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An Operational Strategy for an Effective Spare Parts Management: A Case Study with Validation by Fuzzy Logic

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Abstract

In any organization, the shop floor management is too challenging as it gives a thrust over the executives to accomplish high productivity. Effective utilization of resources for optimizing the production and maintenance related activities has always demanded a serious focus to evolve and frame professional strategies and methodologies. In fact, Management by Objectives is highlighting the need for quantifying the target for all departments. The paper has been attempted to evolve a new operational strategy that ensures effective spare parts utilization and management. In order to validate the strategy, Fuzzy Logic decision making approach (1), is adopted to identify the poorly performing machines.

Keywords

Machine, Cam Wheel, Cost, Spare Parts

I. Introduction

Operations management is concerned with the efficient and effective transformation of inputs into "desired outputs"[2]. Traditionally those outputs have been understood largely in manufacturing terms in the context of profit making organizations. Increasingly, however, it has been recognized that the role of the operations manager can be deployed in any virtual area where a purposeful system or organization is striving to achieve its objectives. Regardless of which sector they operate in, the ability of operations managers to fulfill those tasks is dependent on understanding that they have to make trade-offs. They cannot avoid working under constraints and in each situation there will be some things that they can do well and some they can do less well. Understanding their capabilities and constraints will facilitate current utilization and provide inputs into strategic decision-making about future resources.

This paper is one such attempt in providing the right input for operation managers to develop strategies about their machine overhaul and their employees' skills. An attempt has been made to develop a software model [3], for the use of the managers and organization as a whole to check whether the given inputs provide valuable outputs. The model once implemented will give an updated stock management. It will assist the manager in his strategic decision making.

II. The Software Model and Its Components

The model generates various reports like the stock statement, shift wise issue statement, issue statement of each and every item and issue statement stating the purpose of end – use including the machine number at which the part was used [4].

All these details are very essential for the store keeper and the production manager [5]. All these are imbibed in our software model. This model can be updated to any system already existing in the company premises with slight changes.

The system basically uses a personal computer for the storage of data. For developing our system we can use package like VB in the front end and database like MS-Access, My-SQL in the back end [6].

We can develop this software as a client/server-user friendly model [7] by using VB and Oracle under windows XP/NT/98 etc., Even we can develop this as an Intranet project with oracle backend and ASP, .NET or even JSP as front end .We can even develop it as FOSS (Free and Open Source Software) which has more security, using Python and MySQL or Python and PostgreSQL. It can also be implemented using PHP and MySQL.

The software can be developed with a client server technology.

Table 1: Client Server Approach

Operating System	GNU/Linux (Highly secure)
Database	Postgre SQL
Business logic	Python/mod python
Presentation logic	Cheetah/python(tem plating)

Table 2: Free and Open Source Software (FOSS) Approach

<table>
<tr><td>Operating system</td><td colspan="2">Windows</td></tr>
<tr><td>Database</td><td colspan="2">Oracle, MYSSQL, MYSQL</td></tr>
<tr><td>Business logic</td><td rowspan="2">ASP- .NET / JSP(Intranet model)</td><td rowspan="2">VB(client server)</td></tr>
<tr><td>Presentation logic</td></tr>
</table>

III. The Decision Making Process

The role of the manager becomes very simple only if these calculations are tabulated for a long period of time. The decision making process involves [8], only the top level management and the software. The model generates various reports which help the production manager and other top level executives to analyze the flow of the consumption of raw materials [9], and spare parts. If the consumption of a particular product is more, the reasons can be sorted out very easily. The software will show the decision maker as where the spare part has been used, if the concentration is more on one particular machine then the machine is to be overhauled, or on the other hand if the product does not satisfy it's lifecycle then the analysis on the production is to be made and the change is to be carried out. On the other hand if the above two are correct then the possible conclusion is that the training received by the workers is not sufficient. Thus all these decisions can be easily taken using this software just sitting in front of the analysis screen. The following decision can be taken in the reports generated from our model.

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A. Decision 1: Problem with the Operator

Reports generated for weeks might indicate the problem in either with the operator or machine. It can be easily found out by checking the lists on a periodical basis. The amount of inventory used can be found with ease by using this software. In case that a particular operator is found as a fault then the shift in which he work has been done will consume the maximum amount of inventory and thereby the lack of training for that operator can be easily accounted and necessary steps can be taken.

B. Decision 2: Problem with the Quality of the Spare Part

The model provides excellent idea features to choose your supplier. Whenever the consumption of a particular spare part is increasing on a wide range of machines, that too not meeting out their life time and basic quality requirements then suitable change of vendors can easily made [10].

