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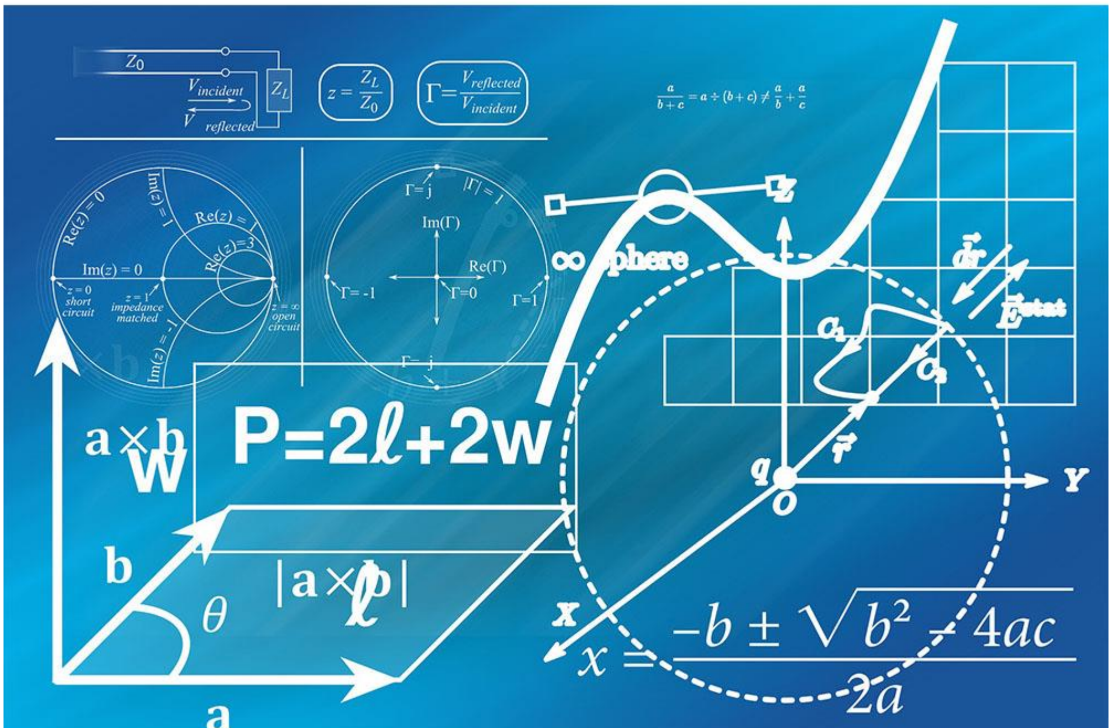

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Analysis of Inventory Level Optimization Using Artificial Intelligence Approach

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Abstract- 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. Formulating a suitable inventory model is one of the major concerns for an industry. The earliest scientific inventory management researches date back to the second decade of the past century, but the interest in this scientific area is still great. Again considering the reliability of any process is an important feature in the research activities. Values of some factors are very hard to define or almost unreal. In such cases, AI models of inventory management take an important place.

KEYWORDS: AI, inventory management, models under uncertainty, EOQ, EPQ

I. INTRODUCTION

Inventory is an accounting term that refers to goods that are in various stages of being made ready for sale, including: Finished goods (that are available to be sold) Work-in-progress (meaning in the process of being made) Raw materials (to be used to produce more finished goods) All the materials, parts, suppliers, expenses and in process or finished products recorded on the books by an organization and kept in its stocks, warehouses or plant for some period of time.

The problem of inventory control is one of the most important in organizational management. As a rule, there is no standard solution – the conditions at each company or form are unique and include many different features and limitations. An occurring task of the mathematical models development and determining the optimal inventory control strategy is related with this problem. Features of inventory management models are that the result- in optimal solutions can be implemented in a fast changing situation where, for example, the conditions are changed daily. Tare is a need for new and effective methods for model- ling systems associated with inventory management, in the face of uncertainty. Uncertainty regarding the control object, as the process of obtaining the necessary information about the object is not always possible. The solution of such complex tasks requires the use of systems analysis, development of a systematic approach to the problem of management in general. Inventory models are distinguished by the assumptions made about the key variables: demand, the cost structure, physical characteristics of the system. These assumptions may not suit to the real environment. There is a great deal of uncertainty and variability.

