Modeling & Analysis of Sequencing Model in KPM PLASTO Rubber Co.

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Abstract— The purpose of this paper is the study of optimization technique to maximize the profit with the data collected from a manufacturing industry which is KPM PLASTO RUBBER COMPANY. This work contains a problem regarding the computation of minimum total elapsed time of machines manufacturing the rubber products using modified heuristics time deviation technique for job sequencing. This paper have some intents:

1) To help the manufacturer to determine the order in which the rubber products should be processed.
2) To maximize the profit of the company.
3) To find the idle time of the machine.
4) To conclude whether the rubber products manufactured even in the idle time gives profit or not.

Key words: Job Sequencing, Processing Time, Schedule, Time Deviation, Time Duration, Total Elapsed Time, Heuristic Technique, Sequencing Rules

I. INTRODUCTION

The selection of an appropriate order for a series of jobs to be done on a finite number of service facilities, in some pre-assigned order, is called sequencing. Sequencing problems arise when we are concerned with situations where there is a choice in which a number of tasks can be performed. A sequencing problem could involve:

- Jobs in a manufacturing plant.
- Aircraft waiting for landing and clearance.
- Maintenance scheduling in a factory.
- Programmes to be run on a computer.
- Customers in a bank and so on.

[1] & [4] help us to make better decisions in complex scenarios by the set of advanced and analytical methods. [2] Explains the responsibility for conversion of inputs into useful products or services. [3] Provides the best method for solving a problem in sequencing model. [5] Provides a foundation for solving the decision making problems that are commonly used in developing mathematical models. [6] Enable us to identify the applications where operation research can be used in decision making problems and also enable us to interpret and analyze the result for for making better management decisions.

II. PRELIMINARIES AND BASIC DEFINITIONS

A. Job Sequencing

In job sequencing, there may be a finite set of n jobs where each job consists of a chain of operations and it consists of a finite set of m machines. Each machine can handle at most one operation at a time. Each operation needs to be processed during an uninterrupted period of a given length on a given machine. Then find a schedule, that is, an allocation of the operations to time intervals to machines that has minimal length. To schedule several jobs, the intervals selected for the jobs must not overlap. The objective is to schedule as many jobs as possible under the constraints.

B. Number of Machines

It refers to the number of service facilities through which a job must pass before it is assumed to be completed.

C. Processing Order

It refers to the order (sequence) in which given machines are required for completing the job.

D. Processing Time

It indicates the time required by a job on each machine.

E. Total Elasped Time

It is the time interval between starting the first job and completing the last job including the idle time (if any) in a particular order by the given set of machines.

F. Idle Time on a Machine

It is the time for which a machine does not have a job to process, i.e., idle time from the end of job (i-1) to the start of job i.

G. No Passing Rule

It refers to the rule of maintaining the order in which jobs are to be processed on given machines. For example, if n jobs are to be processed through three machines M1,M2, and M3 in the order M1,M2 and M3, then this rule will mean that each job will go to the machine M1 first, then to M2 and lastly to M3.

H. Static Arrival Pattern

If all the jobs arrive simultaneously.

I. Dynamic Arrival Pattern

Where the jobs arrive continuously.

III. TYPES OF SEQUENCING PROBLEMS

There can be many types of sequencing problems which are as follows:

- Problem with ‘n’ jobs through one machine.
- Problem with ‘n’ jobs through two machines.
- Problem with ‘n’ jobs through three machines.

Here the objective is to find out the optimum sequence of the jobs to be processed and starting and finishing time of various jobs through all the machines.

IV. BASIC ASSUMPTIONS

Following are the basic assumptions underlying a sequencing problem:

- No machine can process more than one job at a time.
- The processing times on different machines are independent of the order in which they are processed.

- The time involved in moving a job from one machine to another is negligibly small.
- Each job once started on a machine is to be performed up to completion on that machine.
- All machines are of different types.
- All jobs are completely known and are ready for processing.
- A job is processed as soon as possible but only in the order specified.

V. MODIFIED TIME DEVIATION METHOD

Time deviation method is used to obtain the optimal sequence of the jobs. In this method time duration table is calculated for each job in the row wise and the column wise.

1) STEP 1: Maximum time duration of the row minus the time duration of the cell gives the row deviation of the cell in the time duration table.

$$P_{ij} = r_i - t_{ij}$$

Where r_i is the maximum time of the i^{th} row, p_{ij} is the row time deviation of the $(i, j)^{th}$ cell and t_{ij} be the time required for processing i^{th} job on the j^{th} machine.

2) STEP 2: Maximum time duration of the column minus the time duration of the cell gives the column deviation of the cell in the time duration table.

$$C_{ij} = s_i - t_{ij}$$

Where s_i is the maximum time of the i^{th} column, c_{ij} is the column time deviation of the $(i, j)^{th}$ cell and t_{ij} be the time required for processing i^{th} job on the j^{th} machine.

VI. SEQUENCING N JOBS IN THREE MACHINES

The N jobs can be sequenced in three machines by the following steps

1) STEP 1: Calculate the time deviation table for the sequencing problem.
2) STEP 2: The cell which has both the time deviation vectors as zero for machine 1, perform that job first. If both the time deviation vectors are zero in machine 3 then perform that job in the last and if the vectors are zero in machine 2 then find the sum of deviation vectors separately for above and below of the zero cell. Compare both the deviations.
3) STEP 3: Perform that particular job first if the sum of deviation vectors above the cell is less than the other one. If both are same then perform the job either in first or last.
4) STEP 4: Again calculate the reduced time deviation table for all non-assigned jobs and continue the steps mentioned above.
5) STEP 5: Stop the process if we get sequence involving all jobs.
6) STEP 6: Arrange the obtained sequence in reverse order to get minimum total elapsed time.

