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Inventory Management and Organisational Efficiency

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Abstract

The study examined inventory management and organisational efficiency. The classical inventory management techniques were applied to an organisation's inventory system. A door sales company in Ilorin, Nigeria that volunteered information on the basis of anonymity was used and relevant data were collected on six types of doors; panel, flush, sliding, folding and as well as manual and electronic garage doors. The company had no scientific inventory management strategy but the EOQ, inventory cycle time and reorder level were computed for the six doors using the average values of the data obtained for 2011-2017. The results show that the company can minimise its total inventory cost by consciously adopting an inventory management policy of ordering 55 panel doors, 41 flush doors, 41 sliding glass doors, 18 folding doors, 18 manual garage doors and 8 electronic garage doors respectively every cycle time of 17, 14, 17, 30, 35 and 34 days respectively or by placing the above orders each time the inventory level of panel doors, flush doors, sliding glass doors, folding doors, manual garage doors and electronic garage doors fall to 32, 24, 24, 5, 3 and 2 respectively and thus minimise the total cost of inventory.

Keywords: Inventory control; Inventory management; Inventory cycle time; EOQ and reorder level.

1. Introduction

Every person that is saddled with the responsibility of delivering services or providing products to end users will always want to provide a high service level at minimum cost. They'll like to deliver products and services at the due dates in order to gain customers' trust and confidence. Such trust and confidence can enhance customers' perception of product quality and hence position the product favourably in the hearts of the customers or end users of the product or service. Provision of high service level at minimum cost is the major essence of inventory management because inventory management acquaints the entrepreneur or intrapreneur with visibility of the organisation's stock levels at every point in the supply chain and thus assist in managing the stock on hand, when to reorder, and when to ship items.

Demand, cost structure and physical characteristics of the system are key variables in inventory management. But these key variables are not static. Uncertainty exists due to time value of money as far as the control object is concerned, as the process of obtaining the necessary information about the object is not always possible. The situation calls for the application of systems analysis and the development of a systematic approach to the problem of management in general. There are several inventory models in use with associated assumptions, it is the assumptions about demand, the cost structure, physical characteristics of the system (the key inventory variables) that distinguish between the various inventory models.

Inventories are "raw materials, work-in-process goods and completely finished goods that are considered to be the portion of business's assets that are ready or will be ready for sale" (Ziukov, 2015). Thus, inventories consist of inputs in the production process and the outputs of the process. A major concern of firms, especially in the manufacturing industry has to do with the formulation of a suitable inventory model.

1.1. The Need for Inventory Control

The inventory level in a system has significant implication on its profitability because it determines under-stocking and overstocking and the attendant shortage cost and/or holding cost. This inventory level is a function of the rates at which inventory flows into and out of the system. If we let $f(t)$ be the rate at which input flows into the system at time t and represent the cumulative flow of inventory into the system as $F(t)$; furthermore, if we let $y(t)$ be the rate at which output flows out of the system at time t and denote the cumulative flow of inventory out of the system by $Y(t)$, then the inventory level, $I(t)$, is the cumulative input minus the cumulative output.

$$I(t) = F(t) - Y(t) = \int_0^t F(x)dx - \int_0^t Y(x)dx \qquad \text{(ii)}$$

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The flow out of inventory is assumed to be a relatively continuous activity where individual items are placed into the production system for processing. Inventory replenishment involves the placement of an order which materialises after some delay time (*lead time*). At the moment of delivery, the rate of input is infinite and at other times it is zero. "Whenever the instantaneous rates of input and output to a component are not the same, the inventory level changes" (Jensen and Bard, 2018). When the rate of inflow {f(t)} is higher, inventory grows; when the rate of outflow{y(t)}is higher, inventory declines. The level of inventory is expected to be positive {Y (t) < F (t)}, which means there should always be inventory on hand. However, If Y (t) > F (t), we have a backorder (negative inventory level). We call this a *backorder* or *shortage* condition. A backorder is a stored output requirement that is delivered when the inventory finally becomes positive. Backorders are possible for some systems, while they are not for others.

