A REVIEW OF ORDERING POLICIES FOR THE FIXED LIFETIME INVENTORY SYSTEM

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Abstract
The ordering policy adopted by any inventory manager play a major role in the success of the inventory system. The ordering policy which determine what to order (quantity to order) and when to order (time to order) has over the years been based on the quantity of on hand inventory or the number of useful lifetime remaining on the items in inventory. In this work, we review some ordering policies for fixed lifetime inventories over the last three decades.

Keywords: ordering, policy, inventory, order, outdates, shortages.

Introduction

A fixed lifetime inventory system is one where items in inventory has a fixed shelf life or constant utility. Since the lifetime of items is fixed, they outdate if not used to meet demand at the end of the useful lifetime. It is therefore the goal of inventory manager to maintain inventory that ensure items are available to meet demand whenever demand arises and also to ensure items do not over stay inventory to avoid outdating.

The ordering policy for a fixed lifetime inventory system is the policy that determines what quantity of items to be ordered and what time the order is to be placed. In this work, we examine some of the ordering policies in the literature, advantages and disadvantages associated with each policy to be discussed. Some researchers have based the decision to order on the quantity of items on hand while others on the number of useful lifetime remaining on the items on hand in inventory. Also, some ordering policies allow a fixed positive lead between when orders are placed and when they arrive in inventory. Some policies adopt instantaneous arrival, that is the items arrives as some as orders are placed. Examples of fixed lifetime inventory are given in Table 1.

Table 1: Some Fixed Lifetime Items and their Useful Periods

S/N	Product	Useful-lifetime	Source
1	Blood	21days	Shelflive.com
2	Bread	4-7 days	Shelflive.com
3	Rice	12months	Shelflive.com
4	Tea bags	18months	Shelflive.com
5	Milk	12months	Shelflive.com
7	Sugar	4months	Shelflive.com
8	Vegetable oil	6months	Shelflive.com
9	Baking powder	18months	Shelflive.com

The goal of every ordering policy is to minimize outdates and shortages in the inventory system. Outdates occur when items in inventory are not used to meet demand by the end of their utility and shortages occur when there are no items on hand to meet demand whenever demand arises. Millions of naira are lost annually to outdating as reported by Izevbizua and Omosigho (2017) in Table 2.

Table 2: Losses from outdated products

S/N	Time	Value of outdated products (N)	Source
1	April 2001-December 2004	NAFDAC destroyed expired products worth 2.4 Billion	www.nafdac.gov.ng
2	First quarter of 2012	NAFDAC destroyed expired goods worth 810 Million voluntary handed over to the Agency	Guardian news paper 4th May,2012.
3	February 2013	NAFDAC destroyed expired products worth 140 million	www.nafdac.gov.ng
4	November 2013	NAFDAC destroyed expired drugs handed over by Aba Traders worth 30Million	www.nafdac.gov.ng
5	December 2013	NAFDAC destroyed fake and expired products worth 525Million	Daily Newswatch 11th February, 2014.
6	August 2015	NAFDAC discovered an illegal factory within the trade fair complex in Lagos loaded with expired canned food worth Millions of Naira	Vanguard and Tribune 7th August, 2015.
8	August 2015	NAFDAC arrested five persons in Lagos for selling expired tomatoes paste worth millions of naira	Vanguard 8thAugust, 2015.
9	March 2016	NAFDAC destroyed expired malt and glucose belonging to Guinness Nigeria Plc worth millions of naira	PM news 9th March 2016.
10	March 2016	NAFDAC destroyed N1bn worth of expired drugs	Punch Newspaper 25th March, 2016.

Looking at Table 2, the need to reduce the quantities outdating in the fixed lifetime inventory systems cannot be over emphasis and one way to achieve this is using the right ordering policy.

Some Ordering Policies in the Literature
In this section, we present existing ordering policies in the literature. We shall also look at the advantages and disadvantages associated with each ordering policy.

1. Critical Level Policy: The ordering policy was developed by Cohen (1975). It states that a new order is placed whenever the inventory level drops below a critical level. The critical level is predetermined by the inventory manager and can be adjusted from time to time depending on the prevailing demand. The policy is based on the quantity of items on hand and the age of items is not considered by the ordering policy. Outdating may be a problem since the age of the items is not considered.

