Simulation modelling to analyze the significance of a dynamic ordering policy with fresh produce in a large scale retail operation

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***Abstract* __ Simulation is the imitation of the operation of a real world process or system overtime with intention of studying the behavior of the system or the process under different conditions. In this study, the authors attempt to model a fresh produce inventory system of a large scale retail operation with a renowned simulation software package, namely "Rockwell Arena Simulation Software (Student version)" in order to experiment upon the hypothesis of the consistence of a dynamic ordering policy over a periodic review, deterministic inventory replenishment policy. A single product inventory system is considered which is assumed to be depleted in a Weibull fashion and no backorders are allowed at the presence of unavailability of products. Furthermore, by emphasizing the need to have a considerable amount of on display quantity, the authors strive to imitate almost the real world system with very slight amount of deviations.**

I. INTRODUCTION

A walk in to almost every supermarket provides the impression of large stockpiles of fresh food. Consumer choice for retailers is significantly influenced by the assortment and shelf availability of fresh food, and food supply chain management gains strategic importance in retail competition (4). Hence, the importance of a service level approach becomes essential in this context. On the other hand, it's obvious that millions of dollars of worth food are expiring every day due to deterioration. Furthermore, a huge cost is acquired inherently with the keeping lot more inventories. These two arguments reinforce the well-known newsvendor trade-off between ordering too few or too many items of fresh produce. Hence, the significance of having a rational replenishment policy has become a critical aspect. Practically, in most of the retail chains, a deterministic, periodic review replenishment approach is adopted. Simply, they order a pre-determined amount of the product routinely. The authors attempt to demonstrate the significance of a dynamic, continuous review ordering policy over a deterministic, constant review ordering policy by simulating a typical retail fresh produce inventory system. The rest of the paper is organized as follow. In section 2 we cite for previous work done. Section 3 demonstrates the model by introducing the mathematical formulas and assumptions while the section 4 summarizes the results of the study. Finally, we present the conclusion and future work of the study in section 5.

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II. LITERATURE REVIEW

According to [1], adopting a service level based approach is significant as the unavailability of fresh produce on the display passes the bad impression that the available goods are old. It leads to loss the goodwill towrds the company and results in continuos lost sales. Furthermore, [2] emphasizes that the demand for fresh produce of retailers is usually influenced by the amount of stock displayed on the shelves. When it comes to the inventory related costs, most of recent papers including [3] assumes the holding cost to be an increasing function of time. Furthermore, the inventory is considered to be depleted in Weibull fashion. The developed model will be based on the assumptions and the numerical values provided by the literature above.

III. METHODOLOGY

In this study, the authors use the Rockwell Arena Simulation Software (Student version) to visualize a computer based model of the behavior of a real world retail fresh produce inventory. The authors do their best to represent the actual system by embedding more and more decision making modules in to the model. The assumption (as depicted in Table 1), the equations used are as follow.

(A) *Assumptions*

1	No backlogging is allowed. All the shortages are considered to be lost sales
2	The holding cost is an increasing function of time; $C_1(t) = a+bt$, $a>=0$, $b>=0$ [3]
3	The deterioration cost is considered to follow a Weibull distribution with $\Theta(t) = \alpha\beta t^{\beta-1}$; $0<\alpha<1$, $\beta>0$ [3]
4	The order lead time is assumed to be zero
5	The maximum limit of on display quantity is 200 units
6	If the number of units on display is less than 20, the customer will not buy
7	If the entire demanded quantity is not available in the inventory, there's 75% possibility to buy the existing quantity.
8	The ordering cost is independent of the number of units ordered. It's 15$ per each order. [3]
9	The lost sales cost per unit is 0.012$ [3]

Table 1 - Assumptions

(B)Formulas

t_1 – End time of the replications

- Based on assumption 2, The total inventory holding cost is;

$$= \int_0^{t1} a + bt$$

- Based on assumption 3, The total deterioration cost is;

$$= \int_0^{t1} \alpha\beta t^{\wedge}(\beta - 1)$$

Furthermore, in order to convince the major idea behind this study, the authors developed two separate inventory models with same characteristics but with two different inventory replenishment policies. The customer behavior that was depicted in two models which is almost similar to the typical retail fresh produce inventory is depicted in the following figure1.