The relation between flow, time and inventory level that is basic to all systems is given by:

$$\textit{Inventory Level} = (\textit{Flow Rate})\ (\textit{Residence Time}) \quad \ldots \quad \text{(i)}$$

The flow rate is expressed in the same time units as the residence time. When the factors in this expression are not constant in time, the expression relates to time averaged quantities.

Inventory control helps to minimise the deviation of inventory level from the usage rate.

2. Literature Review

2.1. Empirical Review

Chan (2017), investigated "factors influencing the effectiveness of inventory management in manufacturing SMEs in order to identify the constraints confronting manufacturing SMEs in inventory control as well as also to identify the factors that will help stakeholders to enhance inventory management. The design was a survey with a sample of 80 employees randomly selected from the manufacturing SMEs in Batu Pahat. The results revealed that the major constraints to inventory management in manufacturing organizations were underproduction, overproduction, stock-out situation, delays in the delivery of raw materials and discrepancy of records. Furthermore, the factors that were found to have significant influence on the effectiveness of inventory control are knowledge of employees/staff skill, documentation/store records and planning.

Egbunike and Imade (2017), investigated "Just in time (JIT) strategy and financial performance of small scale industry in Ogun state: A study of Ado – Odo/ Ota local government". The purpose of the study was to find out the extent to which JIT technique has influenced the reduction of inventory cost and improved the firm profit level. The specific objective was to ascertain the influence of purchases and sales on return on equity of small scale manufacturing industry. Survey design was employed and secondary data was selected using purposive sampling. Regression analysis was employed to analyse the data. Results indicated a positive relationship between the implementation of JIT and a firm's profit level in the small scale business industry. The need for other small scale businesses to implement just in time strategy was suggested among others. Muhayimana (2015), investigated "the contribution of inventory management techniques to better management of manufacturing companies in Rwanda" with a view to determining the contribution of inventory management techniques to the enhancement of the management of manufacturing companies. One of the manufacturing companies in Rwanda that deals with manufacturing of goods was studied. Purposive sampling was employed on a focus group of 14 respondents with relevant information on inventory management. Descriptive statistics were employed in data analysis. The findings indicated that inventory techniques employed do significantly impact on the profitability of a company. The results also indicate that inventory management significantly influences cost reduction. Szentivanyi (2014), examined cost minimization procedure in inventory control from the system's point of view, with the organisation as the system and the departments in the organisation as the subsystems. He sought to assess the impact of the results of one department on the results of the whole enterprise. Thus, he sought to provide a model that will capture the implication of inventory decision in one department on the other departments in an organisation. The study employed an industry control cost model which consisted of inventory plan, costs and production costs. He concluded that a good inventory system must employ a holistic approach by identifying and utilising the path of mutual satisfaction in order to achieve its main objective of profit maximisation.

Annadurai and Uthayakumar (2014), examined "Ordering cost reduction in inventory model with defective items and backorder price discount" They explored two coordinated inventory models with defective arrivals by using the backorder price discount and ordering cost as decision variables. One of the models had normally distributed demand and the other had distribution free demand. They used Matlab 7.0 to find the optimal solution and used numerical examples to implement the models. They found that total cost reduction is possible through ordering cost reduction and backorder price discount.

Iwu *et al.* (2014), investigate the application of inventory model in determining stock control in an organization. They employed a multi-product economic order quantity model to determine the optimal order times. The results showed that there was no proper inventory management in the organisation investigated, thus making them to either over stock or under stock at times.

Nyamasege *et al.* (2013), investigated "cost minimization through effective stock management in private organizations." The purpose of the study was to examine the efficiency of inventory management techniques adopted by private companies and provide suggestions to enhance effective inventory management in organizations. The data employed consisted of 350 junior employees of private organizations and 100 management staff using structured questionnaires. The ex-post facto and survey research designs were adopted and research data were analysed using factor analysis. Results showed that private organizations were deficient of competent staff to manage their stock and training requirements are not taken into account to fit the staff to the organization's routine requirements. In view of the findings they suggested the need for organizations to recruit informed, competent and professionally qualified people to manage their stocks, among others. Chung *et al.* (2009), proposed an easier solution technique to overcome the shortcoming of the Silver *et al.* (1998) solution procedure to the (Q, r) inventory system with a specified cost per stock-out occasion. They discuss the (Q, r) inventory system for fast moving "A" items and treat shortage cost as the specified fixed cost per occasion. They propose a new solution procedure which can find the optimal inventory policy easily and accurately by comparing all critical numbers of ETRC (k, Q).