2. s, S **Policy:** The policy was first discussed by Nahmias (1978) and was later used by Liu and Lian (1999). The policy states that we order up to S whenever inventory level drops to s. Again, the level s is predetermined by the inventory manager and does not consider the age of the items in inventory. The policy is effective, if the issuing policy is FIFO as the older units will be use to meet demand before the new ones. A good example is a woman who orders 100 bread and only reorder whenever the number of bread drops to 30. She reorders to bring back the quantity on hand to 100.

3. $S-1, S$ **Policy:** The policy was first used by Schmidt and Nahmias (1985) and later by authors such as Perry and Posner (1994), Kranenburg and Van Houtum (2006), Olsson and Tydesjo (2010), etc. The policy also known as one for one policy states that we order up to S, whenever inventory is depleted by 1. Inventory is depleted by either demand or outdating. Age of items is not considered by the policy and it's applicable to heavy inventory with large useful lifetime.

4. Q, r **policy:** The policy was developed by Chiu (1994) and later used by authors such as Bookblinder and Cakanidirin (1999), Mohammed el ta (2007), Emre and Ulku (2008) and Hariga (2010). The policy states that we order Q quantity whenever on hand inventory drops to r. The policy allows a positive leadtime and does not consider the age of items in inventory. A good example is a woman who sells bread. She order 100 bread whenever the number of bread on hand drops to 20 that is $(Q, r) = (100, 20)$. The policy may encourage outdating if demand is low and inventory managers must wait for the number of bread on hand to drop to r.

5. S, T, Q **Policy:** The policy was used by Hwang and Hahn (2000). It states that we order up to S at every fixed time T and the quantity ordered is Q. Q is the difference between the current inventory level and order up to S level. Here the decision to order is time based and the policy does not consider the age of items in inventory. Also, it may encourage outdating of items since T is fixed and one has to order weather there items on hand or not, when we get time T.

6. s, c, S **policy:** The (s, c, S) policy is a joint replenishment policy, also known as the can-order policy used when dealing with more than one item. The policy states that when inventory drops to or below the must-order level s an order is placed to bring the inventory position up to S. However every item have a can-order level c. Whenever an item reached the s level, any other item with inventory position at or below its can-order level is included in the new order even though the item has not reached the must –order level. The policy was used by Johnansen and Melchiors (2003).

7. The minimum volume policy: The minimum volume policy was used by Shen et al (2012). The policy seek to maintain a certain minimum stock level at all time. So whenever inventory drops below this level, new orders are placed to bring back inventory level to the required minimum. The policy is conservative and may create shortages in the inventory system.

8. The $(1, T)$ **policy:** The $(1, T)$ policy states that we order 1 at every fixed time T. It's a special type of $(S-1, S)$ policy and was developed by Mahmoodi et al (2015).

9. The (s, S, R) **policy:** The (s, S, R) policy states that we order up to S whenever inventory drops to s at every fixed review interval R. The policy is credited to Silver et al (2012).

10. The $(y, m-1)$ **policy:** The $(y, m-1)$ policy was developed by Izevbizua and Omosigho (2017) and it states that we order y when the useful-lifetime remaining on the items on hand is 1 period. The number of periods remaining on items before placing a new order can vary from one product to another depending on the prevailing demand. For example when demand is high, the ordering policy can be $(y, m-2)$, which is interpreted as order y when the useful-lifetime remaining on the items on hand is two periods. This ordering policy considers the useful lifetime of the items in placing new orders and as has the potential to reduce outdating, a major concern of fixed lifetime inventory managers.

Finally, we highlight the features of quantity based ordering policies and useful lifetime ordering policies.

Features of Quantity Based Ordering Policies
1. The decision to reorder is based on the quantity of items on hand in inventory.
2. A fixed amount of items chosen by the inventory manager decides the reorder point.
3. The ages of the items in inventory is not consider in reordering new items.
4. The policies are rigid as no new order is placed until inventory level drops to the reordering point.

Features of Useful Lifetime Based Ordering Policies
1. The decision to reorder is based on the number of useful lifetime remaining on the items on hand in inventory.
2. The ages of items is considered before placing a new order.
3. The policy is flexible as the number of period(s) remaining before placing a new order can alter in line with prevailing demand.

Conclusion
One way to minimize the number of items outdating in a fixed inventory system is to adopt the right ordering policy. A ordering policy that will order in such a way that outdates and shortages are minimized. A good ordering policy will also help, reduce the problem of repackaging of outdated items (especially food and pharmaceuticals) which is common in our country. Besides securing the health of our people, adopting the right ordering policy will lead to economic growth as big, medium and small companies will have reduced number of outdated items.

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