PROVIDING MATHEMATICAL PROGRAMMING MODEL TO IMPROVE THE EFFECTIVENESS

Esmaeil Amiri[1], Aziz Noohi Kararoodi[2], Seyed Jafar Mehrabi[3], Meysam Taghipour[4], Mohsen Heydarzadeh[5]

[1 ,2,3,4,5] *M.A. Student of Business Management, Rasht Branch, Islamic Azad University, Rasht, Iran*

Abstract

Operations research or operational research that is called OR as acronym is interdisciplinary branch of mathematics that uses trends such as plan or technical, statistical and designing algorithms to find the optimal point in optimization problems. The main innovation in the TPM is engaging all sectors with the subject. One of its goals is maximize equipment effectiveness by reducing waste and whatever accessibility to equipment is more, effectiveness became more and there is little waste. In this article try to examine the accessibility of equipment

Keywords: TPM, Mathematical Programming Models, Supply Chain

1. Introduction

After World War II, the Japanese industry concluded that to be successful in the global competition, need to increase their products' quality. Accordingly, the Japanese manufacturing techniques and methods and building and also management enter to their country from America and they were consistent with their conditions. In the past, Japan in order to improve equipment maintenance and repairs, preventive assumptions and subjectivity of the United States had entered and the next import has been efficiency and product needless of repair and engineering, reliability etc. What is now known as TPM, it is efficiency system like the way of America that in order to promote Japan's industrial system is improved by the changes. Central and main initiative of TPM is that operator does original work of their maintenance and repairs machines. They put this car in ideal and proper conditions and they increase their ability before Recession and failures (Santosa,Ahmed, tschalckx, Shapiro,2003).

TPM is type of productivity that is applied in small groups by all employees as group activity. Terms TPM, total productive maintenance and repairs by technical managers in Japan in 1971 was created with five main aims.

1 - Maximize equipment effectiveness
2 – Developing productivity system for all life-cycle equipment
3 - Engaging all sectors of the industry.
4 - Engaging all employees
5 - Developing TPM through incentive management

The word of total in total productivity has three basic concepts:

- Total effectiveness: developing and improving economic efficiency
- Total Prevention: designing devices needless of repair
- Collaboration and partnership: doing operation of an independent maintenance and repair by utilization workers. One of the most important factors of TPM is total effectiveness or maximize of equipment effectiveness. This effectiveness is available by improving parts is accessible and the order of parts is machinery and equipment. Renovation of existing systems is caused to reduce costs and increase effectiveness of all system. The purpose of this paper is

to providing mathematical programming model that improve processes. The purpose is to determine optimal capacity of flow between different departments of a production system according to machines costs.

2. Statement of Problem

The effectiveness indicator of equipment effectiveness is a type of measure to determine the added value of production by equipment. The added value in a simple express is the difference between revenue obtained from sale of the product and cost of resources consumed (cases of human resources) to produce. Added Value a product that by equipment is created and considerably reduced due to manufacturing defects and six main losses associated with equipment. By promotion of added value will increase accessibility machines.

TPM improve effectiveness by two types of activities, as follows:

Quantity: Increasing equipment availability and improve productivity factor of equipment in a specified interval.

Quality: Reduce the number of defective products, establish and improving the quality

TPM aim is to enhance the effectiveness factors of the equipment. So that it can exploited any equipment according to potential and maintain and repair in this level. Performance of labor and machinery must be continues both optimum conditions of steady and stable and amount of machine failures and product waste reach to zero.

Six big losses that limit the effectiveness of equipment are as follows:

1 - Destruction waste emergency

2 - Waste of preparation and regulation

3- Waste of move without production or stops

4 - Waste of speed reduction

5 - Quality waste and rework

6- Waste of start production

4. Effectiveness Measurement of Equipment

Effectiveness of equipment can be measured by using the following formula:

Quality ratio × Efficiency ratio × Accessibility = total Equipment Effectiveness

- Accessibility: this factor will improve by remove emergency failures, preparedness waste and regulation f and other waste of stop.

Efficiency: this factor will increase by removing to reduce speed and waste movement without producing and minor stops.

