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Development of Simulation Model for 100% Screening Policy in Supply Chain Management

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Abstract. There are published articles dealt with the integration of acceptance sampling and supply chain management using simulation models. This paper focus on developing simulation model for 100 % screening in supply chain management and considers supply chain model with the re-ordering system. Whatever be the good items produced, practically there are the possibilities of imperfect items or they might not satisfy the standards of production process. Therefore, it needs rectification. Hence, the researcher applies sampling plans in-between the stage of purchase and production process. Generally, after purchase, the entire lot is being sent to the production process, whereas, in this proposed model, the purchased lot is being sent to sampling inspection. In this stage, if the sampling inspection results are positive and the lot is accepted then only the lot is send it to production process. If the lot is rejected then it is allowed to the acceptance sampling process only after 100% screening. Under 100% Screening Policy the simulation model considers the cost effectiveness in supply chain also using the simulation software Goldsim 12.0.
Key Words: Acceptance Sampling, 100% screening, Inspection, Quality, Simulation Model, Inventory, Supply Chain Management

1. INTRODUCTION

ANSI/ASQC standard A2 (1987) defines acceptance sampling as the tactic which deals with procedures from that decision to be made for accept or reject a lot based on the outcome of the sample examination. In acceptance sampling, assessment of items can vary from 100% of the delivery to a relatively few items from which the getting firm draws inferences about the all the items received.

To separate bad lots from good ones, it is to give the attention in the following aspects i) simple administrative procedures ii) economy of observations iii) increase the lot size to reduce the risk iv) from a valuable source of information to use accumulated sample data v) more importantly the sample size should be reduced Hamaker (1960) when the quality is reliable and maintained at satisfactory level.

In this paper, non-Bayesian approach is applied for lot-by-lot sampling plan in the context of supply chain systems.

2. REVIEW OF LITERATURE

In this study, an attempt is made to integrate Acceptance Sampling in inventory of supply chain management with acceptance sampling with the help of simulation model.

Tagaras and Lee (1996) and Starbird (1997) extended the quality replenishment by examining both the supplier's and the customer's decision rather than the decisions of a single participant Larson (1989).

Salameh and Jaber (2000) developed an inventory situation where items received are not of perfect quality (defective), and after 100% screening, imperfect quality items are withdrawn from the inventory and sold at a discounted price. Maddah and Jaber (2008) extended these models by allowing several batches of imperfect quality items to be consolidated and shipped in one lot. This is likely to be useful when there are economies of scale in shipping of imperfect quality items. The analyzed effect of screening speed and variability of the supply process on the order quantity showed that the order quantity in the model is larger than that of the classical EOQ model when the variability of the yield rate is reasonably low.

RaviSankar S and Jeganathan M (2019) Compared of Double Sampling Plan with Single Sampling

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Plan in Supply Chain Management and also developed a Supply Chain Model for Attribute Acceptance Single Sampling Plan using Simulation,

Ben Daya and Noman (2008) recognized integrated models for inventory scrutiny for non-conforming items of both with and without replacement. They anticipated a study between different policy for assessment: no scrutiny, sampling technique and 100% check.

For the same class of supply chain in a stochastic dynamic context, where the manufacturing system is facing a delayed supply and without consideration of quality. Hajji *et al.* (2011) determined the optimum decision variables consisting of the production rate and the sequence of supply orders. Indeed, they showed that the optimal control policy for a joint production and replenishment problem is defined by a combined HPP and Re-order system policies.

Al Salamah (2011) has studied a model for Economic Order Quantity where the quality of the acknowledged bunch of items is controlled by a critical acceptance sampling procedure. Wan *et al.* (2013) considered the support effect of acceptance sampling plans quality product in the supply chan. Recently, Kang *et al.* (2019) also discussed imperfect quality models however it is not a simulation study.

Hariharan Ganeshan and Dr P Suresh (2016, 2017) has arrived a mechanism to measure the improvement in supply chain performance by considering different measures related to increased production, waste reduction, reduce machine breakdown, low transport and inventory cost and also increases of business performance such as sales and revenue.

