Productivity Improvement by Enhancing the Bottleneck Station in an Alternator Production Plant with Layout Improvement and Its Cost Analysis

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Abstract- Required production output of an alternator plant was carried first. From this study it was clear the plant could not produce even half the required alternators. Present layout was simulated using the discreet simulation software arena and the bottleneck station was identified. next aim was to identify whether the plant layout is flexible to occupy a new VTM . By the CRAFT technique we could find an economic area for the new machine. Then the simulation was done based on the new layout and the utilization of machine, product output of the plant and bottleneck station was determined. From the simulation results it was clear that the production of the plant has increased but could not satisfy the full requirement. Some ratings of alternator production was not enhanced by the new machine were another was the critical machine whose alternator output was not enhanced. Then the layout was again simulated by increasing the number of critical machine and the result was compared.

Index Terms- Analysis, Arena, Improvement, Production, simulation

I. INTRODUCTION

Increased productivity is always considered to be the main driver of competitiveness in the price sensitive market. There are different management tools through which the productivity of a firm can be increased. Green manufacturing , Business process reengineering, total quality management, statistical process control, supply chain management etc are some of such tools. Before implementing above tools we should be in a position to say that this plant exists a good plant layout and machine utilization. If the plant layout is not effective the production will decrease and the production cost increases and the profit reduces. so if we analysis a plant we should give first importance to the plant layout and the machine utilization of the plant etc. Management tools will become more effective only if the basic structure of the plant is correct. This study was carried out on an alternator production plant were first the present and past production order was compared.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

In this study it was seen that the plant could not produce half of its required quantity. In order to identify the reason we studied the plant layout and it was clear that the layout of the plant was ok . For the clear study we have taken the production plan for the month of January as reference and using discreet simulation software using arena we simulated the plant and could see that the firm have a bottleneck station which is the main reason for the low production.

Table 1:prodution plane for the month January

Alternator type	Quantity	Time Allotted
LT Induction Motor 100-200 KW	20	170 hours
Traction Alternator 4500 kVA	12	100 hours
2015 (25-35 KVA)	10	30 hours
25 KW Alternator	30	100 hours
Auxiliary Alternator	12	50 Hours

layout simulation

In order to determine the critical machine in each alternator production they were simulated separately with allotted time. In the first step of simulation we found the most critical path in each alternator production alter all the critical path were simulated for a month. In this simulation using arena we could see that the same VTM machine was the bottle neck station for all the production process. The

next aim was to enhance the bottle neck station for the production improvement. since the production was less than the half the best and easy method to increases the production was to purchase a new machine.

