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Developing a data-driven approach to optimizing pharmacy inventory management

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ABSTRACT

The stock of products, commodities, or other financial resources that are kept or set aside for future production or to satisfy future demand is known as inventory. For example, inventory can include raw materials that are awaiting use in the creation of items, finished goods that are awaiting shipping from the factory, wholesaler, or retailer, and semi-finished or in-process goods that are temporarily held throughout the production process. Equipment, furnishings, fittings, etc. are also included in inventory. Direct and indirect inventories are two categories under which the term inventory can be separated. Items that directly contribute to the manufacturing process and are a necessary component of final goods are included in direct inventories. Raw materials, work-in-progress, and finished commodities are the three categories into which direct inventories can be divided. Items that are required for manufacturing but do not end up in the final product, such as lubricants, grease, oil, gasoline, office supplies, maintenance supplies, etc., are included in indirect inventories. Although there are many reasons why inventories are kept, they generally serve the following fundamental purposes.

Keywords: *Pharmacy, inventory, medicine.*

1. INTRODUCTION

Materials must be handled by every producing department, whether it be an engineering department, a factory, or a workshop. When handling these resources, the three main goals are to maximize customer service, minimize material investments, and contribute to low-cost plant operation. In order to find the best answer and maximize profit for a given investment, these three goals are essentially at odds with one another and need for a scientific method. Today, the terms "material management" and "inventory control" refer to the study of the related operations [18]. One of the most crucial yet confusing responsibilities that contemporary managers must deal with is inventory control [1]. For the majority of businesses, inventory investments are significant. Inventories account for 10 to 25 percent or more of the assets of many businesses. The least stable and most challenging asset category to manage is frequently further inventories [12]. A portion or the entirety of an inventory may become outdated due to fads, fashions, technical advancements, etc. Inventory levels are frequently severely impacted by abrupt shifts in business activity levels. Additionally, the cost of keeping inventory has significantly grown in recent years due to skyrocketing loan rates [14]. Theft by customers and employees has significantly raised the cost of inventory maintenance [3]. To make things more complicated, businesses are under a lot of pressure to keep a lot of inventory because of the enormous growth in product sales over the last few decades [2]. In conclusion, all businesses, regardless of size, need to manage their inventory [7]. However, inventory is only a measure of how well the materials management function is performing [5]. To reduce inventories, we employ scientific inventory management models and principles as well as long-term strategies like standardization and variety reduction, vendor rating and source development, and lead-time reduction through improvements in procurement systems and procedures [9]. To make scientific inventory management cost-effective, it is evident that it must be applied carefully rather than indiscriminately [11]. For inventory models to be used effectively, informational inputs like as demand forecasts, lead-time estimates, and other cost estimations must be realistic [15].

2. METHODOLOGY

The foundational idea in inventory management is the optimal inventory model. The goal of every inventory policy is to create as many units as possible in order to meet the demand from customers or merchants in the supply chain. Through the retailers, the manufacturer can accomplish the inventory model's goals in the two-stage supply chain. Customers' demands appear haphazardly from multiple retailers at once [17]. When customers place orders and the stock level is nil, the retailers hold the inventory from the manufacturers. The product's changeable cost is designed to draw in a diverse clientele [4]. The inventory system's most useful tool is the supply chain. To combat the fierce competition to push out inventory against client

demands, the majority of manufacturers rely on the supply chain. For the business to gain, the valuable inventory management system must be helpful. Therefore, the company's inventory system needs to be integrated in accordance with its goals and strategies. A two-stage manufacturing and inventory system involving three parties is the issue this study focuses on: customer, retailer (purchaser), and producer (vendor), whereby a manufacturer creates a single product and supplies it to several shops, who then resell it to their clientele. Demand for a given product is determined arbitrarily by the consumers and the retailers in the market. When the retailer's inventory decreases stochastically, the random cycle time of the retailer's inventory to replenish the manufacturer's inventory is altered. The producer creates an efficient manufacturing strategy to meet the merchants' demands. In order to meet store demand, the producer builds the necessary inventory level during production uptime [16].