Though there are many such studies were conducted for imperfect quality involved supply chain systemand though they used sampling plans, no research has been carried out to design simulation models using software.

3. OBJECTIVE OF THE STUDY

The primary intention of this work is to build up simulation model for 100 % screening in-between the stage of purchase of goods and it reaches the manufacturing process in the overall supply chain process.

4. RESEARCH METHODOLOGY

In this study, the simulation technique is used to design the models for 100 % screening in-between the stage of product purchase and the material reaches the production unit in supply chain management system.

GoldSim (12.0) is specifically designed simulation based software to quantitatively address the inherent uncertainty in real-world systems. It is a user-friendly and well supported for graphical presentation. In addition, it provides powerful capabilities to cover up the happening of discrete events into continuously varying systems. In this study, GoldSim is used for the realistic simulation of discrete events such as financial transactions and amount of resources utilized.

5. DEVELOPMENT OF SUPPLY CHAIN MODEL

In this paper, re-ordering system is having the basic assumption of the items submitted for production process or purchase by the people. However, practically there are possibilities of getting imperfect items i.e., defective or it might not meet the required standards of production process. Therefore, there is a need for rectification of the defective / imperfect items. Hence, the researcher applies acceptance sampling in-between (during the production process) the stage of purchase and production process. Generally after purchase, the entire lot is been sent for production process. But in this proposed model, the purchased lot is being sent for sampling inspection. At this stage, if the acceptance sampling results are positive and if the lot is accepted, then the lot is being sent to production process. If the lot is rejected then it will be sent to 100% screening. And after that, the lot will be again sent to the previous stage. In some situations the lot will be sent back to the supplier itself for replacement, but this situation is not considered in this study.

In the proposed model, if there is any defective which is being found, say for example 1%, that particular defective lot is being sent for sampling inspection. Sampling inspection will decide whether the lot has to be sent for direct production or it has to undergo screening. If the lot is being sent for production directly, then the finished product will also reflect the same percentage of defective, which was detected in the raw material lot. This means the production level has to be increased, i.e. instead of producing 100 items, 101 items have to be produced.

Considering another situation, where the defective item is being sent for screening. The screening is actually good, because all the defective items will be replaced. Therefore, after the production process the finished goods will be free from defectiveness. However, 100% screening policy is a bit costlier when compared to sampling inspection. So, the decision will be taken by considering whether the lot has to be sent for inspection or not. If the lot is sent for inspection, it has to undergo rectification process which involves rectification cost. If the lot is sent for inspection, it incurs just the inspection cost. If the customer is receiving defective lot, then it incurs warrant cost, and to produce extra items it again incurs manufacturing costs. All

these aspects need to be considered for having a good production process. However, if analytical models are considered for deriving at some equations, it becomes more complicated since we need to consider more parameters. Hence, the researcher is trying to solve this with the simulation model. In the simulation model, all the parameters are being fixed with numerical values to find out the total cost of implementation and optimal model is being determined.

GoldSim software is being used because this model involves inventory cost, storage cost (if the produced lot has to be kept inside the go down it involves cost for storage), back-order cost (if there is shortage of goods or if there is any delay in delivery of the lot) and ordering cost. The GoldSim has the capability of doing the computations of time durations, cost and inventory levels, etc.

6. 100% SCREEN POLICY MODEL

This chapter deals with the simulation modeling and construction of sampling plans in supply chain management and considers supply chain model with the re-ordering system. Whatever be the good items produced, practically there are the possibilities of imperfect items or they might not satisfy the standards of production process. Therefore, it needs rectification. Hence, the researcher applies sampling plans in-between the stage of purchase and production process. Generally, after purchase, the entire lot is being sent to the production process, whereas, in this proposed model, the purchased lot is being sent to sampling inspection. In this stage, if the sampling inspection results are positive and the lot is accepted then only the lot is send it to production process. If the lot is rejected then it is allowed to the acceptance sampling process only after 100% screening.