Combined Simulation for a month

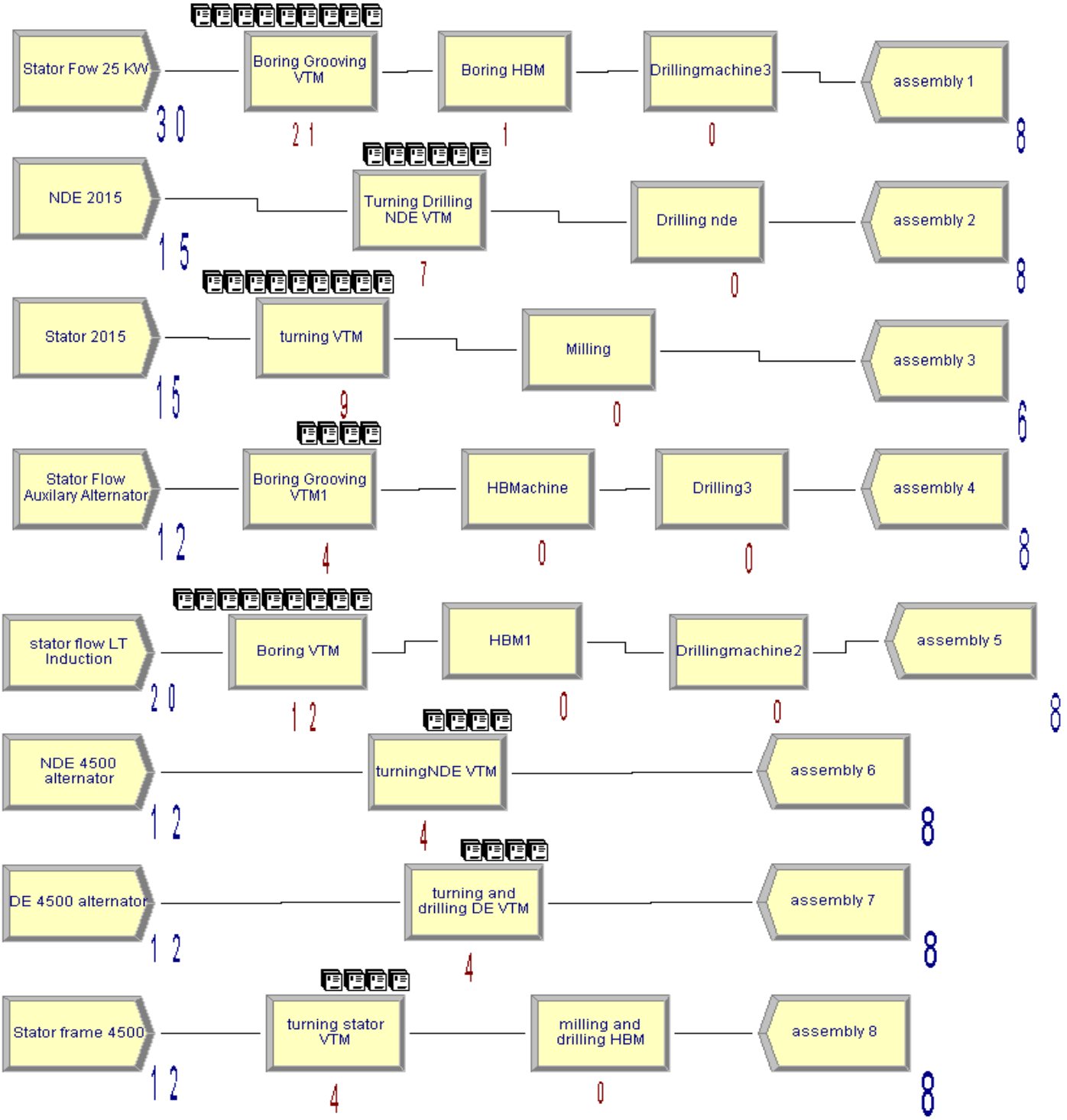


Fig 1: critical path layout simulation using arena

The above figure shows the simulation of the of the plant for the month of January. In this simulation we have considered only the critical path in each alternator production. Critical path was determined by the initial simulation by discreet event simulation arena were the line with least output was considered as the critical path. replication length was set to 450 hours since it is the total working hours of the plant for the month January. Now the plant is working in two shift with eight hours each. Nearly one hour is given for the miscellaneous activities like lunch, tea etc. the actual production can be considered to be 15 hours a day. From the simulation it is clear that the output of the each flow not up to the expected mark showing that there is a bottleneck station which required an emergency enhancement. after simulation it show that the most accumulation of resource is carried out at VTM