II. INVENTORY MANAGEMENT

Stocks (reserves) are created to carry out the normal activities of the company. Proper and timely determination of the optimal inventory control strategy allows freeing a significant amount of assets, frozen in the form of stocks, which ultimately increases the efficiency of resource use. Even though there are literally millions of different types of products manufactured in our society, there are only two fundamental decisions that one has to make when controlling inventory:

1. How large should an inventory replenishment order be?
2. When should an inventory replenishment order be placed?

The objectives of inventory management often reduce the problem if it is more Prof Table to do quickly but more expensive or slower but cheaper. Such a strategy will be optimal inventory control, which minimizes the sum of milestones costs associated with the production, storage and inventory shortage per unit of time or for a specific (including infinite) amount of time.

Management models differ in the nature of the available information on the properties of the simulated system. When the value of the model parameters is well-defined, nature of the corresponding mathematical model is deterministic. If the parameters of the system are random values with a known probability, distribution models are stochastic (probabilistic). If all of the model parameters do not change over time, it is called static, otherwise – dynamic. Static models are used when receiving a onetime decision about the level of reserves for a certain period, and dynamic – in the case of sequential decisionmaking about stock levels or to adjust earlier decisions, taking into account the changes taking place. When static patterns of change in system parameters cannot be installed, it is necessary to solve the problem of inventory management in the face of uncertainty.

III. LITERATURE REVIEW

[1]Ford W. Harris. The first mathematical model for inventory management, the Economic Order Quantity (EOQ) model, was introduced in (1913) by the scientist. It was designed for the purpose of production planning. The EOQ is a one-product deterministic dynamic model and it is very essentially very simple. The model gives the optimal solution in closed form which helps to know about the behavior of the inventory system. The closedform solution is also easy to compute.

[2]NingXue et al. This study tackles the production planning of highly perishable foods (such as freshly prepared dishes, sandwiches and desserts with shelf life varying from 6 to 12 hours), in an environment with highly variable customers demand. In the scenario considered here, the planning horizon is longer than the products' shelf life. Therefore, food needs to be replenished several times at different intervals. Furthermore, customers demand varies significantly during the planning period. We tackle the problem by combining discrete-event simulation and particle swarm optimization (PSO). The simulation model focuses on the behavior of the system as parameters (i.e. replenishment time and quantity) change. PSO is employed to determine the best combination of parameter values for the simulations. The effectiveness of the proposed approach is applied to some real-world scenario corresponding to a local food shop. Experimental results show that the proposed methodology combining discrete event simulation and particle swarm optimization is effective for inventory management of highly perishable foods with variable customers demand.

[3]Angie Tatiana Parga-Prieto et al. At present, inventories are considered as waste, because they do not generate added value, and so they must be reduced or eliminated. However, this reduction in inventories should not lead to a decrease in the level of customer service or generation deficit. Considering this, this article proposes inventory policies that seek to maintain a previously defined level of customer service with the lowest cost of inventory management. The work is applied in a lubricant trading company whose demand shows a growing trend and is subject to randomization. The forecast model that best if is the demand behavior is defined, and it is statistically verified that the error if it's a normal distribution with an average equal to zero. Policy definitions are based on the combination of heuristic techniques for inhomogeneous demands, such as Silver Meal and Wagner-Within, to define order periods and models for stochastic demands, such as periodic review models, for multi-product inventory systems, in which, by means of the probability density function of the forecast errors, the security stock of each period is defined.

