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### A REVIEW ON APPLICATION OF CRISP AND FUZZY LOGIC APPROACH TO SUPPLY CHAIN SYSTEM

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#### ABSTRACT

This paper intends to deal with the application of both crisp and fuzzy logic to the supply chain system. Both crisp and fuzzy models are developed with regards to supply chain. The concepts related to fuzzy logic are reviewed in this context. The supply chain structure is also discussed for proper illustration of the concept. We have also surveyed the recent challenges that are faced by this system and the suggestions that can be made in this regard. Considering the different aspects of the supply chain system we have classified the recent fuzzy models which have been developed for different supply chain systems and then it is compared with the crisp models. The application of supply chain is investigated in both manufacturing as well as service industry.

**Keywords:** *Crisp and fuzzy systems, supply chain, supply chain system, fuzzy logic, supplier buyer relationship.*

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#### I. INTRODUCTION

Due to globalization numerous new strategies and mechanisms have been introduced in all sectors. The strategies help the business enterprises to focus mainly on generating highest profits for the organisation. As a consequence of this strategy the top management is involved in the process of making the most appropriate decisions considering all the factors which may be directly affecting the conditions prevailing within the industry itself and also those which may be regarded as external factors. This kind of holistic approach has led to the development of supply chain system(SC). It is also known as value chain (VC) and value stream (VS) approaches in general terms. These concepts and definitions have been investigated by many researchers at universities and academic centres as well as professionals in industries.

The supply chain begins with the purchase of goods or raw materials. The primary focus in case of purchase is on the selection of the supplier, supplier evaluation, relational activities with sellers. Consider a broad perspective of the system the upstream suppliers are considered as a part of a manufacturing/ buyers enterprises. Buyers are regarded as a source which controls the system and also links them to the suppliers. The level of suppliers actually forms a supply network with the buyer managing and leading it in an integrated way. Supply chain management plays a vital role in any system as its proper regulation determines the revenue generation for any organisation. In this system all the affecting elements related to the customers are considered and analyzed in a broader view.

In the general terms supply chain is defined as follows: (By Mabert and Venkataraman, in 1998) “A supply chain is the network of facilities and activities that performs the functions of product development, procurement of material from vendors, the movement of materials between facilities, the manufacturing products, the distribution of finished goods to customers and after-market support for sustainment.”

Based on this definition, such a network in a system contains a high degree of imprecision. These imprecisions arise due to uncertainties involved at each level i.e. from the procurement of raw materials to the buyer or customer. There are a lot of factors involved in supply chain system which may be due to real world character and its imprecise interfaces. Fuzzy set theory is the most appropriate tool to deal with such complicated systems.

In the present paper we have presented different approaches with regards to supply chain management in terms of crisp and fuzzy methodologies. First of all we have discussed the different aspects and characteristics of a supply chain system. The concepts related to the fuzzy system are also explained. The real world application of crisp and fuzzy supply chain systems have also been discussed. Then a comparative analysis is done for the two approaches.

## II. THE SUPPLY CHAIN SYSTEM

The supply chain system is a very vast system consisting of various aspects. It starts with the procurement of raw materials, preparation of the finished products, supply of these products in the market and buyers. The major perspectives of the supply chain systems are: (1) material flow, (2) information flow, (3) buyer-seller relations. These aspects of the supply chain can be summarised as follows: raw material suppliers, manufacturers of parts, assemblers, original equipment manufacturers, distributors, retailers, customers etc. These components are the vital for examining any supply chain system in a proper manner. The major perspectives of the supply chain system are discussed below:

- (1) Material flow: the materials should be managed in such a way that they meet the market demand. In such cases the managers play a vital role in maintaining a proper flow of materials through different levels of suppliers and distributors. The manufacturing units require a proper planning of the production related activities in order to maintain a proper flow of materials in a supply chain system. The proper scheduling of the production activities is a very complicated process. It has to be managed in a proper manner in order to maintain a desired flow of units in and out of a system to fulfil the demand of the product in the market. Thus in order to implement any such plan in a successful manner, supportive logistics is the primary requirement. There are a few other activities which need to be properly monitored for the smooth flow of materials in a supply chain system. These activities include transportation planning, inventory management and quality assurance. All such activities should be managed in a proper manner.
- (2) Information flow: it plays the most important role in a supply chain system. The proper management and control of each system consists of several parts. The business planning activities have complexities in the following four areas: (1) technological resolution, (2) product changes, (3) research and development, (4) information explosion. The supply chain system is regarded as a business entity in which there is a high level of business transaction. A properly managed and organised information system forms a foundation for the proper flow of materials in a supply chain system.
- (3) Buyer-seller relations: it is the main aspect of the supply chain system. The traditional approaches in the buyer-seller process lays emphasis on the price of the commodity while the supply chain system focuses on the quality, R and D, cost reduction, customer satisfaction and partnerships. In case of supply chain system both the internal and external resources as well as factors are important. Thus the buyer-seller relations are not just based on the price and cost of the commodity. The new concepts such as early supplier involvement and concurrent engineering are the new concepts which are applied to the supply chain and it led to the holistic and comprehensive approach. The other aspects of supply chain which make it different from traditional approaches are long term contracts with suppliers and distributors, emphasizing the value added activities, strategic alliances and information sharing.

