Improvement in Inventory Control System to Enhance Life Cycle Assessment by transshipment method using Taguchi's method with Genetic Algorithm

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Abstract

Inventory control has a major significance in industries for enhancement in their productivity, production timing respective industries have different departments such as quality control, forging, heat treatment process, inspection, store; material is finished and product is developed in industry and several types of inventory is generated to fulfill the customer needs.

In our analysis inventory control is optimized by considering taguchi and genetic algorithm approach in respective department i.e. store room to room quality control and from room quality control to the machining line, the transshipment is used between departments , time evaluation is analyzed by considering two variables i.e. dependent variable which means the material is stored before order manually another is independent variable in which semi – finished material is produced after the order of customer, Genetic algorithm methodology is used to analyzed enhancement in optimized parameters for convergence and enhanced forecasting and is found that by applying these technique 38% of improvement with an overall error of 12% with a significance of a 0.2 in taguchi analysis was observed.

Keywords *Inventory Control, fore casting, Genetic Algorithm, Transshipment*

I INTRODUCTION

Inventory control or stock control can be broadly defined as "the activity of checking a shop's stock." However, a more focused definition takes into account the more science-based, methodical practice of not only verifying a business' inventory but also focusing on the many related facets of inventory management (such as forecasting future demand) "within an organisation to meet the demand placed upon that business economically. Other facets of inventory control include supply chain management, production control, financial flexibility, and customer satisfaction. At the root of inventory control, however, is the inventory control problem, which involves determining when to order, how much to order, and the logistics of those decisions. An extension of inventory control is the inventory control system. This may come in the form of a technological system and its programmed software used for managing various aspects of inventory problems, or it may refer to a methodology (which may include the use of technological barriers) for handling loss prevention in a business.

An inventory control system is used to keep inventories in a desired state while continuing to adequately supply customers, and its success depends on maintaining clear records on a periodic or perpetual basis. Inventory management software often plays an important role in the modern inventory control system, providing timely and accurate analytical, optimization, and forecasting techniques for complex inventory management problems. Typical features of this type of software include: inventory tracking and forecasting tools that use selectable algorithms and review cycles to identify anomalies and other areas of concern inventory optimization purchase and replenishment tools that include automated and manual replenishment components, inventory calculations, and lot size optimization

- lead time variability management
- safety stock calculation and forecasting
- inventory cost management
- shelf-life and slow-mover logic
- multiple location support

Through this functionality, a business may better detail what has sold, how quickly, and at what price, for example. Reports could be used to predict when to stock up on extra products around a holiday or to make decisions about special offers, discontinuing products, and so on. Inventory control techniques often rely upon barcodes and radio-frequency identification (RFID) tags to provide automatic identification of inventory objects including but not limited to merchandise, consumables, fixed assets, circulating tools, library books, and capital equipment which in turn can be processed with inventory management software. A new trend in inventory management is to label inventory and assets with a QR Code, which can then be read with smart-phones to keep track of inventory count and movement. These new systems are especially useful for field service operations, where an employee needs to record inventory transaction or look up inventory stock in the field, away from the computers and hand-held scanners.

II MEANING AND NATURE OF INVENTORY

In accounting language it may mean stock of finished goods only. In a manufacturing concern, it may include raw materials, work in process and stores, etc. Inventory includes the following things:

Raw Material: Raw material form a major input into the organisation. They are required to carry out production activities uninterruptedly. The quantity of raw materials required will be determined by the rate of consumption and the time required for replenishing the supplies. The factors like the availability of raw materials and government regulations etc. too affect the stock of raw materials.

Work in Progress: The work-in-progress is that stage of stocks which are in between raw materials and finished goods. The raw materials enter the process of manufacture but they are yet to attain a final shape of finished goods. The quantum of work in progress depends upon the time taken in the manufacturing process. The greater the time taken in manufacturing, the more will be the amount of work in progress.

Consumables: These are the materials which are needed to smoothen the process of production. These materials do not directly enter production but they act as catalysts, etc. Consumables may be classified according to their consumption and criticality. (d) Finished goods: These are the goods which are ready for the consumers. The stock of finished goods provides a buffer between production and market. The purpose of maintaining inventory is to ensure proper supply of goods to customers.

