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"STUDY ON ECONOMIC PRODUCTION QUANTITY IN A MULTI ITEM PRODUCTION SYSTEM"

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Introduction:

In any organization inventory plays a vital role, inventory is the life blood of the organization. Usually the decisions involves the amount of resources to be committed and the rate at which goods need to be produced during a given time period. The manufacturer needs to meet the demand of customers over a finite planning horizon in a batch production system with the available production facility. So that company requires the mathematical model to calculate the optimal batch quantity. In this project we applied the mathematical inventory control model to study the inventory control within the company and to calculate the optimal production quantity.

We first identified the optimal job sequence based on which the production department operates. This is a typical N job on M machine type of problem. The Johnsons rule for sequencing not holds good for this problem so that used the SAI method of sequencing. After finding the optimal job sequence the production schedule is prepared using the tabulation method scheduling. Scheduling of the jobs helps to reduce the idle time on the machines. The Economic Production Quantity (EPQ) is calculated for all the three types of products (plug) which we have considered for our study. Lastly to determine the cost savings total cost is calculated for quantities with EPQ and without EPQ.

Literature review

Feng-Tsung Cheng et al. (2010) This paper investigates the optimal inventory policy for an economic production quantity (EPQ) model. Due to some factors random machine breakdown occurs in the production process, and to deal with it the production planners must practically compute the mean time between failures (MTBF) and establish a robust production plan accordingly in terms of the optimal lot size that minimizes total production-inventory costs. So for this the author developed the EPQ model and calculated the optimal lot size which helped to minimize the total annual cost.

Bhausaheb R Kharde et al. (2012) In this paper the author used the concept of Equivalent Holding Cost (EHC) or Equivalent Carrying Cost. With this concept EPQ model is no different from EOQ model in terms of formulae. All formulae of EOQ model could be used for EPQ model only by putting Equivalent Holding cost in place of holding cost. This study has really simplified the mathematical formulation of EPQ model which helped in calculating the economic lot size and to reduce the total cost.

Arindum Mukhopadhyay et al. (2013) In this paper the author studied three types of imperfect quality items which are avoidable in an inventory system due to imperfect production process. The study reveals that the setup cost and production cycle time increases due to process deterioration and learning and forgetting effects. They studied the EPQ model by taking these time and cost related to the imperfect items into considerations. As a result of these factors the total cycle time increases and also the total cost of production also increases.

Y S P Chiua et al. (2014) In this paper author utilized the mathematical modeling and differential calculus to determine the production cycle time that minimizes total production, inventory, and delivery costs. Also they carried this study for the multi-item production system. In studying this EPQ model they also considered the time and cost related with the scrap, rework, and multi-delivery of the products. By considering this they developed the EPQ model.

Need for Study

The Economic Production Quantity model (EPQ model) determines the quantity which minimizes the total inventory costs by balancing the inventory holding cost and setup cost. When the setup time increases all the production operations are delayed which leads to increased work in process (WIP) inventory. Holding the high amount of inventory is not good to the company. As a result of high holding timing the waiting time also increases, that means the all other machineries and the equipments need to wait for some time. By using EPQ model we can be able to balance or optimize the production timings and also the production batch quantities which reduces the timing and total costs which helps in reducing the inventory in the company.

The variations in production timings tend to increase the delivery timings to the customers. This increases the lead time in the delivery process. Increased lead time result into the lack of coordination in the supply chain of the company which reduces the efficiency and increases the total cost.

Objectives

The objectives of this study are as follows,

- To calculate the Economic Production Quantity
- To schedule the jobs on machines in an optimal production sequence so that the total production time is minimized.
- To minimize the total annual cost by using the Economic Production Quantity (EPQ) model in production.