[4]BurcuBalcik et al. In this paper, we present a review and analysis of studies that focus on humanitarian inventory planning and management. Specifically, we focus on papers which develop policies and models to determine how much to stock, where to stock, and when to stock throughout the humanitarian supply chain. We categorize papers according to the disaster management cycle addressed; specifically, we focus on pre-disaster and post-disaster inventory management. We evaluate existing literature in terms of problem aspects addressed such as decision makers, stakeholders, disaster types, commodities, facility types, performance measures as well as methodological aspects (i.e., types of policies, models, and solution approaches). We identify current gaps in the literature and propose directions for future research.

[5]Paul and Azaeem et al. Developed another AI-based model that determines the optimum level of a finished goods inventory. Inputs to this model are product demand, setup, holding, and material costs, where data originated from a manufacturing industry. The results indicated that the model can be used for a finished goods inventory level forecasting in response to the model input parameters. In general, the constructed model can be applied for finished goods inventory optimization in any manufacturing enterprise.

[6]Hamzaçebi et al. The results from the modeled AI utilized for time-series forecasting proved that the proposed AI model comes with significantly lower prediction error than other methods.

[7]Megala and Jawaharet al. Deals with a dynamic lotsizing problem including capacity constraint and discount price structure. Two meta-heuristics - genetic algorithm and Hopfield neural network – are established for the dynamic lot-sizing problem. In recent years many other global publications have dealt with the lot-sizing problem

[8]Gaafar and Choueiki et al. Applied a neural network model to a lot-sizing problem as a part of material requirements planning (MRP) for the case of deterministic time-varying demand.

[9]Hachicha et al. Utilized an AI and worked with the lot-sizing problem in supply chains by applying a meta modelling simulation. The supply chain, which is also a subject of Hachicha's research, is handled in a make-toorder environment (no possibility of keeping stock and limited production capacity).

[10]Zhang et al. Investigated the estimated technical efficiency score's sensitivity through different methods including the stochastic distance function frontier.

IV. IN MODELS OF INVENTORY MANAGEMENT, THE FOLLOWING CHARACTERISTICS ARE TAKEN INTO ACCOUNT

Single versus multiple items. Tis dimension considers whether a single item can be used in isolation for calculations, or whether multiple interdependent products should be taken into account, as a result of collective budget or space constraints, coordinated control or substitutability between items.

Time duration. In some inventory management situations, the selling season for products is short, and excess stock at the end of the season cannot be used to satisfy the demand of the next season. In such cases, a single period model is required. When multiple periods need to be considered, a common approach is to use a rolling horizon implementation approach. Here, decisions consider only a relatively small number of future periods and are made at the start of each period. To decisions are then implemented in the current period, and the problem resolved at the start of the subsequent period.

Number of stocking points. Sometimes, it is appropriate to treat a single stocking point in isolation. In many real world cases, inventories of the same item are kept at more than one location. In multi-echelon situations, the orders generated by one location (e.g., a branch warehouse) become part or all of the demand at another location (e.g., a central warehouse).

Types of demand could be classified as it is shown in Figure 1. Deterministic demand is exactly known, unlike the probabilistic demand. It can be of two types. One of them is static, which does not have any variation. The amount of demand known or can be computed with certainty. Second type is dynamic, which may vary. This type of demand varies with time, but the way in which the demand varies is known with certainty.

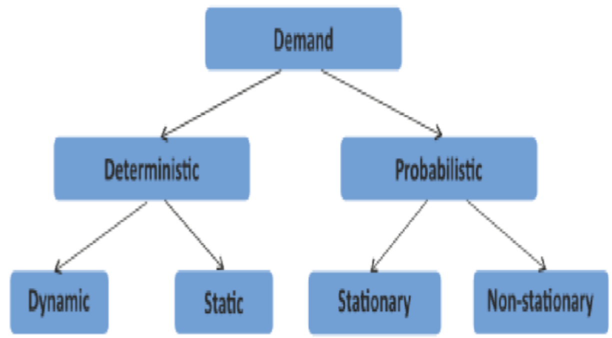

Figure 1: Types of demand classification

Stationary distribution with known parameters. This type of demands follows a probe- ability distribution that is known or estimated from historical data. Commonly used distributions include normal, gamma, Poisson.