Babatunde and Arogundade (2013), investigated "the reflection of inventory - production cost minimization on organization's profit." The purpose of the study was to identify the inventory-production (I-P) cost minimization techniques that maximises profit as well as finding the chances of I-P cost minimization in manufacturing industries. Regression analysis was used. The result indicated a positive reflection of inventory-production cost minimisation on organisation's profit.

2.2. Theoretical Review

Models of Inventory Management

Inventory models can be classified into *deterministic* and *stochastic Models.* Precisely, the deterministic models assume that demand and replenishment time of inventories are predictable while the stochastic models assume that demand and lead time of inventories have some degree of uncertainty associated with them.

There's no gainsaying that the optimum level of inventory is desirable but this optimum inventory level is not easy to obtain. However, some models for obtaining optimum inventory level have been developed in the recent past. All the models can be classified into**:** Deterministic and Probabilistic Models. Summarily, the deterministic models assume that there is no uncertainty associated with demand and replenishment of inventories while the stochastic models assume some degree of uncertainty for the lead time and demand pattern of inventories (Sinha, 2018). Inventory models can be classified according to a number of factors; the most common ones are: Order quantity that minimises total inventory cost (EOQ), inventory level (reorder level) nature of demand (deterministic or stochastic), period of feasibility of inventory (one period or multi-period) and number of items involved (single or multi-items), among others. The particular factor of interest determines the model that is suitable

2.2.1. Economic Order Quantity Models

The EOQ model was presented originally by Ford W. Harris 1913. Since then, many other researchers, especially Chen and Wang (1996), Roy and Maiti (1997), Yao and Chiang (2003) and Chang (2004) have extended the well-known EOQ inventory model to fuzzy versions. Some of the authors that have applied EOQ in their studies include Chung *et al.* (2009), Iwu *et al.* (2014), Kontusi and Kastav (2014), Ziukov (2015).

2.2.2. Economic Production Quantity (EPQ) Models

The EPQ model is an extension of the EOQ model. It was developed by E.W. Taft in 1918 (Ziukov, 2015). The classical economic production quantity model (EPQ) has been widely used. Owing to numerous research efforts undertaken overtime to extend the model, various assumptions have been made to modify the initial assumption to enhance the model's conformity with real-world situations.

2.2.3. Reorder Point Models

Reorder point is the appropriate inventory level at which order can be placed. Reorder point models and economic order quantity models go hand in hand Thus, a reorder point model seeks to determine the minimum level that inventory must fall to before order is placed for a new economic order quantity. The goal of the reorder point model is to ensure that the request for new inventory items materialises before the current inventory level drops to zero. Pan *et al.* (2004), are among authors that have examined inventory control using reorder point model.

2.2.4. Single Period Model

In a single period model the inventory is relevant and valuable in one period, after one period, the inventory items may not be useful, although they may have a salvage value which is a fraction of the value of the item in the ideal period. The newsvendor model is a single-period, probabilistic inventory model. In this model, the newspaper becomes less relevant after the date on it although it may still be sold for a meagre amount. First single-period inventory models were designed by Petrovic *et al.* (1996), "through the introduction of second level fuzzy set, methods of s-fuzzification and arithmetic defuzzification". Ishii and Konno (1998), introduced fuzziness of shortage cost explicitly into the classical newsboy problem. Other contributors to single period models include Dash and Sahoo (2015), Dutta *et al.* (2007), Hnaien *et al.* (2014) as well as Zhang *et al.* (2009).

2.2.5. Multi-Period Models

In a multi-period model, the relevance of the inventory items spans beyond one period. Thus, unsold stock in one period can be rolled over to another period without necessarily eliciting a loss in value of items. Thus, "the main difference between the single-period model and the multi-period model is that the multi-period model may involve stock leftovers from previous periods, which makes the optimal choice of order quantities more complicated" (Ziukov, 2015). Some other authors that have contributed to multi-period inventory models include Farahvash and Altiok (2011), Gallego (2004), Lim (2011) as well as Zhang *et al.* (2009).