Methodology

During our study in the company we followed the research methodology to collect the required data from the company which is as follows,

- Study area: This study is conducted in the production and assembly department of the manufacturing company.
- Sampling technique: For our study purpose we used convenience sampling technique for data collection in the company. We have taken the data from company's monthly production plan and also collected the data about the products which have high demand.
- Sample size- Collected the data for 3 types of products.
- Data Collection Methods
- Primary data
  - ✓ Observation method
  - ✓ Interview method

Primary data is collected from the employees and by observation method. Also we asked some questions to the employees of all the departments to clear our doubts and to collect the data regarding production process.

- Secondary data
  - ✓ Companies monthly production plan
  - ✓ Research papers

Secondary data refers to data that was collected by someone other than the user. We collected the secondary data by studying various research papers related to the production engineering and from companies monthly production plan.

Data analysis

- Sequencing
  - ✓ Johnsons rule :

This rule is used to solve the job sequencing problems of various types like n jobs on 2 machines, n jobs on 3 machines, n jobs on m machines etc. The condition of Johnson's rule is as below,

"The minimum time on machines (M1, M5) is > = to max time on machines (M2, M3, M4)"

This condition is not satisfied to our problem. So we used SAI method of sequencing.

✓ SAI method :

Shortest processing time is the basis for this method.

➢ **Steps:**

1. Table consists of the process timings of N- jobs (k=1,2 3...n) on M-machines (1, 2, 3...m)
2. Examine the jobs (k=1,2...n) with least processing times and mark them as (-)
3. Similarly examine the jobs (i=1,2...m) with least processing times and mark them as (+)
4. Again examine the rows and columns of table, select the cell with (±)sign corresponds to i^{th} machine and k^{th} job
5. The k^{th} job is excluded from the table and is placed in the optimal job sequence.
6. Repeat the steps 2 to 5

Table 7: process timings of all jobs

I, k	J1	J2	J3
M1	35 -	40	45
M2	30 -	35	40
M3	20 -	25	25
M4	35 -	40	45
M5	15 ±	15 ±	25

Resulting sequence

J1			

Next the job J1 is excluded from the table, the resulting table is as shown below,

Table 8: resulting table after excluding job J1

I, k	J2	J3
M1	40 -	45
M2	35 -	40
M3	25 -	25 -
M4	40 -	45
M5	15 ±	25

Resulting sequence

J1	J2	J3

- **Economic Production Quantity (EPQ)**

The Economic Production Quantity is calculated for all the three types of jobs using the collected data and the given formulae.

$$EPQ = \sqrt{\frac{2DK}{H}}$$

D- Demand
K- Setup cost
H- Holding cost

Table: Economic production quantities for all three types of jobs

Job	Demand	HC in Rs	SC in Rs	EPQ in units
J1	400	12	1920	358
J2	250	13	1920	272
J3	100	14	2160	176

- **Total Cost**

The total cost is calculated for the production quantities with EPQ and without EPQ using the collected data and given formulae.

$$TC = \frac{Q}{2} * H + K * \frac{D}{Q}$$

Table: total costs for production quantities

Job	Total Cost in Rs		Savings
	with EPQ	without EPQ	Rs/year
J1	51519	51840	321
J2	42392	42540	148
J3	29511	34320	4809

Findings and conclusion

- **Findings**

✓ The condition of Johnsons rule is not satisfied to this problem.

✓ From SAI method we found out that J1 - J2 - J3 is the optimal job sequence for production.

- **Conclusion**

✓ The economic production quantity is calculated for all the three types of jobs.

✓ Although the job J1 incurs the cost savings of Rs.321 per year, we cannot use EPQ model to job J1 as the production rate is less than demand rate i.e (p < d)

✓ The jobs J2 and J3 incur significant cost saving of Rs. 148 and Rs. 4809 per year by using EPQ model.

Scope for future study

The EPQ model is used to analyze the deterministic case. The model effectively and efficiently helps to reduce the total annual cost as well as the cycle time. When the Economic Production Quantity Model (EPQ) is used in the production system, it helps to calculate the economic batch size of production which optimizes the holding costs and the setup costs. By studying this model we can also be able to analyze the economic order quantity and the reorder point in the inventory management.

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