Combined simulation of layout after improvement with a new VTM

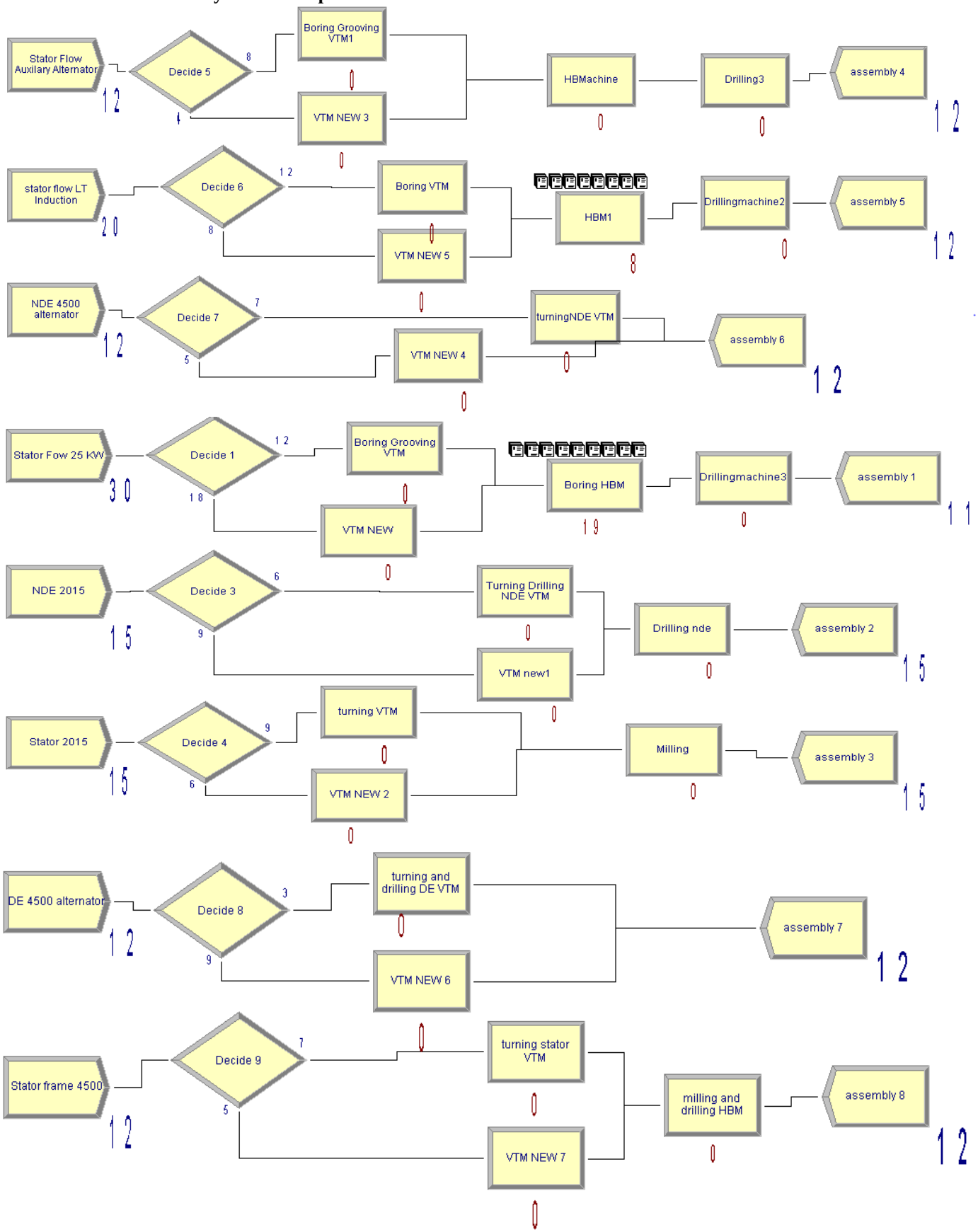


Fig 2:plant layout simulation with two vertical turning machine

Table 2:scheduled utilization of the machines for the month with two vtm

Scheduled Utilization	Value
Drilling machine 2	0.07266667
Drilling Machine 3	0.3133
HBM	0.9656
milling machine	0.03533333
VTM	0.9779
VTM 2	0.9242

The same critical machine is proposed to purchase so that its bottle neck is removed and increase the productivity of the firm. Before purchasing the firm should know weathered the plant layout is flexible for the improvement. For this the new layout is studied and improved using CRAFT technique and then simulated using arena which help as to compare the performance of the plant before and after the changes. The cost analysis is also carried out were the payback period and related data's are checked.