2.2.6. Joint Economic Lot Sizing Models

Economic lot size model is one that models the units of manufactured goods that can be produced within the lowest unit cost range. It is determined by finding the trade-off between the decreasing unit cost of producing larger quantities and the increasing cost of handling, storage, insurance and interest. Joint economic lot sizing models concern simultaneous economic lot sizing of products for the producer and the buyer. Thus, the joint lot sizing model (JELS) addresses issues of inventory coordination between a buyer and a seller.

3. Methodology

This paper examines how inventory management can assist in minimising the total cost of inventory and hence an organisation's cost of doing business. Multi-inventory system was examined at a company that sells doors in Ilorin; the company volunteered information on the basis of anonymity. Conclusive research design, consistent with Inegbedion (2018) and Inegbedion *et al.* (2016), was employed. Specifically, focus was on six special types of doors (sliding glass doors, folding doors, manual and electric glass doors, flush doors and panel doors). Mix method of data collection was employed as company records were combined with information elicited from key workers in the organisation, through interview schedule, to obtain the required data on usage rate of the items, holding cost, ordering cost and procurement cost as well as the selling price of each of the items. The study sought to predict the expected total cost associated with EOQ as well as order quantities greater than and less than EOQ with a view to justifying the supremacy of the EOQ to other order quantities. Inegbedion and Aghedo (2018) used value iteration to predict vehicle replacement time in Nigeria while Inegbedion and Obadiaru (2018), used Markov chain analysis to predict ultimate market shares of GSM companies in Nigeria. Asaleye *et al.* (2018), used vector Error correction model to predict the impact of financial development indicators on the manufacturing sector in Nigeria. This study employed the EOQ model. The economic order quantity (EOQ) and total cost (TC) were computed for each of the 6 products using the data elicited; next, total costs were computed for order quantities less than and more than the EOQ to demonstrate that the computed EOQ optimises the system's inventory cost.

4. Data Presentation and Analysis

The research data are presented and subsequently used in computing some of an inventory system's performance indicators (EOQ, TC and reorder point) as well as the TC associated with order quantities other than the EOQ

4.1. Data Presentation

Table 4.1 presents a summary of the responses elicited from the company's senior representative using the questionnaire. The responses show that: The company has no inventory control policy, replenishes its inventory when the inventory level is zero, sometimes run out of stock, responds to shortages by subcontracting or postponement of delivery and when delivery is postponed to a later date some of the customers often end up not honouring the arrangement. Table 4.2 presents the annual usage rates of each of the six items (panel door, Flush door, sliding glass door, folding door, as well as manual and electronic garage doors) under investigation; Tables 4.3 and 4.4 present the holding cost and ordering cost of each the items, while Table 4.5 presents the inventory system performance indicators (EOQ, numbers of cycles, cycle time, under-stocking, overstocking and TC), with indicators treated as point estimates for the company under focus. Lastly, Table 4.6 presents the inventory system performance indicators (EOQ, numbers of cycles, cycle time, under-stocking, overstocking and TC), with indicators treated as interval estimates for the company under focus.

4.2. Discussion of Findings

Results in Table 4.5 show that the EOQ for panel door is approximately 55 and the number of cycles is approximately 22, the cycle time is approximately 17 days and the total cost of inventory (ordering and holding costs) is N52, 874.71. The implication is that the company should order 55 panel doors once in every 17 days, resulting in approximately 22 orders per annum and a total cost of N52, 874.71. Alternatively, management should place order for 55 panel doors each time inventory level drops to 32.

Similarly, management should place order for 41 flush doors once in every 14 days, resulting in approximately 27 orders per annum and a total cost of N65, 182.82; or place order for 41 flush doors each time the number falls to 24. The EOQ for sliding glass doors is 41 with a cycle time of 17 days and a cycle period of 24 and a reorder level of 24, indicating that management should place order for 41 sliding glass doors once in every 17 days or when the number of glass doors reduces to 24. Also, the EOQ, number of cycles, cycle time, TC and reorder level for folding doors are 18, 13, 30, N29, 007.28 and 5 respectively, thus indicating that management should place order for 18 folding doors once in every 30 days, resulting in a total cost of N29, 007.38 or place order for 18 folding doors each time there are 5 left in the store.