- Quality: this factor will improve by removing quality problems in process and in time the production setup. Factors of utilization, efficiency and quality of product are determinable in any plant. However, the importance of each factor is depends on the product characteristics, production equipment and systems desired. For example, if the time spent to set emergency failure time is high, utilization level is low and if the number of minor failures is too short, efficiency will be low. Access to an optimal effectiveness level is possible only in terms every three levels factor is high (Hajshiri Mohammadi, 1998).

4. Objectives of improving in waste

row	Type of waste	target	Description
1	Emergency Record Failure	0	Zero for all equipment
2	Waste of preparation and planning	Minimum	preparation time and planning reach to Less than 10 mins
3	Waste of speed reduction	0	Speed of manufacturing operations achieve to designed speed
4	Quality Waste and rework	0	Exist of waste is accepted In the limit very

			low
5	Waste of non- produce move or stop	0	Zero for all equipment
6	Waste of Start of production	Minimum	-

In reduce or eliminate six big losses is designing a planned process. For example, when a device malfunctions due to deterioration or operator misuse or quality waste and rework be high, can be increase the device of total productivity by determine the optimal size of the input (Tsiakis,Shah and Pantelide,2001).

Continued a planning model is presented that its aims are to reduce the cost. Four-level model is provided and has two products and model parameters do not change over time. The order of multi-level is the various operations that are performed on the raw material. The objective function includes the annual costs and managing that respectively is called investment of fix and operational. Fix Investment costs is relation to operational levels that include purchase and installation of equipment. Operational costs is in relation to the costs of providing material in supply places, manpower and maintenance and operational levels, transportation costs between different levels of operational.

Cost component of the objective function are:

- Creating costs: costs related to the purchase and installation of equipment
- Costs of providing
- Human resources costs: these costs are directly proportional to the rate of inflow to the operational level.
- Transportation costs between operational levels

5. The objective function

Objective function of this problem due to the total cost of function as follows:

$$\sum_{m} C_m y_m + \sum_{k} C_k y_k + \sum_{ij} C_{ij} k_{ij} + \sum_{i,m} C_{i,m}^{CH} (\sum_{j} Q_{ijm}) + \sum_{i,k} C_{ik}^{CH} (\sum_{j} Q_{imk}) + \sum_{i,j,m} C_{i,j,m} Q_{ijm} + \sum_{i,m,k} C_{imk} Q_{imk} + \sum_{i,j,l} C_{ikl} Q_{ikl}$$

The variables are:

Q_{ijm}: Flow from supply place j to operational level m^{th}

Q_{imk}: Flow capacity from operational level m^{th} to operational level k^{th}

Q_{ikl}: Flow capacity from operational level K^{th} to customer level L^{th}

D_{il}: Customer request amount for the product j

C_m: fixed cost to create equipment of level m^{th}

C_k: fixed cost to create equipment of level k^{th}

C_{ijm}: The cost of transportation between suppliers local j^{th} to operational level m for product j

C_{ikl}: The cost of transportation between operational level k and customer L for product j

C_{ig}: The cost of providing piece i^{th} in suppliers' local g

S_{ig}: Volume of supplier of piece I th in supplier g

C_m^H: Expenses of human forces at the operational level m

C_k^H: Expenses of human forces at the operational level k

kim: Equipment capacity at the operational level m for product i

kik: Equipment capacity of Operational level k for product i (Azar, 2000).

6. Limitations of Model

Flow between first operational level and second operational level exist so that exist first operational level. This case is also true for other levels; Flow between second operational level and third operational level exist so that exist second operational level. And so on and limitations is provided as follows:

$$Xmk \leq Ym$$

$$Xkl \leq Yk$$

7. Solving the Case Study:

At this stage considering the relation obtained between performances of proposed model are discussed. The two-stage production process is considered. At each stage, we assume that there are four machines and there are two suppliers in the entrance location of factories and the output of line is two products (Alain, 2004). The following table shows the parameters used in the model.

Row	Description	Sum (Thousands Of Rials)
1	cost of providing parts	1-400 2-500
2	Transportation costs between first and second stage	45
3	Transportation costs between second and third stage	35
4	Transportation costs between third stage and customer	40
5	Operational and human resources costs In the first stage	55
6	Operational and human resources costs in the second stage	50

In addition to the items listed in this model should also be repairs and maintenance costs. These costs should be provided for any equipment separately. According to mentioned context cost per machine differs from other machine. The cost due to operational level and machine type as follows.