## III. FUZZY SET THEORY AND SUPPLY CHAIN SYSTEM AT A GLANCE

There are several subsystems with unlimited relations in different aspects. Each subsystem has a lot of uncertainties.

Petrovic et al (1999, p 444) demonstrate the uncertainties in the supply chain systems as follows:-

“..... A real supply chain operates in an uncertain environment. Different sources and types of uncertainty exist along the SC. They and random events, uncertainty in judgement, lack of evidence, lack of certainty of evidence that appears in customer demand, production and supply. Each facility in the supply chain must deal with uncertain demand imposed by succeeding facilities and uncertain delivery of the preceding facilities in SC.

If there is any kind of uncertainty in any subsystem or even an element makes the entire system uncertain. These uncertainties may be in the different aspects like material flow, information flow and supplier buyer relations. SC system is based on several factors due to which it becomes complex. When such an SC uses real data there is an exponential growth in its complexity. In the SC system design and modelling, a large scale system is built in such a way that it involves limited abilities related to quantitative approaches. In the year 1992 Turksen stated several factors which are primarily related to the weakness of the quantitative models, they are (1) of managers' requirement of precise information, (2) difficulties in understanding them and (3) complexities in expressing them in the natural language of managers. This complexity related to the real system increases as the companies capture large amount of data in the warehouse. In 1996, Zimmermann suggested that real situations cannot be described precisely and humans are not able to understand and analyze real systems. Supply chain system is the most realistic approach and not just a mathematical or theoretical approach. It takes into account the real world problems and analyses and solves them.

In 1973 Zadeh stated “ As the complexity of a system increases, our ability to make precise and yet significant statements about its behaviour diminishes until a threshold is reached beyond which precision and significance becomes almost

mutually exclusive characteristics. It is in this sense that precise quantitative analyses of the behaviour of humanistic systems are not likely to have much relevance to the real world societal, political, economic and other types of problems which involve humans either as individuals or in groups.”

The fuzzy system approach has the following advantages in the real world applications:

1. Fuzzy models are easy to understand
2. Fuzzy models are more flexible as compared to other models and also easy to manage.
3. These models can capture the complex non-linear functions which cannot be done by other models.
4. These models are tolerant even in case of imprecise data.
5. They can be built by using the appropriate experience of experts.
6. These models can be easily blended with the conventional control techniques.
7. Thus the supply chain systems having uncertain parameters and conditions can be analyzed and modelled by the appropriate use of fuzzy set theory.

#### IV. RECENT TRENDS IN SUPPLY CHAIN SYSTEM: CRISP AND FUZZY ASPECTS

Supply chain system is analysed considering the different aspects listed below:

1. Price analysis through the supply chain system:-

The uncertainties in any SC system may be due to the manufacturing processes. These uncertainties appear mainly in the time duration of each state of the project. In such cases the primary motive is to minimize the variability of the sum of local or partial duration's which leads to the minimization of the variability of the supply chain as a whole. In order to reduce the total cost of a SC system, the alternative ordering policy is used. An approach of activity based costing is also applied. This technique also result in the reduction in the cost of the SC system. The assessment of the demand behaviour in the SC system has a tremendous effect on reducing the cost.

2. Inventory management and control through SC system:-

There is always uncertainty due to the real world production planning, inventory control and scheduling. In case of fuzzy systems, all sort of constraints can be easily merged. The major difficulty that exists in SC system is production planning and scheduling models. The fuzzy logic approach provides a tool to achieve stipulated goals, constraints laid down by the system. These motives help to achieve remarkable solutions to simplify the complexity related to the production planning and scheduling problems.

3. Quality considerations in SC systems:-

Maintaining an appropriate quality in the production sector is the primary consideration. The SC system helps in improving the quality in all ways. The development of proper quality concepts and their appropriate applications from the product quality through process and system qualities helps managers to expand the scope of quality into their supply chain system. The use of fuzzy variables helps in improving the quality in the supply chain systems by large extent.

In the present era the presence of various applications on the Information technology (IT) have improved commerce and the other industrial activities. The SC system as an integrated enterprises has been incorporated into IT. This has also led to the improvement in the SC system as it has become more systematic and planned.

A huge amount of difference has been observed in the buyer-seller relations as well. Due to uncertainties in such relations, makes this aspect of SC different from the conventional view of production systems. Strategic sourcing, supplier partnership, risk analysis in such partnering and the use of new generation of operations research models are the topics of prime consideration. As we know there are numerous uncertain aspects in this relationship as well and it can be properly predicted by assuming uncertain variables which are used for the prediction of the related values. SC system helps in improving this buyer-seller relations also as it helps in prediction of the most appropriate strategies in this context.

#### V. CONCLUSION

The various aspects related to SC system have been discussed in this survey. Both the crisp and fuzzy aspects have been taken into consideration. From this survey we conclude that the classical systems cannot cope up with the imprecise information and the uncertainty which is due to the lack of proper information on the related topics and also due to human components. In such cases the fuzzy set theory provides a new dimension to all areas under study as it provides membership functions to the input and outputs of the SC system models. This helps in resolving all the issues related to the real world SC system.

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