Manual garage doors have approximately 8, 11, 35, N25, 993.19 and 3 as the EOQ, number of cycles, cycle time, TC and reorder level respectively, thus indicating that management should place order for 8 manual garage doors once in every 35 days, resulting in a total cost of N25, 993.19 or place order for 8 manual garage doors each time there are 3 left in the store. Lastly, electronic garage doors have approximately 4, 11, 34, N27, 027.48 and 2 as the EOQ, number of cycles, cycle time, TC and reorder level respectively, thus indicating that management should place order for 4 manual garage doors once in every 34 days, resulting in a total cost of N27, 027.48 or place order for 4 manual garage doors each time there are 2 left in the store. Lastly, Table 4.5 presents the total costs associated with order quantities less than the EOQ by five units for panel doors, flush doors, folding doors, sliding glass doors as well as manual and electronic garage doors and the total costs associated with order quantities greater than the EOQ by five units for panel doors, flush doors, folding doors, sliding glass doors as well as manual and electronic garage doors. In all the cases it was observed that the total inventory cost associated with the EOQ is lower those associated with lower and higher order quantities than the EOQ thus implying that the EOQ yields optimum total cost.

5. Conclusion

The company is not currently minimising its inventory cost because it does not have an inventory management policy. The current situation has resulted in occasional stock outs making it to incur unnecessary stock-out costs in the case of customers who do not meet up with the appointments to return to purchase the items at a later date or overstocking and the associated overstocking costs. However, the company can minimise its total inventory cost by consciously adopting an inventory management policy of ordering 55, 41, 41, 18, 8 and 4 units of panel doors, flush doors, sliding glass doors, folding doors, manual garage doors and electronic garage doors respectively every cycle time of 17, 14, 17, 30, 35 and 34 days respectively or by placing order for 55, 41, 41, 18, 8 and 4 units of panel doors, flush doors, sliding glass doors, folding doors, manual garage doors and electronic garage doors respectively each time the inventory level falls to 32, 24, 24, 5, 3 and 2 respectively. Only such a deliberate inventory control policy will help to optimize inventory cost and thus enhance efficiency.

The study has made significant contribution to management science and operations management literature by applying the classical inventory control technique to an organisation, thereby creating awareness on the possibility of optimising the firm's inventory cost for better profitability. By so doing, the study has demonstrated the practical importance of the EOQ model beyond the theoretical implication. To this end, the study has successfully justified the inventory control technique in an organisation by demonstrating that the EOQ is the quantity that optimises the inventory total cost and that the classical inventory control techniques are feasible in an organisation provided the relevant data on usage rate, holding cost, purchase cost and ordering cost are available. To the best of the author's knowledge, although there are several studies on inventory control and inventory management, all but Iwu *et al.* (2014), employed other techniques. This is the first study in Nigeria to have utilized company data on usage rate, holding cost and ordering cost to compute an inventory system's performance indicators to optimise inventory total cost in the construction industry, thus making it unique. The study has thus given useful indications on how company records can be applied to determine an inventory system's performance indicators

The study is not without limitations which call for further studies. First, most organisations were not willing to divulge information about their usage rate and inventory related costs, for fear of divulging business information to agents of competitors. Those that were willing to divulge information volunteered on the basis of anonymity but many still refused to give information about their usage rate for security reasons. Future studies should attempt to infer the usage rate through some other strategies that will not make the firm feel threatened. Secondly, the usage rate used in the study was an average of the usage rates of the company's items for a period of seven years. While this may appear logical, the mean value may be infeasible when the demand for a particular item exhibits high uncertainty. Lastly, the difficulty in estimating the rolled over inventory in multi-period inventory items poses some constraints to the results of this study. Future studies should attempt a longitudinal study that monitors the records of the company for the length of time that the data are required. This will enable the researcher to note the closing inventories from period to period and the corresponding opening inventories from period to period and thus be able to estimate the true cost of holding and ordering inventory from period to period.

6. Recommendations

Management of companies that are concerned with inventory management but do not currently have a scientific inventory management approach should adopt measures to implement inventory control strategies to optimise inventory cost and thus enhance efficiency. To this end, proper record keeping of all the company's transactions relating to the inventory items should be undertaken to provide the necessary data for inventory control.

