Inventory Model for Items with Imperfect Quality and Screening at Vendor Site

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During production, items produced cannot be of perfect quality and some items produced may be defective due to imperfect production. Identification of defective items at early stage and their efficient management is very important to reduce overall loss. Through this paper various ways to dispose defective items have been discussed and a model has been proposed for screening of defective item from a lot of items at the vendor site in a single-vendor single-buyer situation for a single product. It is also assumed that the screening process itself is not perfect due to human errors.

Key Words: Imperfect Quality, Imperfect Screening, Single Vendor, Single buyer, Single product

Introduction

Defective items at production stages of a supply chain directly impact the coordination of the product flow within its supply chain. In response to this concern, production and inventory lot sizing models, which incorporate imperfect items into their formulation of models, have become an important and growing area of research. Items are being produced by the producer in a batch as per market demands and orders. The quality of the production could not be of a perfect quality, so each batch contains some defective items in it. The vendor sends items produced to the consumer through its dealers (buyer) as soon as the lot size becomes equal to the Economical Lot Size determined by a Supply Chain Inventory Models. The dealer starts screening of the items as soon as it arrives. The dealer can have different types of screening.

Salameh and Jaber (2000) first gave Economic Order Quantity (EOQ) model. As per their paper assumptions used for economic order quantity (EOQ) models needs to be justified. They gave emphasis to include more factors that contribute to the cost of the inventory. They had given a situation where an item is of imperfect quality; not necessarily defective; could be used in other production/inventory where these items can be utilized. The paper extended traditional EOQ model by accounting for imperfect quality items. The paper also considers that poor-quality items could be sold as a single batch by the end of the 100% screening process.

Goyal & C’ardenas-Barron (2002) published a Note which presented a simple approach with the optimal method for determining the economic production quantity for an item with imperfect quality.

Wee et al. (2007) had developed optimal inventory model as shown in figure 1 for items with imperfect quality and shortage back ordering with a view of the fact that poor-quality items do exist during the production. Defective items are filtered during the screening process and removed from the stock. It may lead to shortage of the items in the supply chain system and buyer has to wait for new the lot to arrive and to screen.
After arrival of a lot $t$ time is required for screening process. At the end of the screening process $py$ items found defective from $y$ items received from the vendor and inventory level of the dealer drop by it (i.e., $py$). During the period $t$, the inventory meets the market demand. After the time $t$, the inventory of the item becomes zero and buyer have to wait for the arrival of new lot. There are backorder of $B$ items during the period. When the new lot arrives the backorder of $B$ items will be clear.

Maddah & Jaber (2008) rectified Economic Order Quantity (EOQ) Model of Salameh and Jaber (2000) with unreliable supply. They extended the model by allowing for several batches of imperfect quality items to be consolidated and shipped in one lot.

Wahab and Jaber (2010) presented the optimal lot sizes for an item with imperfect quality based on Salameh and Jaber (2000), Maddah and Jaber (2008), and Jaber et al. (2008) where different holding costs for the good and defective items are considered. They showed that learning in the system could reduce the differences between the lot sizes with and without different holding costs for the good and defective items.

Hus & Hus (2012) worked on the model proposed by Wee et. al. (2007). They pointed out contradictions between Wee et. al. (2007) model and assumptions used in the model. In Wee et. al. model backorder of B items are cleared as soon as the lot of new items arrived. They did not consider the time needed to screen B items before clearing them. Hus & Hus (2012) developed a corrected model as presented in figure 2.
The model shows that time is required to clear backorder. During this period the market demand and backorder are cleared and is equal to the screening rate of items. The slope of the above figure during the period represent rate of screening. After this period items are sold in market as per the market demand. This slope is represented in the above figure from $t_1$ to $t_2$ and $t_2$ to $T$.

Above all models are based on assumptions that all items are being produced by vendor and supplied to its dealers. A dealer after receiving items from the vendor conduct screening test of items. Items found defective are either sent back to the vendor or sold by the dealer at lower price in the market. The purpose of this paper is to explore alternative ways to deal with defective items found during screening test.

2. Handling Defective Items Found in Screening Test

Items found defective in the screening test are not waste but have some market value. Due to production of defective items, the vendor has to incur some loss. Selection of an appropriate alternative for disposal of defective items reduces the loss to the vendor. The vendor should try to explore alternatives. Following are the ways the defective items could be handled.

1) There are some defects which can be easily rectified by spending some more money on defective items. The vendor has to take decision whether he will go for rectification of items or sell them at discounted price. If the cost of the rectification of items is very less and cost of rectification plus the selling price of defective items in market is less then selling price of the item then vendor should go for rectification otherwise items should be sold at discounted price.

2) If the cost of rectification of the item is high or quality of items after rectification is low/unsatisfactory, then it would be better to sell the defective items at discounted price in the market.

3) Defective items which cannot be rectified and have no market value should be sold as scrap

4) Defective Items not traced during screening can be sold in the market. The user of the items finds defect and gets replacement by fresh one. These items are returned to the vendor for disposal if it could be rectified otherwise it could be sold in the market as scrap (no market value).

3. The Model that perform screening at the vendor site

In all the above research papers screening of items are done by dealers. Defective items also contribute to the total transportation cost. Screening at vendor site not only reduces the cost of transportation, but also gives more options to deal with defective items in efficient ways.

Assumptions of the model

a. The demand rate is known, constant and continuous
b. The lead time is known and constant
c. The replenishment is instantaneous
d. Screening is performed at vendor site
e. The screening process is not perfect and there is error in screening.
f. The screening process and production proceed simultaneously
g. The defective items exist in the lot size y.
h. Single product is considered
i. Single buyer is considered
Here, a model has been proposed as given in figure-3 that performs screening at vendor site and consider that there may be errors in screening process also in single vendor and single buyer situation. The vendor produces items in a lot ($y + B_3$). The screening process starts immediately after the production at the vendor. During the screening $B_3 = py$ items found defective. $p$ is the probability of an item to be found defective. Defective items are removed from the inventory immediately after screening and send for disposal. When screened items level reaches to the lot size $y$, the lot is transported to the dealer (the buyer) immediately, reducing the inventory level to zero for the vendor. Following fig shows inventory level of the vendor. One cycle completed in $T$ time.

The dealer (the buyer) receives items in lot size of $y$. It sells items in the market. As it has been assumed in the model, there are possibilities of screening errors in the screening process. These errors are of two types

1) Non-Defective item declared as defective items (items are with vendor)

2) Defective items declared as non-defective item.

The first error causes loss to the vendor as fresh items are being sold at discount. If
4. Conclusion

Various options for disposal of defective items have been discussed in this paper. An outline of the inventory model which deals with defective items with imperfect production and imperfect screening at vendor site for single vendor and single buyer of single product has been given. Screening has to start with production of items and defective items found could be immediately sent for disposal. Level of the inventory will be reduced by $B_n$ (number of defective items found in screening) which results into cost saving. Due to imperfect screening, some items still penetrate into market and their defect are found by the consumer of the items. Consumer returns them and an inventory of these defective items are maintained at buyer site. These defective items are sent back to the vendor for disposal. A mathematical model of this model is area of further work.

References