VII. ANALYSIS OF SEQUENCING MODEL

A. Modeling

The KPM Plasto rubber company produces eight different types of rubber products, namely o-rings, quad rings, seals, gaskets, rubber bellows, bush, grommet, diaphragms. These products are processed on three different machines. The machine 1 involves the process mixing. Rubber and Rubber chemicals (raw materials) are mixed in mixing mill according to the ratio required. The batch weight for this is 10 kgs.

The machine 2 involves the process moulding. Mixed rubber is weighed and cut according to the profile and weight required. The output is named as slug about 40 gm. Then 16 cavity mould is taken for production. Mould is fixed in the machine which works under hydraulic pressure with the parameters time and temperature. The preformed slug is kept inside mould cavities. Then mould is closed by using hydraulic pressure.

And the machine 3 involves the process Deflashing. In this process, the extra moulded rubber around the rubber product is trimmed by the machine.

Due to design and size , the time taken for mixing, moulding, and deflashing differs from one rubber product to another.

The time consumed for each operation is given in the table. The manufacturer wants to determine the order in which the rubber products should be processed to minimize the total time required to process all the products.

RUBBER PRODUCTS	1	2	3	4	5	6	7	8
MIXING (M2)	12	12	12	12	12	12	12	12
MOULDING (M2)	15	20	18	22	15	11	18	20
DEFLASHING (M3)	2	3	1	2	3	3	3	1

Table 1:

B. Analysis

The time deviation table will be first calculated for the given problem. . The table is as follows,

JOBS/MACHINES	1	2	3	4	5	6	7	8
M1	(0,3)	(0,8)	(0,6)	(0,10)	(0,3)	(0,0)	(0,6)	(0,8)
M2	(7,0)	(2,0)	(4,0)	(0,0)	(7,0)	(11,1)	(4,0)	(2,0)
M3	(1,13)	(0,17)	(2,17)	(1,20)	(0,12)	(0,8)	(0,15)	(2,19)

Table 2:

Job 6 in machine 1 and job 4 in machine 2 have both the vectors zero and so they are assigned as follows.

6	4						

The time deviation table for the jobs other than job 6 and 4 are given as follows.

JOBS/MACHINES	1	2	3	5	7	8
M1	12	12	12	12	12	12
M2	15	20	18	15	18	20
M3	2	3	1	3	3	1

Table 3:

The time deviation table for the above jobs is specified as follows:

JOBS/MACHINES	1	2	3	5	7	8
M1	(0,3)	(0,8)	(0,6)	(0,3)	(0,6)	(0,8)
M2	(5,0)	(0,0)	(2,0)	(5,0)	(2,0)	(0,0)
M3	(1,13)	(0,17)	(2,17)	(0,12)	(0,15)	(2,19)

Table 4:

The job 2 and job 8 in machine 2 has both vectors zero and so they are assigned as follows:

6	4	8	2				

Leaving job 8 and 2, we have the time deviation table as follows

JOBS/MACHINES	1	3	5	7
M1	12	12	12	12
M2	15	18	15	18
M3	2	1	3	3

Table 5:

The time deviation table for the above jobs is specified as follows:

JOBS/MACHINES	1	3	5	7
M1	(0,3)	(0,6)	(0,3)	(0,6)
M2	(3,0)	(0,0)	(3,0)	(0,0)
M3	(1,13)	(2,17)	(0,12)	(0,15)

Table 6:

Job 3 and job 7 in machine 2 has both the vectors zero. Therefore the sequence is as follows:

6	4	8	2	7	3		

Leaving job 3 and job 7 we have the time deviation table as follows:

JOBS/MACHINES	1	5
M1	12	12
M2	15	15
M3	2	3

Table 7:

The time deviation table for the above jobs is specified as follows;

JOBS/MACHINES	1	5
M1	(0,3)	(0,3)
M2	(0,0)	(0,0)
M3	(1,13)	(0,12)

Table 8:

The above both the jobs in machine 2 having vectors zero and the job sequence is,

6	4	8	2	7	3	5	1

This sequence is then arranged in the reverse order from last obtained job to the machine 1 jobs and machine 2 jobs. It is represented as follows:

1	5	3	7	2	8	4	6

The minimum total elapsed time is calculated for the obtained sequence as follows

JOB SEQUENCE	MACHINE 1		MACHINE 2		MACHINE 3	
	TIME-IN	TIME-OUT	TIME-IN	TIME-OUT	TIME-IN	TIME-OUT
1	0	12	12	27	27	29
5	12	24	27	42	42(13)	45
3	24	36	42	60	60(15)	61
7	36	48	60	78	78(17)	81
2	48	60	78	98	98(17)	101
8	60	72	98	118	118(17)	119
4	72	84	118	140	140(21)	142
6	84	96	140	151	151(9)	154

Table 9:

Minimum total elapsed time = 154 mins
Idle time,

- M1 = 58 mins
- M2 = 15mins
- M3 = 136mins

C. Conclusion

From the above result, we come to know that if the manufacturer follows the above order of the sequence in which the jobs to be performed, the time of the job process on each machine get reduced. And so the manufacturer able to produce more number of parts of each product in the remaining time and it also gives more profit.

- The total elapsed time is 154 minutes.
- The total idle time of all the three machines is = 58+15+136 = 209 mins.
- If the three machines undergoes their process to produce the rubber products even in the idle time, the profit will raise.

VIII. CONCLUSION

In this paper, we have studied about the study of optimization technique to maximize the profit in KPM Plasto Rubber Company. Several conditions are discussed for a sequencing model. Here example is illustrated and solutions are also obtained. Hence the product produced in the idle time only gives profit.

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