References

Annadurai and Uthayakumar (2014). Ordering cost reduction in inventory model with defective items and backorder price discount. *Journal of Optimization*: 1-15. Available: http://.org/10.1155/2014/767943

Asaleye, A., Lawal, A., Asamu, F., Inegbedion, H., Arisuku, O. and Popoola, O. (2018). Financial development, Manufacturing sector and sustainability, Evidence from Nigeria. *The Journal of Social Sciences Research*, 4(12): 539-46.

Babatunde, B. O. and Arogundade, K. K. (2013). Reflection of inventory-production cost minimisation and organisation's profit performance. *The Journal of Commerce*, 3(4): 39-44.

Chan, S. W., 2017. "Factors influencing the effectiveness of inventory management in manufacturing SMEs." In *IOP Conference Series, Material Science Engeneering.*

Chang, C. T. (2004). An EOQ model with deteriorating items under inflation when supplier credits linked to order quantity. *International Journal of Production Economics*, 88(3): 307-16.

Chen, S. H. and Wang, C. C. (1996). Backorder fuzzy inventory model under functional principle. *Inf. Sci.*, 95(1-2): 71-79.

Chung, K., Ting, P. and Hou, K. (2009). A simple cost minimization procedure for the (Q, r) inventory system with a specified fixed cost per stockout occasion. *Applied Mathematical Modelling*, 33(5): 2538-43.

Dash, J. K. and Sahoo, A. (2015). Optimal solution for a single period inventory model with fuzzy cost and demand as a fuzzy random variable. *Journal of Intelligent and Fuzzy Systems, Application in Engineering and Technology*, 28(3): 1195-203.

Dutta, P., Chakraborty, D. and Roy, A. R. (2007). An inventory model for single-period products with reordering opportunities under fuzzy demand. *Computers and Mathematics with Applications*, 53(10): 2502-1517.

Egbunike, P. A. and Imade, O. G. (2017). Just in time strategy and financial performance of small scale industry in Ogun state: A study of Ado – Odo/ Ota local government. *Business Trends*, 7(3): 72-76.

Farahvash, P. and Altiok, T. (2011). A multi-period inventory model with multi-dimensional procurement bidding. *Annals of Operations Research*, 186: 101. Available: https://doi.org/10.1007/s10479-011-0893-4

Gallego, G. (2004). Multi-period models. IEOR 4000 production management. 1-6. Available: file:///C:/Users/HENRY%20INEGBEDION/Documents/Inventory-27%20Multi%20Period%20Model.pdf

Hnaien, F., Dolgui, A. and Wu, D. D. (2014). Single period inventory model for one-level assembly system with stochastic lead times and demand. *International Journal of Production Research*, 54(1): 186-203. Available: https://doi.org/10.1080/00207543.2015.1066518

Inegbedion, H. E. (2018). Factors that influence customers' attitude towards electronic banking in Nigeria. *Journal of Internet Commerce*, 17(4): 325-38.

Inegbedion, H. E. and Aghedo, M. (2018). A model of vehicle replacement time with overloading cost constraint. *Journal of Management Analytics*, 5(4): 35-370.

Inegbedion, H. E. and Obadiaru, E. (2018). Modelling brand loyalty in the Nigerian telecommunications industry. *Journal of Strategic Marketing*: Available: http://10.1080/0965254X.2018.1462842

Inegbedion, H. E., Obadiaru, D. E. and Bello, D. V. (2016). Factors that influence consumers' attitude towards internet buying in Nigeria. *Journal of Internet Commerce*, 15(4): 353-75.

Ishii, H. and Konno, T. (1998). A stochastic inventory problem with fuzzy shortage cost. *European Journal of Operational Research*, 106(1): 90–94.

Iwu, C., Ogbonna, C. J., J., O. and Onuma, K. G. (2014). Application of inventory model in determining stock control in an organization. *American Journal of Applied Mathematics and Statistics*, 2(5): 307-17.

Jensen, P. A. and Bard, J. F. (2018). Operations research models and methods. Available: http://www.me.utexas.edu/~jensen/ORMM/supplements/models/inventory

Kontusi, E. and Kastav, G. (2014). Management of inventory in a company. *Economic Views*, 27(2): 245-56.