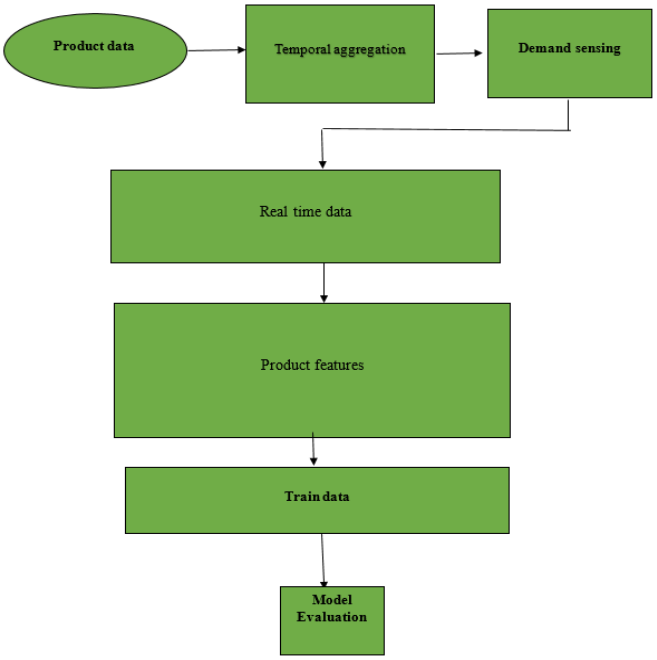

Figure 1: Proposed architecture of prediction method

A model that can convert a student question into a fixed-length vector representation is what we're searching for. This vector can be used for tasks like searching the dataset for related queries because it captures the meaning of the text. For this reason, we used Universal Sentence Encoder (USE) in our experiment [6]. This encoder model summarizes any given query to a 512-dimensional phrase embedding. To identify any similar questions in our dataset, we used the same embedding. The same embedding will only catch the most useful parts and ignore the rest because it must work on many queries. This encoder performs a number of internal operations. It starts by converting queries to lowercase and then converting them into tokens using the Penn Treebank (PTB) tokenizer [13]. Each query is then wrapped into a 512-dimension embedding of a predetermined length. Although there are two varieties of USE, we choose to use DAN, or Deep Averaging Network architecture, for our investigation. A phrase's embeddings are first averaged across all of its words and bi-grams. A 512-dimensional phrase embedding is created by feeding the query's output into a 4-layer feed-forward deep DNN. Word and bi-gram embeddings are learned during training.

3. RESULTS AND DISCUSSION

Two fundamental problems are frequently faced by many businesses, such as manufacturers, retailers, and merchants. Selecting the production or request quantity for short-lived commodities prior to the selling season is the primary challenge. Doing the portion of a restricted asset is the second problem for businesses. According to the main problem, the retailer will impose oldness costs if the sum requested for an item exceeds its interest.

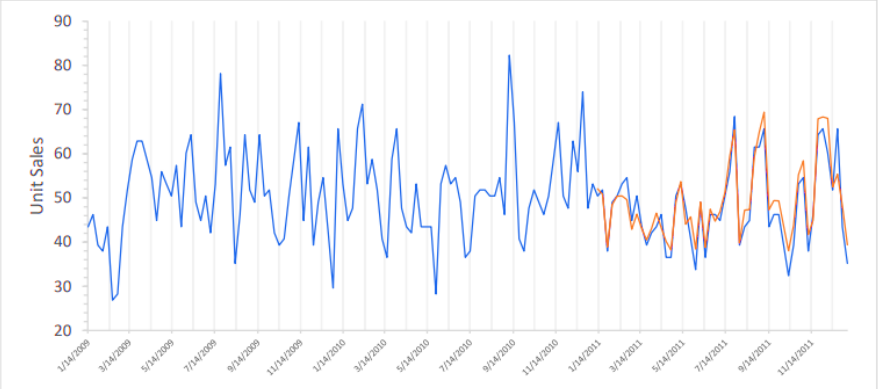

Figure 2: Weekly distribution of sales and forecast values for a sample series

On the off chance that the request amount for an item is lower than the interest, the retailer will have an open door and generosity misfortune. In this way, a store must strike a balance between making too many requests and making too few. This stock administration problem is addressed by a newsvendor model and its variants. This kind of issue is applicable to numerous ventures, for example, cheap food, style clothing, food, pastry kitchens, sports merchandise, and short-lived items industry.

