because these plants take a lot of time than their previous plants in the manufacturing line. The comparison of the results before the bottleneck solution and after the bottleneck solution is displayed in the tables given above. The contrast displays that OEE value for each machine is improved from 3% to 7% as shown in figure 3.Approximately whereas, OPE of the plant is enhanced by 5% and shown in figure 4.

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