Lim, S. (2011). *A Study on a multi-period inventory model with quantity discounts based on the previous order. In: Watada J. Phillips-Wren G. Jain L. C. Howlett R. J. (eds.) Intelligent decision technologies. Smart innovation, systems and technologies.* Springer: Berlin, Heidelberg. 10: https://doi.org/10.1007/978-3-642-22194-1_37

Muhayimana, V. (2015). Inventory management techniques and its contribution to better management of manufacturing companies in Rwanda. *European Journal of Academic Essays*, 2(6): 49-58.

Nyamasege, D., Sixtus, O., Kerere, L. and Obenge, P. (2013). Cost minimization through effective stock management in private organizations, Challenges and recommendations. *International Journal of Development and Sustainability*, 3(4): 902-08.

Pan, J. C., Lo, M. and Hsiao, Y. (2004). Optimal reorder point inventory models with variable lead time and backorder discount considerations. *European Journal of Operational Research*, 158(2): 488-505.

Petrovic, D., Petrovic, R. and Vujosevic, M. (1996). Fuzzy models for the newsboy problem. *International Journal of Production Economics*, 45(1/3): 435–41.

Roy, T. K. and Maiti, M. (1997). A fuzzy EOQ model with demand dependent unit cost under limited storage capacity. *European Journal of Operational Research*, 99(2): 425-32.

Silver, E. A., Pyke, D. F. and Peterson, R. (1998). *Inventory management and production planning and scheduling.* 3rd edn: John Wiley & Sons: New York, NY.

Sinha, D. K. (2018). Inventory control: Forms and models of inventory management– Explained. Available: http://www.yourarticlelibrary.com/production-management/inventory

Szentivanyi, I. S. (2014). Proposal of the cost minimization procedure in the inventory control. *European Scientific Journal*, 10(9): 22-27.

Yao, J. S. and Chiang, J. (2003). Inventory without back order with fuzzy total cost and fuzzy storing cost defuzzified by centroid and signed distance. *European Journal of Operational Research*, 148(2): 401-09.

Zhang, D., Xu, H. and Wu, Y. (2009). Single and multi-period optimal inventory control models with risk-averse constraints. *European Journal of Operations Research*, 199(2): 420-34.

Ziukov, S. (2015). A literature review on models of inventory management under uncertainty. *Business Systems and Economics*, 5(1): 26-35.

Table-4.1. Primary data (Questionnaire)

Question	Response
Does this company have an Inventory control policy?	No
How does the company replenish items?	When the items are finished
Has the company ever run out of stock?	Yes
If yes to question 3, how often?	Fairly often
How do you respond to inventory stock out?	Subcontracting, postponement of delivery
If you arrange to supply at a later date, do the customers honor the arrangement?	Some do but others don’t

Source: Author’s fieldwork, 2018

Table-4.2. Usage rate of the inventory items

YEAR	ITEMS Usage Rate					
	Panel Door	Flush Door	Sliding Glass Door	Folding Door	Garage Door	
					Manual	Electronic
2011	1180	1080	940	224	78	32
2012	1200	1120	980	242	76	32
2013	1160	1114	1008	236	79	38
2014	1220	1128	1014	224	82	46
2015	1200	1080	962	184	84	41
2016	1120	1044	882	178	78	36
2017	1168	1062	842	180	71	34
Total	8248	7628	6628	1468	548	259
Mean	1178.29	1089.71	946.86	209.71	78.29	37
Std. Dev.	30.53	29.32	59.55	25.89	3.88	4.75
Lead time	Minimum (4 days) Maximum (8 days)					

Source: Anonymous company Records/Author’s Computations 2018

Table-4.3. Holding cost of the inventory items

Year	Holding cost of inventory items (N)					
	Panel Door	Flush Door	Sliding Glass Door	Folding Door	Garage Door	
					Manual	Electronic
2011	830	1424	1300	1480	3140	5000
2012	880	1450	1380	1560	3410	6000
2013	880	1450	1380	1580	3410	6000
2014	950	1600	1420	1700	3500	7500
2015	990	1700	1420	1800	3625	10500
2016	1020	1720	1490	2000	3750	10500
2017	1210	1780	1490	2000	3750	10740
Total	6760	11124	9880	12120	24585	56240
Mean	965.71	1589.14	1411.43	1731.43	3512.14	8034.29
Std. Dev.	117.46	137.30	61.97	194.75	201.92	2306.80