Spares: Spares also form a part of inventory. The consumption pattern of raw materials, consumables, finished goods are different from that of spares. The stocking policies of spares are different from industry to industry. Some industries like transport will require more spares than the other concerns. The costly spare parts like engines, maintenance spares etc. are not discarded after use, rather they are kept in ready position for further use

III **INDUSTRIAL SURVEY**

3.1.1 Investigation of process performed in gear manufactuiring industry is illustrated below:

Fig. 3.1 Inventory of long plates

Fig. 3.2 Finished product inventory

Fig. 3.3 Inventory of same part families

Fig. 3.4 Semi finished inventories.

Fig. 3.5 Similar application with different part families' inventories

Fig. 3.6 Storage of finished and semi-finished inventories.

Fig. 3.7 inventory of semi-finished goods

Fig. 3.8 Layout of store room in final gears for dispatch

V METHODOLOGY

5.1 Taguchi Method

The Full Factorial Design requires a large number of experiments to be carried out as stated above. It becomes laborious and complex, if the number of factors increase. To overcome this problem Taguchi suggested a specially designed method called the use of orthogonal array to study the entire parameter space with lesser number of experiments to be conducted. Taguchi thus, recommends the use of the loss function to measure the performance characteristics that are deviating from the desired target value. The value of this loss function is further transformed into signal-to-noise (S/N) ratio. Usually, there are three categories of the performance characteristics to analyze the S/N ratio. They are: nominal-the-best, larger-the-better, and smaller-the-better.

5.2 Steps Involved in Taguchi Method

The use of Taguchi's parameter design involves the following steps [3].

- Identify the main function and its side effects.
- Identify the noise factors, testing condition and quality characteristics.
- Identify the objective function to be optimized.
- Identify the control factors and their levels.
- Select a suitable Orthogonal Array and construct the Matrix
- Conduct the Matrix experiment.
- Examine the data; predict the optimum control factor levels and its performance.
- Conduct the verification experiment

5.3 Taguchi's rule for manufacturing

Taguchi realized that the best opportunity to eliminate variation of the final product quality is during the design of a product and its manufacturing process. Consequently, he developed a strategy for quality engineering that can be used in both contexts. The process has three stages:

- System design
- Parameter (measure) design
- Tolerance design

The statistical models related with different variables to analyze the variation between these variables, independent and dependent variable are specified for statistical modeling the actual condition and the possible condition with probability distribution analyzed linearly with regression function to enhance the situation such as in case of prediction, forecasting, machine learning casuals relationship these functions are used to differentiate observational data so that it proves how independent variable is an optimized formulation of dependent variables.

5.4 Previous method adopted in industry

The previous method that were adopted to operate the industrial process were

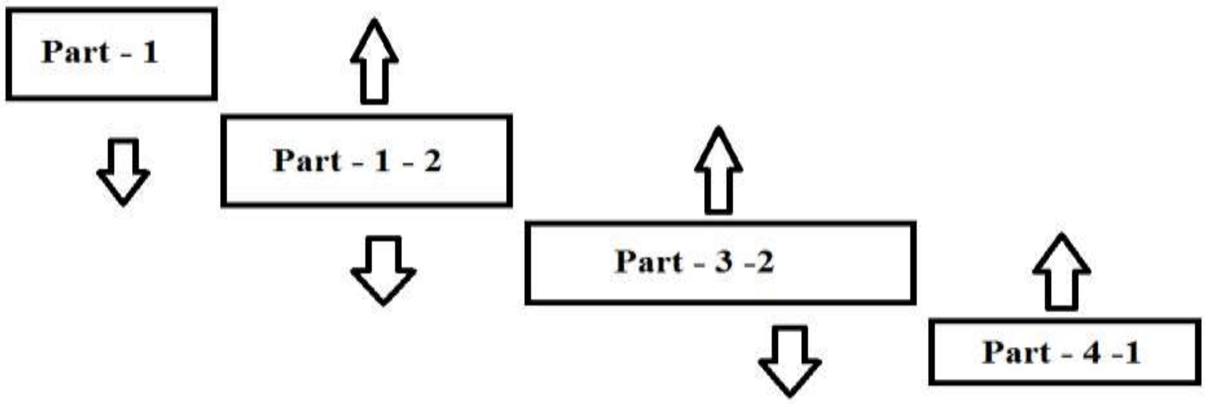
- Manual material handling.
- Step wise inventory storage.
- Manual material transfer.