According to Hlioui *et al.* (2015), the three different quality inspection policies are summarized as 100% policy with rectification process is given by

$$\begin{cases} Inspection\ limited\ to\ the\ sample\ of\ size\ 'n'; & if\ x \leq c \\ 100\%\ inspection\ and\ rectification\ process; & otherwise \end{cases}$$

However, 100% screening policy is costlier than sampling inspection. So, the decision regarding whether the lot has to be sent for inspection or not will be taken based on this fact only. If the lot is sent for screening, it involves rectification, which incurs rectification cost. If the lot is sent for inspection, it incurs just the inspection cost. If the customer is receiving a defective lot, then it incurs warrant cost, and to produce extra items, it again incurs additional manufacturing cost. Hence, each and every item needs to be considered for having a good production process. However, if analytical models are considered for deriving at some equations, it becomes complicated because of the involvement of a greater number of parameters. Therefore, the researcher is trying it with simulation model. In the simulation model, all the numbers are being fixed to find out the total cost of implementation and optimal model is being determined. The GoldSim software is being used in this research because it has the capability of doing the computations of time durations, cost and the inventory levels, etc., Of course, it involves inventory cost, storage cost, back-order cost if there is shortage of goods or if there is any delay in delivery of the lot and ordering cost.

6.1. Development of Simulation Model

It is explained that after purchase, the lot is being sent to the sampling inspection after which the lot is sent to production process. Finally, the lot will be sent to sales. The decisions regarding the purchase are taken based on the stock level. The level of production will be determined based on the availability of raw material. If the stock level is less than the expected level and then there will be a need for a new purchase order. This is called as the re-ordering system. In the simulation models, the arrows are used just for referencing and not to show the flow of the process.

6.2. Process Flow for Supply Chain System

A supply chain process flow is given in the Figure - 1. The process flow is being elaborated below to illustrate how the supply chain system is working:

A supply chain process is given in the Figure-1, which shows the supply chain process i.e. from purchase the lot is being sent to sampling inspection after which the lot is being sent to production process (the arrows are used just for referencing and not to show the flow of the process).

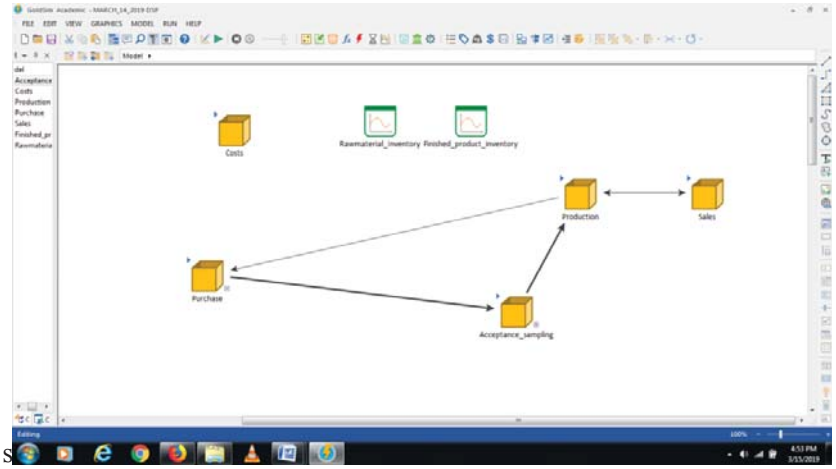

FIGURE 1. Operating Procedure for the supply chain system

Finally, the lot will be sent to sales after production process. Purchase decisions are taken based on the production unit. The level of production will be determined based on the availability of the raw material. If there is any change, it is called as the re-order system, i.e. if stock level is less than the expected level, there will be need for new purchase order.

7. CONCLUSION

Simulation model have been developed for accepting the raw material for sending to the production process how 100% screening policy is adapted to ensure the quality input for the production process in the overall supply chain. This would be useful for floor engineers who are the in-charge of quality control for systematic inspection process. Further a set of tables can be constructed for various acceptance sampling plans for 100 % screening of Supply Chain Management by assuming different demand values (D) for three different types of cost patterns namely, Low cost Raw material, High cost Raw material and Low Storage cost.

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