Source: Anonymous company Records/Author’s Computations 2018

Table 4.4. Ordering Cost Per order for Inventory Item

Year	Ordering cost of inventory per order for items (N)					
	Panel Door	Flush Door	Sliding Glass Door	Folding Door	Garage Door	
					Manual	Electronic
2011	960	960	960	960	960	960
2012	1060	1060	1060	1060	1060	1060
2013	1060	1060	1060	1060	1060	1060
2014	1300	1300	1300	1300	1300	1300
2015	1380	1380	1380	1380	1380	1380
2016	1420	1420	1420	1420	1420	1420
2017	1420	1420	1420	1420	1420	1420
Total	8600	8600	8600	8600	8600	8600
Mean	1228.57	1228.57	1228.57	1228.57	1228.57	1228.57
Std. Dev.	181.38	181.38	181.38	181.38	181.38	181.38

Source: Anonymous company Records/Author’s Computations 2018

Table-4.5. Multi-product Economic Order Quantity (EOQ) Model

Average values	Panel Door	Flush Door	Sliding Glass Door	Folding Door	Garage Door	
					Manual	Electronic
Annual Demand	1179	1090	947	210	79	37
Holding Cost	965.71	1589.14	1411.43	1731.43	3512.14	8034.29
Ordering Cost	1228.57	1228.57	1228.57	1228.57	1228.57	1228.57
$q_0 = \sqrt{\frac{2C_oD}{C_H}}$	55	41	41	18	8	4
$n_0 = \frac{D}{q_0}$	22	27	24	13	11	11
t_0(days) $= \frac{1}{n_0}$ x 365	16.98	13.75	16.65	30.02	34.5	33.24
Total Cost (N)	52874.71	65182.82	57302.20	29007.28	25993.19	27027.48
EOQ – 5	50	36	36	13	3	2
TC (EOQ − 5)	53114.69	65792.99	57799.96	31637.12	44291.55	34435.73
EOQ +5	60	46	46	23	13	9
TC (EOQ+5)	53082.28	65654.24	57691.21	30841.64	29532.10	39054.46

Source: Author's Computations 2018

Table-4.6. Multi-product Economic Order Quantity (EOQ) Model (with interval estimation of annual and average daily demand)

Average values	Panel Door	Flush Door	Sliding Glass Door	Folding Door	Garage Door	
					Manual	Electronic
Annual Demand	1178 ±31	1089±29	947±60	210±26	78±4	37±5
Holding Cost	965.71	1589.14	1411.43	1731.43	3512.14	8034.29
Ordering Cost	1228.57	1228.57	1228.57	1228.57	1228.57	1228.57
$q_0 = \sqrt{\frac{2C_oD}{C_H}}$	54.8	41	40.6	17.25	7.40	3.37
$n_0 = \frac{D}{q_0}$ (no. of cycles)	21.5	26.54	23.32	12.16	10.58	10.98
t_0(days) $= \frac{1}{n_0}$ x 365	16.98	13.75	16.65	30.02	34.5	33.24
Total Cost (N)	52874.71	65182.82	57302.20	29007.28	25993.19	27027.48
EOQ – 5	49.8	36	35.6	12.25	2.4	1.63
TC (EOQ − 5)	53114.69	65792.99	57799.96	31637.12	44291.55	34435.73
EOQ +5	59.8	46	45.6	22.25	12.40	8.37
TC (EOQ+5)	53082.28	65654.24	57691.21	30841.64	29532.10	39054.46
Avg. Daily demand	3.23±0.1	2.98±0.1	2.6±0.2	0.58±0.1	0.21±0.01	0.1±0.01
Avg. Lead Time (days)	6	6	6	6	6	6
Safety Stock	12	6	8	1	1	1
Reorder Level = dl_t + SS	31.38	24	23.6	4.48	2.3	1.6

Source: Author's Computations 2018