C. Decision 3: Problem with the Maintenance Technician

This is one of the easy cases where the machines in which a particular engineer works alone fails in a short period of time [11]. The advantage of using the software will provide the manager with easy choices so that he can be provided with training [12].

D. Decision 4: Problem with the Machine

The problem in the case of a machine can be easily understood by referring the various charts as seen below. The case of a machine problem is discussed elaborately in the following paragraphs under the working of the model.

IV. The Working of the Model

Once the model is implemented the system automatically starts preparing the various issue statements. The data entry work is the only work needed for the software. A simple prototype consisting of three parts is discussed here and the use of the software in decision making process is also described elaborately. The results will be tabulated from the database. The results are stored for longer periods and only one time entry is enough and the other requirements will be automatically computed. The following tables may be perused for analysis.

Table 3: Issue Statement for a Shift in Day One

Name of the part	Quantity used	Price of one item (in Rs.)	Total Value (in Rs.)	End- Use Machine Number	End- Use Number of items in each machine
Cam Wheel	4	3500	14000	M-60 M-4 M - 52	1 1 2
Priming Washer	50	4	200	M- 57 M- 4 M- 52	14 21 15
Nut M 20	14	1	14	M – 52 M- 60 M-57 M-4	4 5 3 2

Table 4: Issue Statement Machine Wise for the Same Shift in Day One

Machine number/ Part	M-4	M-60	M-57	M-52
Cam – Wheel	1	1	0	2
Priming Washer	21	0	14	15
Nut M 20	2	5	3	4
Cost	3586	3505	59	7064
No .of items used	24	6	17	21

Table 5: Issue Statement for Similar Shift in Day Two

Name of the part	Quantity used	Price of one item (in Rs.)	Total Value (in Rs.)	End- Use Machine Number	End- Use Number of items in each machine
Cam Wheel	6	3500	27000	M-5 M-42 M – 52 M – 32 M – 56	1 1 2 1 1
Priming Washer	71	4	284	M- 57 M- 4 M- 52 M - 38	14 21 15 21
Nut M 20	14	1	14	M – 52 M- 60 M-57 M-4	4 5 3 2

Table 6: Issue Statement for Similar Shift in Day Three

Name of the part	Quantity used	Price of one item (in Rs.)	Total Value (in Rs.)	End- Use Machine Number	End- Use Number of items in each machine
Cam Wheel	5	3500	17500	M-61 M-43 M – 52 M - 67	1 1 2 1
Priming Washer	76	4	304	M- 54 M- 41 M- 52 M – 65	14 21 15 26
Nut M 20	14	1	14	M – 52 M- 60 M-57 M-4	4 5 3 2

Table 7: Weekly Consumption of Important Spare Parts by Various Machines

Name of the Machine	No. of Cam wheels used for the week
M – 4	6
M – 5	6
M – 32	4
M – 38	3
M – 41	2
M – 42	2
M – 43	2
M – 52	14
M – 54	3
M – 56	3
M - 57	3
M - 60	2

M - 61	2
M - 62	2
M – 65	3
M – 67	1

Table 8: Cam Wheel Consumption for M – 52 Weekly for the Month of February

Week	Number of Parts
Week 1	14
Week 2	15
Week 3	12
Week 4	17

Table 9: Cam Wheel Consumption for M – 52 Weekly for the Month of March

Week	Number of Parts
Week 1	15
Week 2	16
Week 3	21
Week 4	17

V. Analysis from the Model

The software analyses with the help of reports generated. The reports like issue statements, shift wise statements, machine wise issue statements, machine wise weekly issue statements and machine wise monthly issue statements. According to world class manufacturing system, performance measurement is done by conducting micro study of all the reports generated which is of valuable help for an effective decision making. The micro study is carried out by the following inferences,

A. Inference 1

Table 3, gives the details about the various spare parts consumed by various machines in a particular shift in a particular day. The report directs us to know the values of the spare parts consumed by the machineries. It is inferred that cam wheel being the critically required and costly spare part has been consumed more by the machine M – 52.

B. Inference 2

The inference 1, is supported by seeing the machine wise issue statement for the above shift given in table number 4. It is also inferred that machine M – 52 has consumed maximum value of spares comparatively.

C. Inference 3

Table 5, gives the spare consumption for various machines in a similar shift including machine M - 52 on day two. It is clearly understood that the machine M - 52 repeatedly consumes spares especially cam wheel which is costlier than other spares. This point may be highlighted for the corporate decision making.

