Inventory Control with Soft Computing Techniques

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Abstract— The objective of this paper is the findings a systematic review of existing research papers concern with the application of soft computing techniques to inventory management. In business organization, inventory management is one of the major core competencies to compete in the global market place. The most important purpose served by the stores is to provide the uninterrupted service to the manufacturing divisions. The purpose of inventory in any business is to decrease the cost of set up and shortage cost. Whenever demands of customers are not fulfilled then good-will of the customers may be lost and the cancellations of orders i.e., result may be in the lost of business.

Keywords: Inventory Control, Soft Computing, Fuzzy Logic, Genetic Algorithm.

I. INTRODUCTION

Soft Computing is a fusion of methodologies that were designed to model and enable solutions to the real world problems which are not modeled, or too difficult to model, mathematically. These problems are typically associated with fuzzy, complex, and dynamical systems, with uncertain parameters. Many ways, soft computing represents a significant paradigm shift in the aims of computing - a shift which reflects the fact that the human mind, unlike present day computers, possesses a remarkable ability to store and process information which is pervasively imprecise, uncertain and lacking in category. Soft computing techniques are more powerful and efficient as they provide the feasible and less costly solutions compared to hard computing techniques. It is a multi-disciplinary field. Recent developments in sciences and computers have led to improved modeling and understanding of situations in all areas of human activity. In effect, the role model for soft computing is the human mind. With the fuzzy logic based technique, imprecision, uncertainty and human oriented knowledge representation is possible; still self learning and generalization of rules can not be possible. There are several methods for soft computing family from which Fuzzy Logic (FL) and Genetic Algorithm (GA) are the most important techniques.

A system based on the fuzzy logic known as fuzzy control system. Generally, control systems modeling have been based upon the use of mathematical techniques to the model (input/output) relationship of the system in question. Many real-world systems however, may not be as readily described mathematically due to the complexity of the components of the plant and the interaction between them, and consequently, the model may be subject to certain assumptions or conditions.

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In such models, the degree of mathematical precision required to completely describe every aspect of the process, is either prohibitive or non-trivial. In addition, for actual implementation of such systems, heuristics, gained through human experience, are often employed in the tuning of the final controller.

The proper utilization of space is also a critical component in business world, whether one is a manufacturer, retailer or a wholesaler. Business organizations mainly focus on improving the customer services and reduce the inventory costs in such a manner so that profit can be maximum. Inventory is the lifeblood for any business organizations i.e., it is the biggest asset and often inefficiently managed. Inventory has always been the foundation of conducting business in any organization. Holding and managing of an inventory is essential for efficient and smooth running of any business organization be it a manufacturing industry, an educational institute, a five star hotel, a hospital and a printing press etc. In business organization, inventory management is one of the major core competencies to compete in the global market place. The most important purpose served by the stores is to provide the uninterrupted service to the manufacturing divisions. Inventories represent a substantial portion of the total assets of a company and considerable effort is required to control the inventories. The purpose of inventory in any business is to decrease the cost of set up and shortage cost. Whenever demands of customers are not fulfilled then good-will of the customers may be lost and the cancellations of orders i.e., result may be in the lost of business. The only solution for that type of problems is the upkeep of inventory.

The use of Fuzzy Logic has an important application in the area of control system design where human expert knowledge, rather than precise mathematical modeling, of a process or plant is used to model/implement the required controller. The application of soft computing techniques has mainly two important advantages. First, it solve the non-linear problems and second is introducing the human knowledge such as recognition, learning, understanding and others field of soft computing. Today's inventory control models for time-varying demand recently attracted a great deal of research which helps to develop the interest of researcher in this field. In real life situations, demand is not constant so take the demand rate is usually in terms of a linear, exponential, quadratic, time-varying, production dependent, multivariate, or some other stock-dependent function. The study of deteriorating items with inventory model started **Ghare** and **Schrader (1963)** who established the inventory model for constant rate of decay. The concept of soft computing techniques (fuzzy logic) first introduced by **Zadeh (1965).** The invention of soft computing techniques (fuzzy set theory or fuzzy logic) by the need to represent and capture the real world problem with its fuzzy data due to uncertainty.