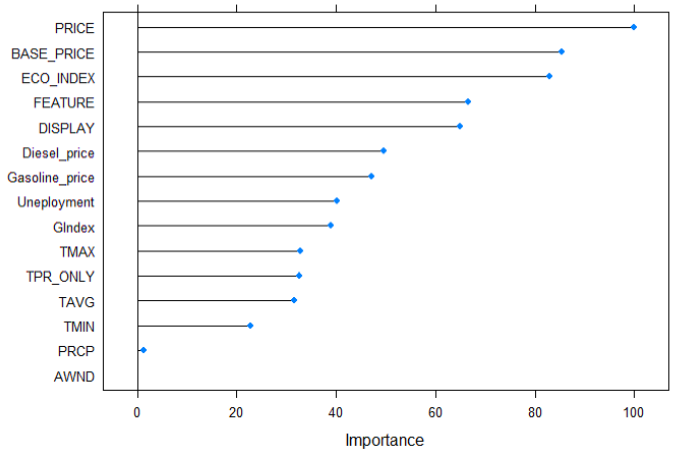

Figure 3: Variables' relative importance in predicting sales

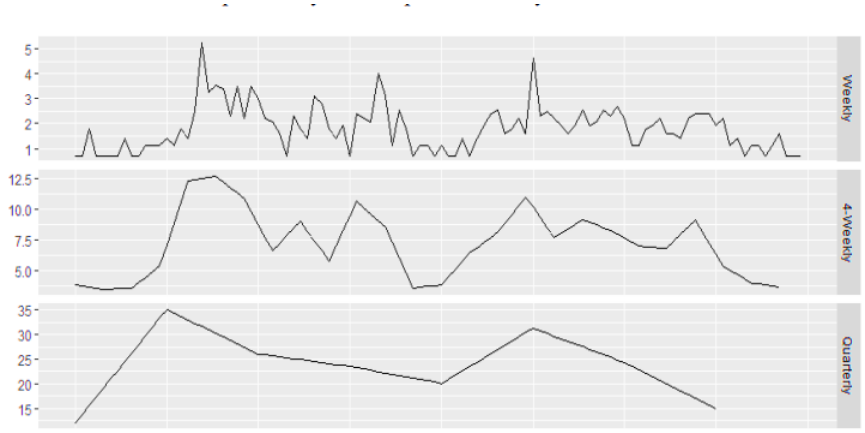

Figure 4: An internet channel's demand series (log of demand) and its temporal aggregates

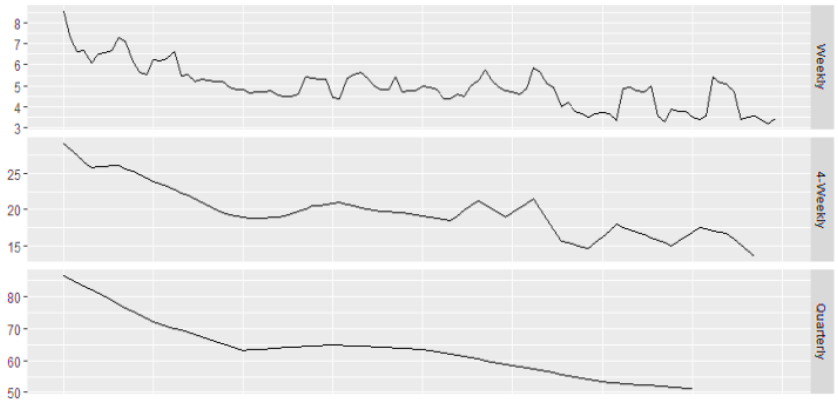

Figure 5: An offline channel's demand series (log of demand) and its temporal aggregates

Two distinct dimensions are used to analyze the various graphs in Figure 5. First, the marginal influence of inventory optimization strategies is dominated by precise demand estimations in conjunction with demand estimation methodologies. Second, among inventory optimization models, it is evident that NVM based on a normal distribution is always less expensive than MA, and the suggested QR-ML based inventory optimization is less expensive than the empirical model based on a normal distribution, with the exception of a few instances where the difference is negligible. As a result, the quantile regression-based machine learning inventory optimization method that has been suggested is outperforming alternative combinations. Instead of assuming incorrect demand distributions for inventory optimization, it is due to the ML method's prediction power and effective use of data for optimization.

4. CONCLUSION

It has been noted that the logistics network can benefit manufacturers in terms of profit if it is planned to satisfy demand and encourage the number of customers. It has also been discovered that decentralizing the supply centres to all of the main areas of the location lowers handling, operating, and transportation expenses. The degree to which inventory policy goals are met depends on how easily inventories can be accessed. proposed a clever cross-transient progressive gauging structure for the multi-channel retailing climate. The proposed system joined the cross-sectional and fleeting orders to fostering an original gauging structure. For every level of the retailer's decision-making process, the new framework helps with the creation of sensible short-term to long-term estimates. This part of the suggested system aids in modifying the association's navigation at every level. As stand-ins for accuracy and gauge change, the estimations from the suggested method are evaluated using a couple precision metrics, namely ARMAE and ARMSE. The figures are better than estimations from other measuring systems, according to the proof. Additionally, the measurable tests were conducted in order to truly examine the significance of the results, and these tests. The gauges from the proposed system are assessed on a few measurements of precision, in particular ARMAE, and ARMSE, as intermediaries for exactness and difference of estimates. The proof proposed that the gauges are superior to the estimates from other determining systems. Additionally, factual tests were conducted to examine the significance of the results and to demonstrate that gauges from the suggested system have essentially fewer conjecture errors than direct numbers.

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