5.5 Present methodology which would be adopted on behalf of present method

- Conveyor belt transmission between different departments.
- Optiz technique for inventory balance.
- Flexible manufacturing system in production area.
- Stair based material storage in inventory.
- Transshipment method in inventory system.

Advantage of present study

The enhancement that would improve performance of productivity in industry is by reducing overall production timing with different inventory demands this method also reduces man power and cycle time.



Stepped Inventories Technique

V COMPUTATIONAL RESULTS AND DISCUSSION

Validation of Present Study -

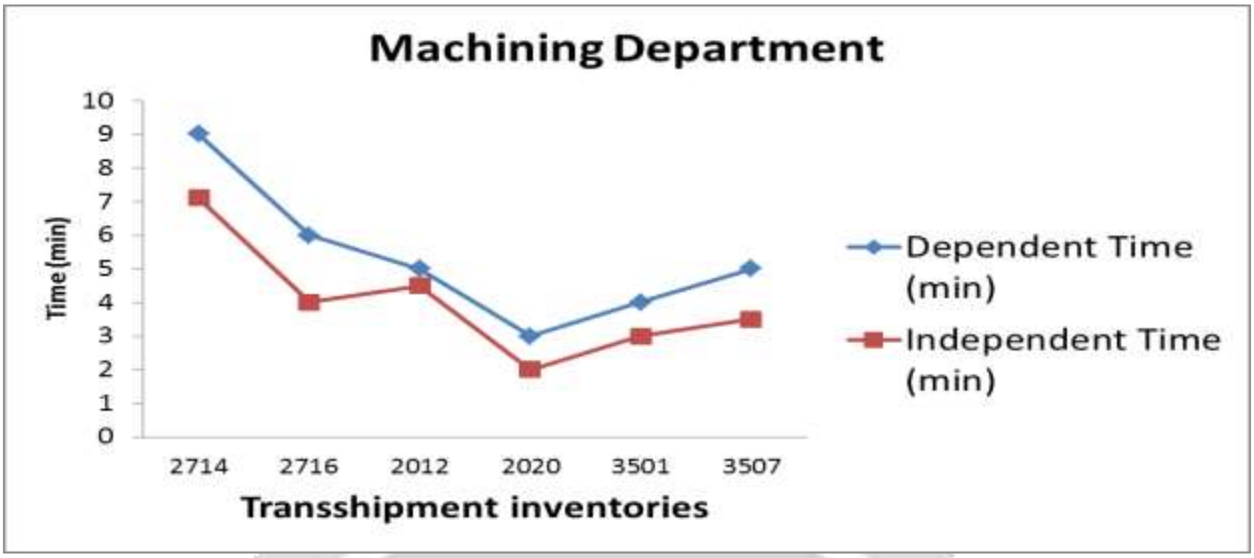


Figure – Representation of Inventory Arrangement Timing in Machining Department

The specifications of parts are described below:

2714 – Circular parts for facing

2716 – Circular parts for turning

2012 – Assembling of components

3501 – Axle components

3507 – Fastening components

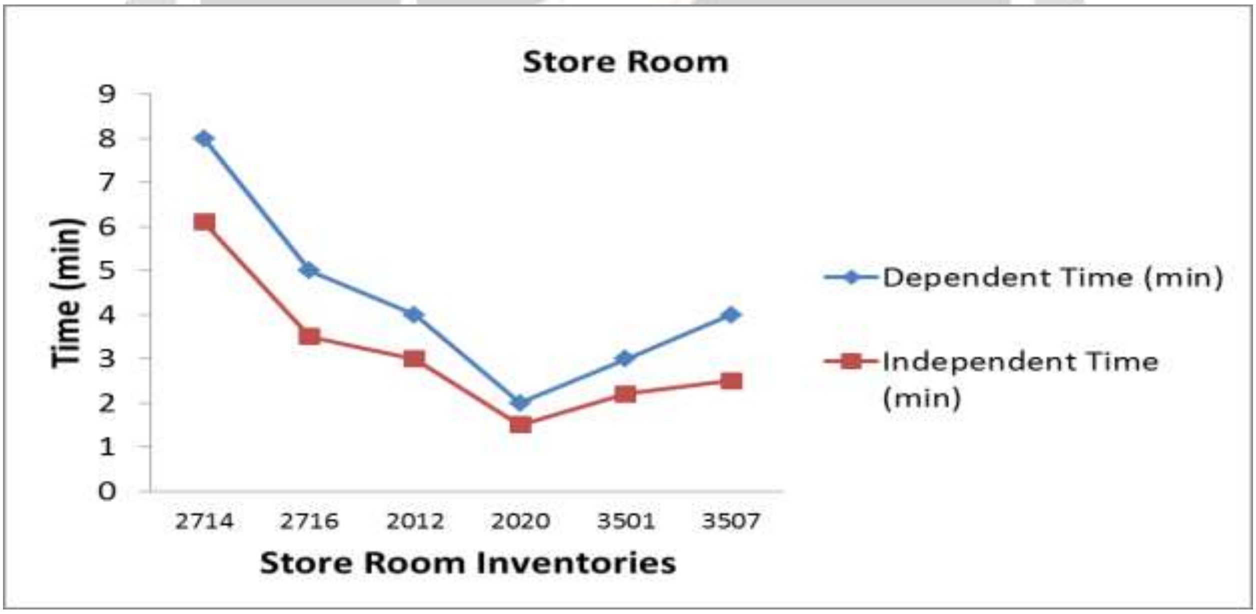


Figure – Representation of Inventory Arrangement Timing in store room

In above shown graph represents the timing of store room in respect of transshipment inventories and is determined as optimized independent timing with respect to transshipment inventories the dependent time is a time observed practically before application of transshipment independent time is a forecasted time after application of transshipment.

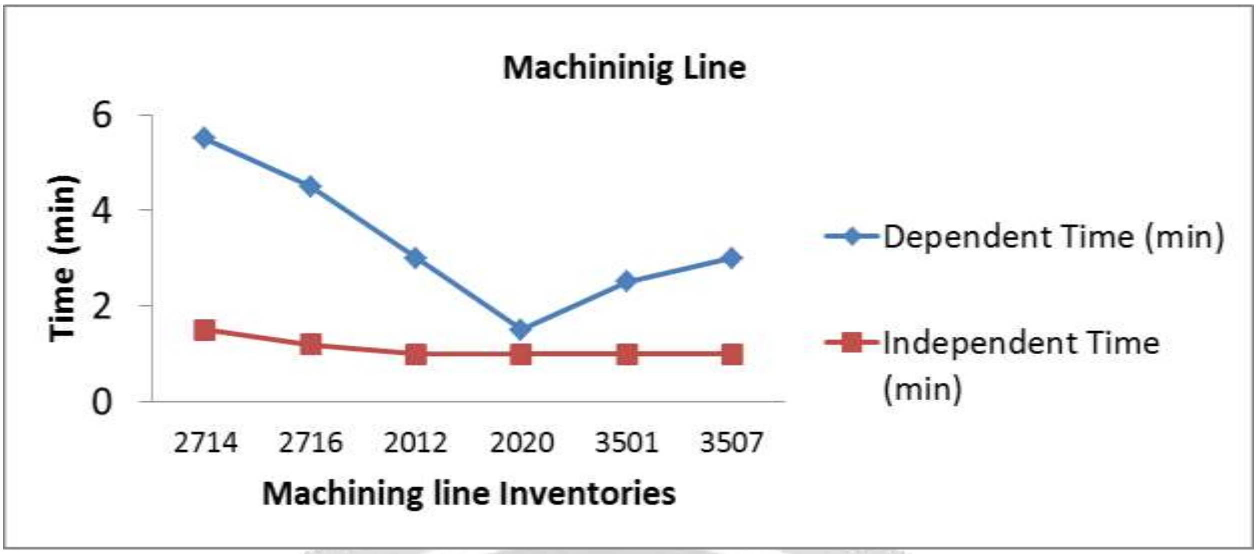


Figure – Representation of Inventory Arrangement Timing in Machining Line

In above shown graph represents the timing of machining line in respect of transshipment inventories and is determined as optimized independent timing with respect to transshipment inventories the dependent time is a time observed practically before application of transshipment independent time is a forecasted time after application of transshipment.