V. RESEARCH METHODOLOGY

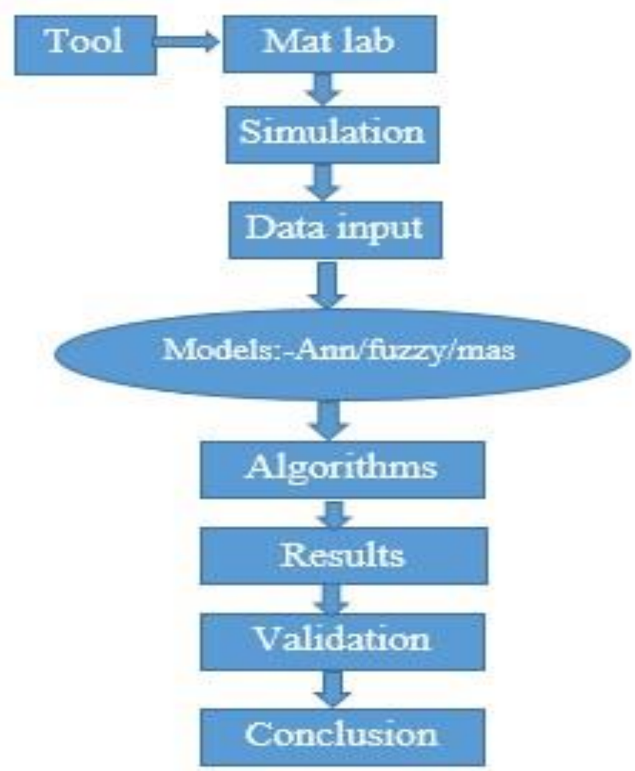

Figure 2: Basic flow for designing artificial network mode

AI-base modeling. For data analysis and preprocessing, MS Office Excel software is used. As an instrument for neural network forecasting Math Works MATLAB Neural Network Tool is used. Deductive quantitative methods for research are also used. The effort is direct at finding whether the method of prediction using artificial neural networks is suitable as a tool for enhancing the ordering system of an enterprise. The research also focuses on finding what architecture of the artificial neural networks model is the most suitable for subsequent prediction.

Inventory control techniques are the tool available for smooth running of the business enterprises. The inventories should be maintain at a level lying between the excessive and the inadequate. This level is known as the “OPTIMUM LEVEL” of inventories.

Technique such as AI is a promising tool for forecasting inventory in manufacturing environment. AI behaves as model free estimators i.e it can capture and model complex input-output relationships even without the help of a mathematical model.

VI. The AI working models for data analysis

1. Artificial neural networks (ANN)
2. Fuzzy models
3. Multi agent systems (MAS)

1. ARTIFICIAL NEURAL NETWORKS

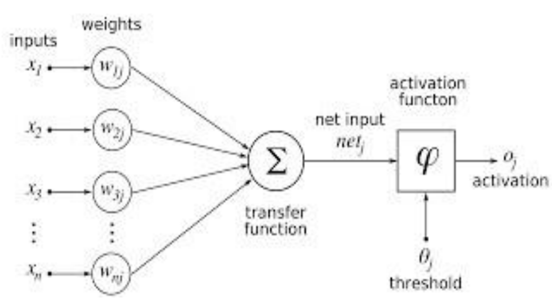

Figure 3: Deep learning flow chart of (ANN)

The ANN structure includes units for processing essential information, which are neurons. They are defined in several levels and connected together defining weights. Synaptic weights show the interaction between each pair of neurons. These structures distribute information about neurons.
The input assignments and the estimated output responses are calculated from combinations of different transfer functions. We can use the self-adaptive information model recognition method to analyze artificial neural network training algorithms. The most commonly used calculation algorithm is the error propagation algorithm. Neural networks can be divided into single layer perception networks and multi-level perception networks (MLP networks). The multilayer perceptual network comprises several layers of simple two-state sigmoid transfer functions and processing neurons that interact by applying weighted connections. A typical neural network with multilayer anticipatory perception includes the input level, the output level and the hidden layer.