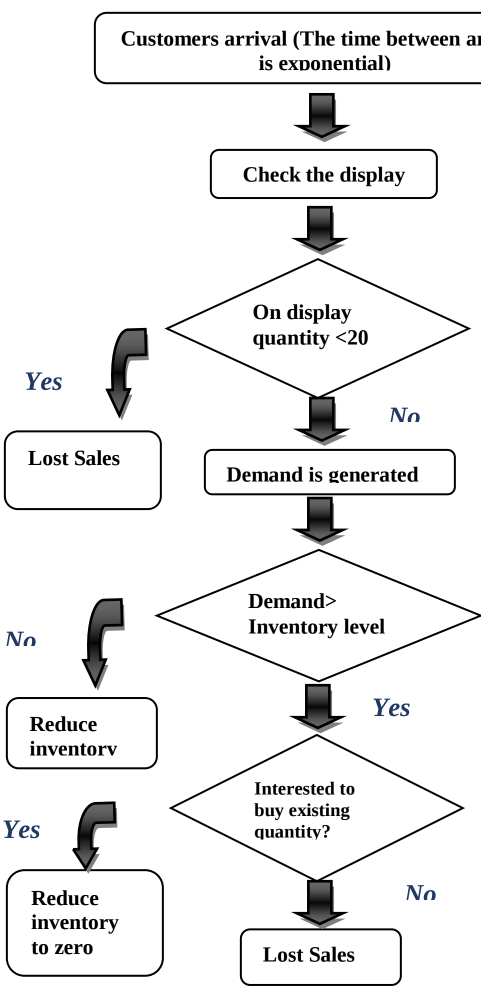


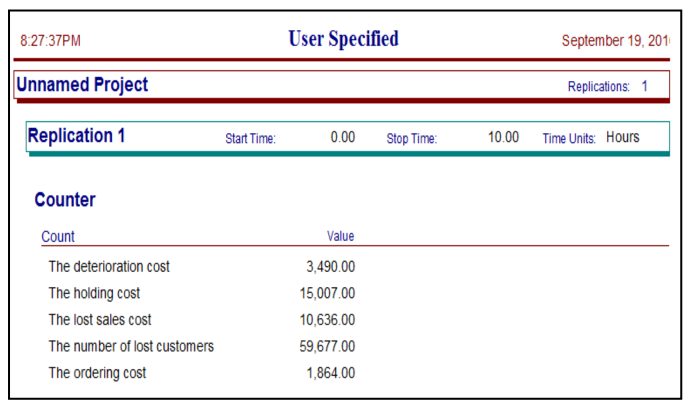
Figure 1- The customer behavior in brief

The first model (The inventory system with deterministic, periodic review replenishment policy) is developed so that the orders are placed in a routine manner with a pre-determined quantity and so that the above consumer behaviour is assisted. The second model (The inventory system with continuous, dynamic replenishment policy) follows the (R,Q) replenishment policy. It continuously checks the inventory level and ones it's dropped down to the reorder level of 150, the inventory is refilled so that it becomes equal to the order up to level of 1000.

IV. RESULTS

Two models were compared against 2 very important KPIs (Key Performance Indicators) namely the total cost of the inventory (Ordering cost, Holding cost, Deterioration cost and the lost sales cost) and the total lost customers.

The Deterministic, periodic review inventory policy



8:27:37PM User Specified September 19, 201

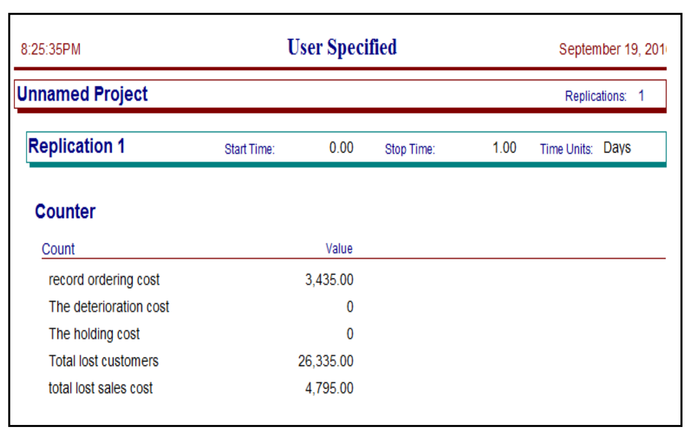
Unnamed Project Replications: 1

Replication 1 Start Time: 0.00 Stop Time: 10.00 Time Units: Hours

Counter

Count	Value
The deterioration cost	3,490.00
The holding cost	15,007.00
The lost sales cost	10,636.00
The number of lost customers	59,677.00
The ordering cost	1,864.00

The dynamic, continous review inventory policy



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Unnamed Project Replications: 1

Replication 1 Start Time: 0.00 Stop Time: 1.00 Time Units: Days

Counter

Count	Value
record ordering cost	3,435.00
The deterioration cost	0
The holding cost	0
Total lost customers	26,335.00
total lost sales cost	4,795.00

It's crystal clear that the all the costs other than the ordering cost has been reduced in a considerable amount. And also, the number of lost customers also has been reduced in a considerable amount. The ordering cost is increased because with the dynamic ordering policy we continuously place orders when we need. But, the number of plus points are higher than the numbe of negetive points with the dynamic ordering policy. Therefore, based on this simulation study, we could prove that a dynamic ordering policy is better with a retail fresh produce inventory rather than a deterministic inventory replenishment policy.

V. CONCLUSION AND FUTURE WORK

The comparison convinces the significance of adopting a continuous review (Dynamic) replenishment policy for fresh produce in a retiail outlet as the consumer demand for fresh produce is highly uncertain. Furthermore, the fresh produce is a kind of way of cross selling. Thus, the better management of the shelf space as well as the inventory is essential.The developed dynamic order quantity model is capable enough to control the lost sales level by managing the on display quantity effectively. And also, it assists in minimizing the deteriotion cost, inventory holding cost as well.

A suggesion for future work for this study is, the minimum on display invnetory that should hold …. Etc can be found by doing emphirical research studies by analyzing big data. Furthermore, the other invnetory policies for the system can be checked for it's consistence with the retail fresh produce inventory systems.

VI. REFERENCES

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