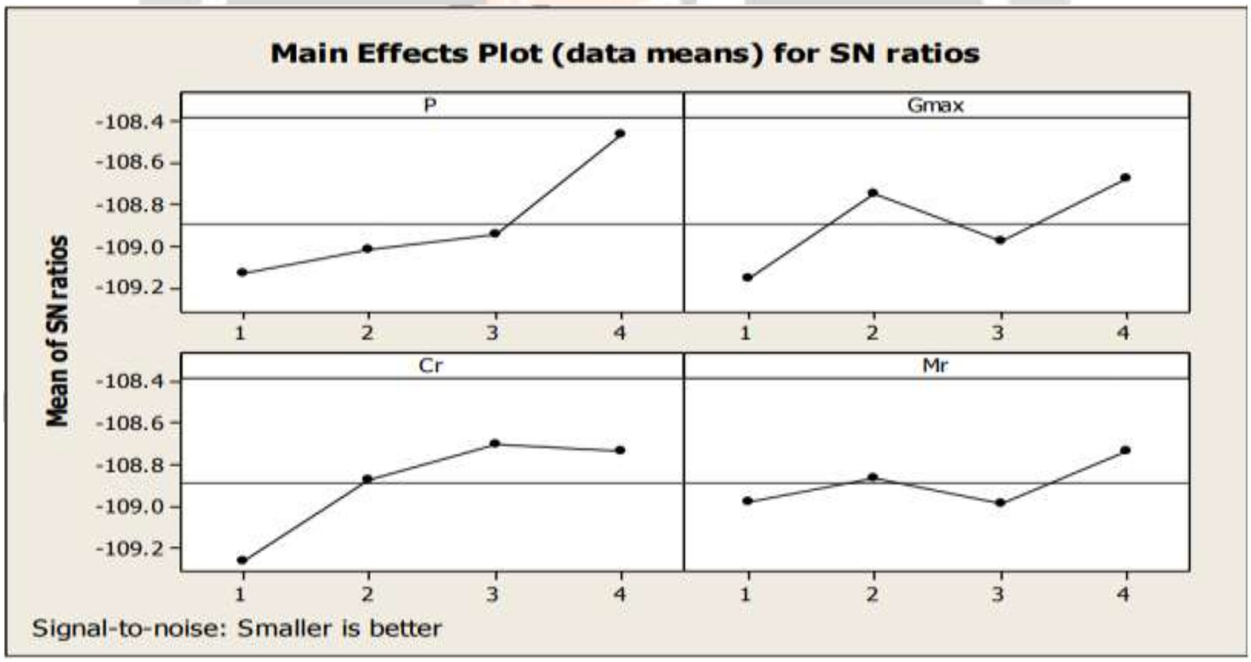


Table 6.1 Different levels of GA parameters used for turning

Factors (GA parameters)	Levels			
	1	2	3	4
Population Size	800	100	120	140
Iteration	100	150	200	250
Crossover rate	0.7	0.75	0.8	0.85
Mutation	0.25	0.3	0.35	0.4

Table 6.2 Result obtained from different designs of Taguchi approach

Design	GA parameters				Result
	Population size	Iteration numbers	Crossover rate	Mutation rate	Fitness Function
1	80	100	0.7	0.25	313442
2	80	150	0.75	0.3	278013
3	80	200	0.8	0.85	278013
4	80	250	0.85	0.4	277344
5	100	200	0.7	0.3	302842
6	100	250	0.75	0.25	277189
7	100	100	0.8	0.4	280789
8	100	150	0.85	0.35	270566
9	120	250	0.7	0.35	275589
10	120	200	0.75	0.4	275297
11	120	150	0.8	0.25	303253
12	140	100	0.85	0.3	267720
13	140	150	0.7	0.4	260027
14	140	100	0.75	0.35	265406
15	140	250	0.8	0.3	263677
16	140	200	0.85	0.25	270761