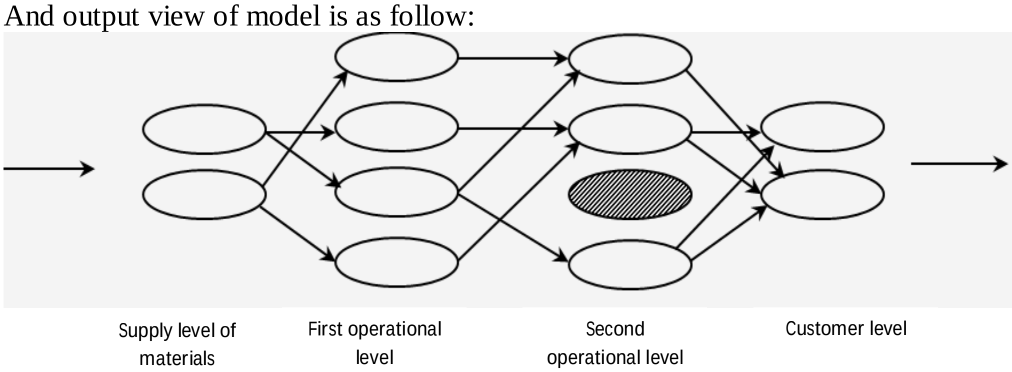
	Purchase Costs (Million Rials)		**Productivity Costs (Thousand Rials)**		**Maximum Annual Capacity (Thousands Of Numbers)**	
First operational level	1- First machine	1500	4	3	3000	5000
	1- second machine	1800	3	5	5000	2000
	1- third machine	1200	3/5	4/2	7000	4000
	1- fourth machine	1700	4/2	3	4000	3000

	Purchase costs (million Rials)		Productivity costs (Thousand Rials)		Maximum Annual Capacity (thousands of numbers)	
second operational level	1- First machine	1400	3	4	8000	6000
	1- second machine	1300	3/7	3/2	3000	5000
	1- third machine	2000	4/2	5/5	7000	8000
	1- fourth machine	1900	4	3	9000	7000

Demand required for first part of 10/000 and for second part of 15/000 and general specification of model by using software lingo6 becomes like this.

Description	Characteristics
Total number of variables	202
Total number of constraints	159
.The number of zero-one variables	8
Number of nonlinear constraints	16
Frequencies	36
Upper limit of the target function	1619250

And output view of model is as follow:



Output Figure

8. Conclusion and Discussion

As was noted, TPM was defined initially by the five main purposes. One of its aims is to raise the efficiency of equipment that it is possible to remove the six big losses. The three factors affecting the efficiency of equipment is accessibility, efficiency and the quality ratio that in addition to the usual methods of overcoming the six big losses, manufacturing process design optimization to determine the optimal flow between the various operating segments. One of the methods is to improve the system. Determining optimal size of input materials flow of equipment is based on the net cost of the device. Thus disability of system reduces and increase efficiency. In the model presented is defined a simple mode from operational system of production that the raw material is only one way to become the final product. Machine of each level has been the same and are only changed maintenance and operation costs according to the input capacity of part of to meet customer needs. In development and improvement in mentioned model, use of BOM materials and also different production processes can be part of future research in this field.

References

Alain martel,(2004). the design of production-distribution network: a mathematical programming approach, network organization technology research center.

EhapH.sabri, Benita M.Beamon,(2000). Amulti-objective approach to simultaneous strategic operational planning in supply chain deign, OMEGA 2000, pp581-598.

Hajshir mohammadi,a.(1998). Maintaining and repairing comprehensive productivity, First Edition

p.Tsiakis, N.shah and C.C.Pantelides, (2001).design of multi echelon supply chain network under demand uncertainty industrial engineering 2001, 3585-3604.

Santosa.T ,Ahmed.S, 6eo tschalckx.M, Shapiro.A,(2003). A stochastic programming approach for supply chain network design under uncertainty. School of industrial and system engineering.