Machine allocation

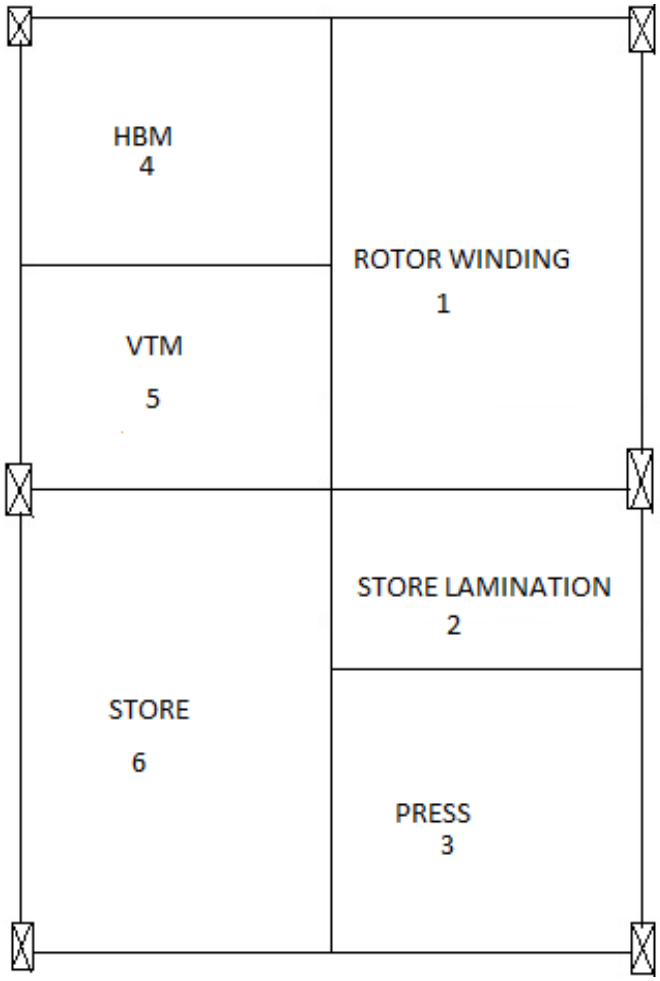


Fig 3: layout of fabrication section

In the above figure we can see the six department were department six and two are now used as store. here we use CRAFT technique were we require some basic input which is collected from the plant. Since we are interested in placing a new VTM in the layout it will be more economical to fix the new VTM near by the present VTM. So here two economic interchangeable are possible. Thus there will be two cases in this situation to determine the most economic one. In order to do the craft technique these are the input required.

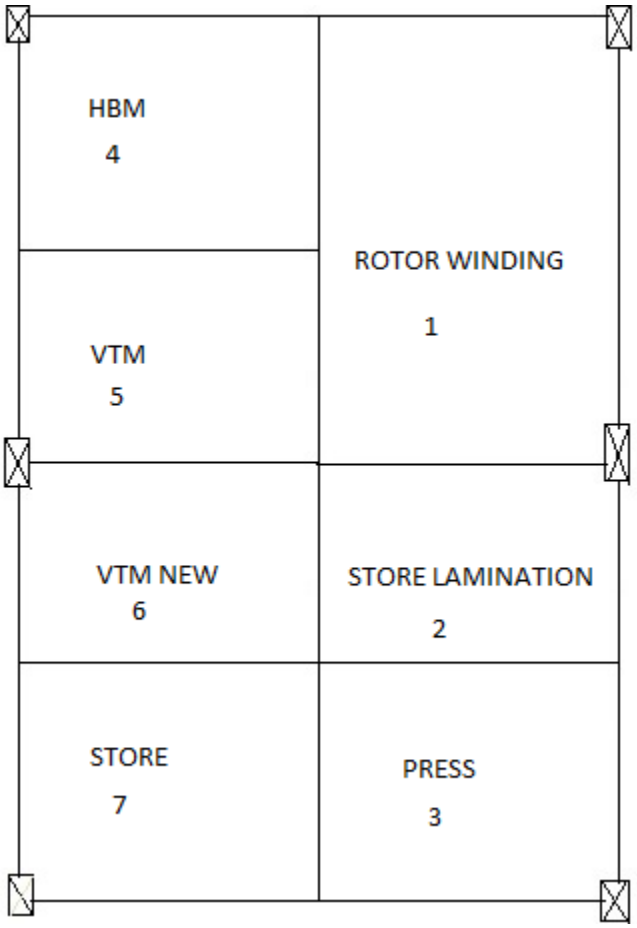
1. Number of departments

2.Department area

3.Unit transportation cost

4.Number of transportation

Case 1:



Case 2:

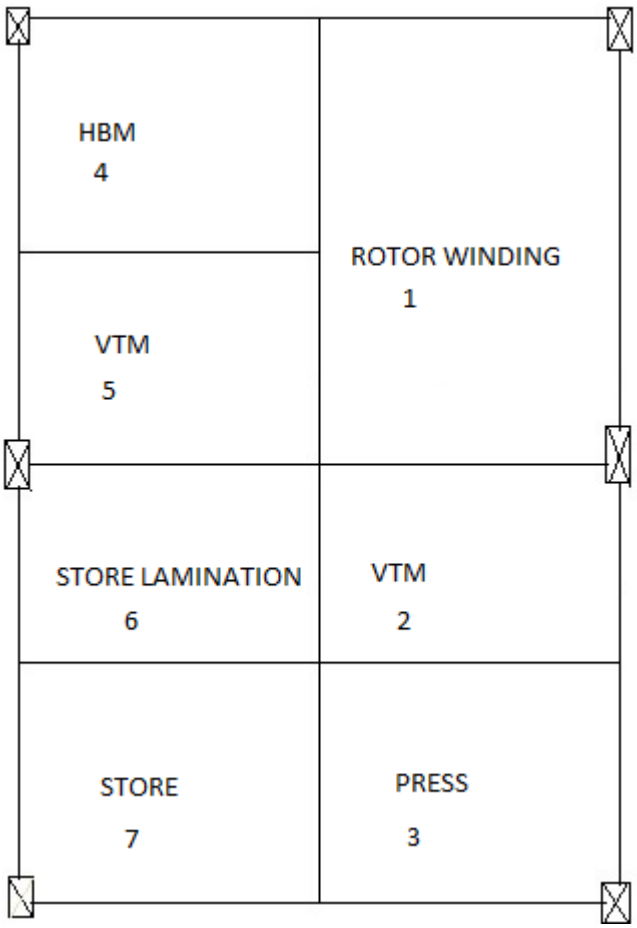


Fig 4:New Plant layout with possible two cases

total number of department =7
total number of interchangeable department =2

Table 3:departmental area in m^2

1	2	3	4	5	6	7
112.5	45	67.5	67.5	45	45	67.5

From the two total cost case 1 have the least total cost with 4052.50 were in case 2 it is 4252.25. So it is the first layout which is the most economic layout. From this study it is clear that the plant layout can occupy a new machine and we have find an economic area for its installation. Now our aim is to select a good VTM as the plant concerned

machine selection by scoring technique

Table 4: Scoring technique to identify the suitable machine for the plant

Priority	Priority scoring	2500 VTC	VTC TOSHULIN
Operation	A	6	6
Flexibility	A	6	9
Size	A	9	9
Operation cost	A	9	6
Cost	B	9	3
Durability	B	6	9
Service	B	3	3
Supply	C	3	3
Style	C	6	3

Benefit	C	6	3
Total score		63	57

In calculation it was clear that 2500 VTC have the higher value so we will select this machine for the plant. This selection was carried based on the scoring technique. There are other effective technique to determine the economic machine since we have only two machine to compare it is easy to use the scoring technique.

Cost Analysis

Here in cost analysis we are looking what is the amount of profit the firm have acquired by the arrival of new VTM machine. whether it is good to have another HBM for the firm and what will be the payback period for different cases. Payback period in capital budgeting refers to the period of time required for the return on an investment to "repay" the sum of the original investment. Payback period as a tool of analysis is often used because it is easy to apply and easy to understand for most individuals, regardless of academic training or field of endeavor. When used carefully or to compare similar investments, it can be quite useful. To calculate a more exact payback period: Payback Period = Amount to be Invested/Estimated Annual Net Cash Flow

Table 5: Production output with improved alternator layout

Alternator	Alternator to be produced	Output with single VTM	Output with	Production increased	Profit for a month
LT	20	8	12	4	30000*4
4500	12	8,8,8	12,12,12	4	130000*4
Auxiliary	12	8	12	4	23000*4
2015	15	6,8	15,15	9	9500*9
25 KW	30	8	11	3	19000*3
Total	89	30	62	24	874500

profit for the month January = Rs874500
average profit for an year = 12*874500= 10494000
Amount for the new VTM =Rs 35000000
payback period =3500000/10494000 =3.3 years