Bellman and **Zadeh (1970)** developed the difference between randomness and fuzziness by showing that the former deals with uncertainty regarding membership or non-membership of an element in a set while later is concerned with the degree of uncertainty by which an element belongs to a set. **Zimmermann (1985)** presents a review on fuzzy set theory with its applications. **Park (1987)** discussed the economic order quantity model (EOQ) in which trapezoidal fuzzy numbers are used to model ordering costs and inventory holding cost. **Bard** and **Moore (1990)** discussed a model for production planning with variable demand. In some cases, uncertainties can be defined as fuzziness or vagueness, which are characterized by fuzzy numbers of the fuzzy set theory. **Lee et al. (1990)** suggest the application of fuzzy set theory to lot-sizing in material requirements planning. **Yao** and **Lee (1999)** presented a fuzzy inventory model with and without backorder for fuzzy order quantity with trapezoidal fuzzy number. **Tang et al (2000)** presented a multi-product planning and scheduling using genetic algorithm approach. **Hsieh (2002)** considered two fuzzy production-inventory models: one for crisp production quantity with fuzzy parameters and the other one for fuzzy production quantity. He used the graded mean integration representation method for defuzzifying the fuzzy total inventory cost. **Papadrakakis** and **Lagaros (2003)** discussed about soft computing methodologies for structural optimization. **Sundarraj** and **Talluri (2003)** developed a multi-period optimization model for the procurement of component-based enterprise information technologies. **Wang et al (2003)** presented a fuzzy decision embedded genetic algorithm for the fuzzy due date bargaining problem and suggested an idea to the quantification of fuzzy rule. This idea has been successfully applied to some practical problems such as partner selection, and production planning and scheduling.

Chang et al. (2004) presented a lead-time production model based on continuous review inventory systems, where the uncertainty of demand during lead-time was dealt with probabilistic fuzzy set and the annual average demand by a fuzzy number only. **Chang et al. (2006)** presented a model in which they considered a lead-time demand as fuzzy random variable instead of a probabilistic fuzzy set. **Mahapatra** and **Maiti (2006)** formulated a multi-item, multi-objective inventory model for deteriorating items with stock- and time-dependent demand rate over a finite time horizon in fuzzy stochastic environment. **Mahata** and **Goswami (2006)** developed a fuzzy production-inventory model with permissible delay in payment. They assumed the demand and the production rates as fuzzy numbers and defuzzified the associated cost in the fuzzy sense using extension principle.

Yung et. al (2007) discussed on procurement planning of time-variable demand in manufacturing system based on soft computing techniques. **Dutta et al. (2007)** considered a continuous review inventory system, where the annual average demand was treated as a fuzzy random variable. The lead-time demand was also assessed by a triangular fuzzy number. **Maiti** and **Maiti (2007)** developed multi-item inventory models with stock dependent demand, and two storage facilities were developed in a fuzzy environment where processing time of each unit is fuzzy and the processing time of a lot is correlated with its size. **Singh** and **Singh (2008)** developed the fuzzy inventory model for finite rate of replenishment using the signed distance method. **Halim et al. (2008)** developed a fuzzy inventory model for perishable items with stochastic demand, partial backlogging and fuzzy deterioration rate. The model is further extended to consider fuzzy partial backlogging factor. **Goni** and **Maheswari (2010)** discussed the retailer's ordering policy under two levels of delay payments considering the demand and the selling price as triangular fuzzy numbers. They used graded mean integration representation method for defuzzification.

Halim et al. (2010) developed the lot sizing problem in an unreliable production system with stochastic machine breakdown and fuzzy repair time. They defuzzified the cost per unit time using the signed distance method. **Singh** and **Malik (2010)** discussedd an optimal ordering policy with linear deterioration, exponential demand and two storage capacities. **Singh** and **Malik (2011)** presented an inventory model with stock-dependent demand and two storage facilities. If we consider the real world inventory systems we find that the exits parameters and variables which are uncertain or almost uncertain. When these uncertainties are significant, they are usually treated by probability theory. Our objective in this paper is to provide a review on inventory control with soft computing techniques. **Malik and Singh (2011)** developed the Inventory Model for Deteriorating Items with Soft Computing Techniques and Variable Demand. **Malik, Singh and Gupta (2012)** presents a Fuzzy based Inventory Model for Deteriorating Items. **Malik and Singh (2013)** represent a Fuzzy mixed two warehouses Inventory Model with linear demand.

II. CONCLUSION

This paper presents a review for the application of soft computing techniques like fuzzy logic and genetic algorithms to use for improve the effectiveness and efficiency for various aspect of inventory management. The proposed paper can be used as a guidance to start research in inventory control with soft computing techniques.

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