2. FUZZY MODELS

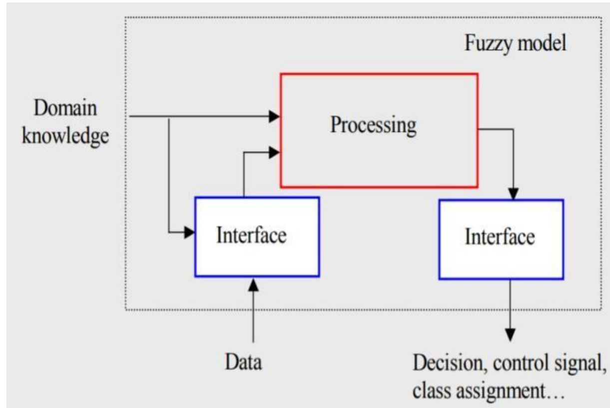

Figure 4: Basic flow chart for Fuzzy Logic

- Input interface: accepting heterogeneous data (information granules and numeric data) and converting them to internal format processing at the level of fuzzy sets is carried out
- Processing module: processing pertinent to information granules
- Output interface: converting results of processing information granules into the format acceptable by the modeling environment

3. MULTI-AGENT SYSTEMS (MAS)

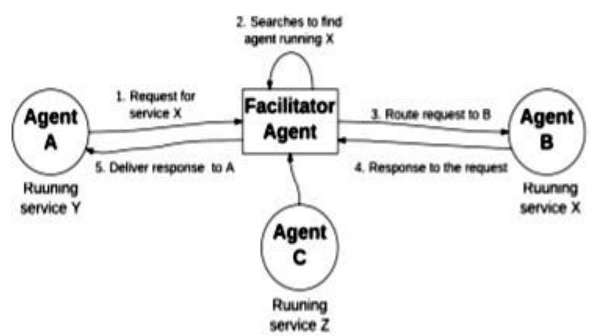

Figure 5: Basic flow for Multi-Agent Systems (MAS)

The salient features of MAS, including efficiency, low cost, flexibility, and reliability, make it an effective solution to solve complex tasks. Their efficiency stems from the division of labor inherent in MAS whereby complex task is divided into multiple smaller tasks, each of which is assigned to a distinct agent.

VII. ECONOMIC PRODUCTION QUANTITY MODELS

Economic Production Quantity model (EPQ) determines the quantity a company or retailer should order to minimize the total inventory costs by balancing the inventory holding cost and average fixed ordering cost. The EPQ model was developed by E.W. Taft in 1918 (Taft, 1918). Tis method is an extension of the EOQ model. The classical economic production quantity model (EPQ) has been widely used. Numerous research efforts have been undertaken to extend the basic EPQ model by releasing various assumptions or adding new so that the model conforms more closely to real-world situations. Recently, re-work activities have attracted considerable attention because of the reduction of the natural resources and the rise in the cost of raw material.

VIII. ECONOMIC ORDER QUANTITY MODELS

For the fixed order size inventory models, the economic order quantity (EOQ) model is most well-known. The basic EOQ model is a formula for determining the optimal order size that minimizes the sum of carrying costs and ordering costs. The model is derived under a set of restrictive assumptions, as follows:

- Demand is known with certainty and is constant over time.
- No shortages are allowed.
- Lead time of orders is constant.
- The order quantity is received all at once.

The EOQ model was presented originally by Ford W. Harris, in a paper published in 1913 in Factory, the Magazine of Management (Harris, 1913). Many researches were made on the base of this model. However, the coefficients of the model may be fuzzy.

IX. CONCLUSION

The efficiency of inventory management has become an area of major concern in business. New inventory models for managing the inventory levels are now available. Tis paper has presented a literature survey of models of inventory control under uncertainty. Most of the analytical models addressed only one type of uncertainty and assumed a simple structure of the production process. The most common dimensions to be considered as AI00 variables are demand, the cost of acquisition.

Each model, based on some assumptions, has its benefits and disadvantages, but still, many authors continue to design inventory control models using such approach as AI, which can suppose a great advance in inventory management.

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