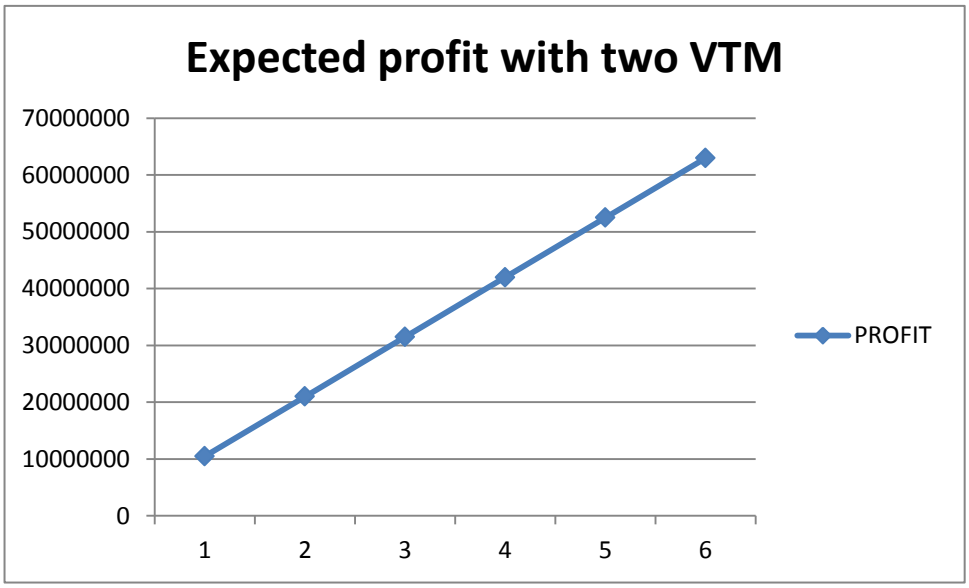


Fig 5 Expected profit for consecutive years

III. CONCLUSION

The study could really show that the productivity of the firm can be increased with the new VTM which was the critical machine in the former stage. Next we identified the economic location of the machine in the plant layout for the new VTM. For including the machine we used CRAFT technique for locating the new VTM. In the detailed simulation using discreet simulation software arena it was clear that the HBM should be also enhanced for meeting the required output for 25KW alternator and LT induction motor a output of the firm. It was suggested to buy a new HBM machine for the productivity improvement. Then cost analysis is we could find the payback period for the plant with different layout. The proposal is submitted to the management

APPENDIX

VTM - vertical turning machine
HBM - horizontal boring machine

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REFERENCES

[1] Redesign of the layout and the materials flow of a production plant a master thesis desta a. hailemariam july 2010
[2] Software evaluation criteria for rapid factory layout planning,design and simulation n. shariatzadeha, g. sivarda, d. chena manufacturing systems 2012
[3] A simulation based experimental design to analyze factors affecting production flow time Banu y. Ekren a,*, Arslan m. ornek,2007
[4] Thesis abstract bottleneck detection and mitigation in serial production systems Abishek ramesh master of science, December 15, 2006
[5] Bottleneck detection and mitigation in serial production systems Abishek Ramesh a thesis submitted to the graduate faculty of auburn university in partial fulfilment of the requirements for the degree of master of science auburn, Alabama 2011
[6] A facility layout problem in a marble factory via simulation Rahime Sancar edis1, Bayram kahraman2, Ozlem Uzun araz3, m. Kemal özfırat2
[7] Analysis plant layout design for effective production Anucha Watanapa, Phichit Kajondecha, Patcharee Duangpitakwong , and Wisitsree wiyaratn IMECS 2011
[8] Biller, s., Li, j., Marin, S.P., Meerkov, s. m., Zhang, l. (2008): bottlenecks in production lines with rework: a system approach. in: proceedings of the 17th world congress the int. federation of automatic control, Seoul, Korea, July 6-11, 2008, pp.14888-14893
[9] Introduction of Government Process Modelling With Rockwell Arena Software Bruce J. Neubauer Albany State University Shelley K. Stewart Saint Leo University JPAE 15(3): 383–395 Journal of Public Affairs Education
[10] Introduction of Government Process Modeling With Rockwell Arena Software Bruce J. Neubauer Albany State University Shelley K. Stewart Saint Leo University 2010

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