D. Inference 4

Table 6, too throws light on the same fact similar to inference three and supports the facts said therewith. Again it is inferred that machine M– 52 seems to be the black sheep in the shop floor which is noticed neither by the production nor by the maintenance executives thanks to their busy day to day shop floor schedules.

E. Inference 5

Table 7, lists out the weekly consumption of important spare parts namely the cam wheel. This gives us serious information that the case of M- 52 requires much attention. The table number five is the core focus of our micro – study.

F. Inference 6

Table 8, and Table 9, give us the consumption of cam wheel by machine M - 52 listed out weekly for the months February and March. By studying the table thoroughly from top to bottom shows us that the machine M - 52.

VI. Validation using Fuzzy Logic

From all the inferences observed, it is quite clear that machine 52, must be replaced immediately. This is justified by applying any multi criteria decision making tool. To validate the working of the model the Fuzzy decision making logic has been applied.

Fuzzy logic [13], concepts can be employed to arrive at a suitable decision by incorporating an individual's perception about alternative options and their constraints as simple fuzzy sets. The validation for the new operational model can be done by taking into account the following input parameter for a few set of machines collected from the shop floor [14].

Table 10: Range of Productivity, Cost and Number of Breakdowns

Machine number	Maintenance cost (Rs)	Productivity (%)	Average number of breakdowns per day
4	3586	79	2
60	3505	89	2
57	59	88	2
52	7064	79	2

A decision making process as per the fuzzy logic perspective, includes these components options (O), goals (G) and constraints (C). Here cost and productivity [15] are taken as goals and breakdown is assumed as constraints. The goals and constraints are to be developed as Fuzzy sets. Generally, each goal or constraint requires only one fuzzy set [16]. The fuzzy sets are to be delineated as per the priorities of an individual. Considering the table number 10, the membership grade of each action O's in goal and constraint is determined.

Let O_i = options. Where, O is called as group of options with machines. (Here machines are 4, 60, 57, and 52). Let goals be Cost=g_1, Productivity=g_2

Therefore a set of G for goals consists of

$$G=\begin{bmatrix} g1/o1 & g1/o2 & \cdots & g1/ol \\ g2/o1 & g2/o2 & \cdots & g2/ol \\ \vdots & \vdots & \vdots & \vdots \\ gm/o1 & gm/o2 & \cdots & gm/l \end{bmatrix}$$

Where, l – Number of options and
n - Number of goals

To calculate the membership grade, the following assumptions are made. Referring the table number 10 [5],

1. The highest value of maintenance cost Rs.7064 is considered to minimize the maintenance cost as Rs.0. Hence graph value

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1 is given for Rs.0.

2. The highest productivity is assumed as 90 and the graph value 1 is given for 90%.
3. The number of break down is almost even and equal for all the machines under study. It is understood to minimize break down to 0 and graph value 1 is assumed for 0 breakdown. Let us call this membership grade as machine discipline whose values are tabulated as,

Table 11: Goals and Constraints for Various Machines

Machine number	M4	M60	M57	M52
G1	0.56/3586	0.6/3505	1/59	0.12/7064
G2	0.87/79	0.99/89	0.96/88	0.87/79
C	0.33/2	0.33/2	0.33/2	0.33/2

D (O_i) = Minimum of μ (g) and μ (c).
Here, g = goals, c = constraints
D (O_i) = [0.33/2, 0.33/2, 0.33/2, 0.12/7064]
Machine Discipline (MD) for all the machines as follows,

Table 12: Machine Discipline for Various Machines

Machine number	Machine Discipline
4	0.165
60	0.165
57	0.165
52	0.0000165

Machine Discipline is the lowest for M52 which has to be replaced immediately according to Fuzzy concepts [17].

VII. Conclusion

Thus it is understood that the new operational strategy with the software model is helping in a professional decision making in many aspects like

1. The model helps in identifying the machine to be replaced.
2. The model helps in supplier selection.
3. The model helps to judge the quality of the spare parts supplied by particular vendor.
4. The reports generated help us in realizing the need for the technical training for the employees who are poorly skilled.
5. The reports generated are like first information reports which motivate us in taking efforts for reducing the maintenance cost.
6. The reports also help us in preparing the maintenance schedule.
7. In an overall view, the model is guiding the executives in decision making.
8. The Fuzzy approach has been useful in identifying the worst machine [18].

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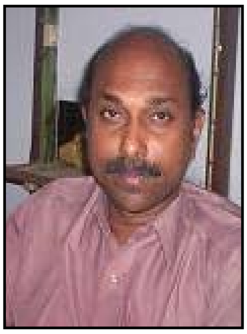

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