Table 6.3 The features of this study versus other studies

Study	Feature			
	Perishable product	Multiple period	Transshipment	Solution method
This study	√	√	√	Genetic algorithim and Taguchi approach
Coelho et al. 2012		√	√	Adaptive large neighborhood search heuristic

VII CONCLUSION

- Several studies are performed on the modeling and improvement of inventory routing downside by considering totally different assumptions like settled demand, random demand, multi-product, single amount, multi amount, transferal, and so on. Within the present study, a list routing downside was projected during which inventories are spoiled throughout their period of time.

- The employment of transferrable with the provider vehicle reduces the chance of probable stock-outs moreover because the transportation prices. within the projected model, because of the character of perishable merchandise, the utmost level (ML) policy has been utilized in order to satisfy the requirements of consumers. Because of the NP-hard nature of the model, an approach supported genetic algorithmic rule was adopted to resolve the matter.

- Vehicle routing and inventory decisions are made simultaneously
- Parameters are determined using Taguchi approach to achieve the best solution in inventories.
- An Actual case is used to illustrate the validity of the model
- It ought to be noted that, applied genetic algorithmic rule was designed supported the projected model.

References

1. AtaJalili Marand, Rosado, Pierluca Vitale, Carmenlucia S.G. Penteado, Umberto Arena., Joint inventory control and pricing in a service-inventory system, International Journal of Production Economics Volume 209, March 2019, Pages 78-91.

2. Anwar Mahmoodi, Joint pricing and inventory control of duopoly retailers with deteriorating items and linear demand, Computers & Industrial Engineering Volume 132, June 2019, Pages 36-46.

3. Ya Yang, "Cross perishable effect on optimal inventory preservation control", European Journal of Operational Research Volume 276, Issue 3, 1 August 2019, Pages 998-1012.

4. Qiang Wang, Charlotte Scheutz "Inventory control and supply chain management: A green growth perspective" Resources, Conservation and Recycling Volume 145, June 2019

5. Liu Xinbao, S. Thomas Ng "Replacement and inventory control for a multi-customer product service system with decreasing replacement costs" European Journal of Operational Research Volume 273, Issue 2, 1 March 2019, Pages 561-574.

6. Matthew E. H. Petering, Marion Loubiere, Matteo Vittuari "Inventory control with flexible demand: Cyclic case with multiple batch supply and demand processes," International Journal of Production Economics Volume 212, June 2019, Pages 60-77.

7. Allen H.Tai, David A. Turner, Jonathan Coello, Anne M. Stringfellow Ibrahim A. Bello a, William Powrie, Geoff V.R. Watson, "Joint inspection and inventory control for deteriorating items with random maximum lifetime," International Journal of Production Economics Volume 207, January 2019, Pages 144-162.

8. Felipe Silva Placido dos Santos, "An enhanced L-Shaped method for optimizing periodic-review inventory control problems modeled via two-stage stochastic programming," European Journal of Operational Research Volume 275, Issue 2, 1 June 2019, Pages 677-693.

9. Lina Johansson, Stewart Burn, Enda Crossin, Maazuza Othman, “Controlling Distribution Inventory Systems with Shipment Consolidation and Compound Poisson Demand” European Journal of Operational Research Available online 27 June 2019

10. Rohit Bhatnagar. The joint transshipment and production control policies for multi-location production/inventory systems. European Journal of Operational Research Volume 275, Issue 3, 16 June 2019, Pages 957-970.

11. Andrzej Bartoszewicz. Sliding mode control of inventory management systems with bounded batch size. Applied Mathematical Modelling Volume 66, February 2019, Pages 296-304.

12. Melanie Haupt, Thomas Kägi, Stefanie Hellweg: Life cycle inventories of waste management

13. processes, Data in Brief 19(2018)1441–1457.

14. E.Balugani and Animesh Dutta, Clustering for inventory control systems, IFAC-Papers online Volume 51, Issue 11, 2018, Pages 1174-1179.