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Optimization of Supply Chain Link Using Neural Network

A Project Report

Submitted by

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BONAFIDE CERTIFICATE

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Who carried out the project work under my supervision.

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10th March 2006

CERTIFICATE

This is to Certify that Mr.E.Prabhu, II year M.E.,(IE) student of M/s Kumaraguru College of Technology, Coimbatore was with us in our organisation from 26th December 2005 to 10th March 2006 for collecting the data and for discussions at various stages of this project on "Optimization of supply chain link using Neural Network".

For Attur Textiles Pvt. Ltd

Managing Director.

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as ~~participated~~/ presented a paper entitled Optimization of Supply chain Link using Neural Network

the **National Conference on "Optimization Techniques in Engineering Sciences and Technologies (OPTEST-2006)"** during **11-12 April 2006,** organized by the **Department of Mechanical Engineering, Bannari Amman Institute of Technology,** Sathyamangalam.

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ABSTRACT

In today's world of competitive business, coordination of business activities is very important in order to survive in the market. SCM is a concept that assumes a business as a chain of inter-connected entities of commercial activities. The coordination of data and material transfer should be fast and controlled to achieve better performance, so to coordinate all these activities an efficient algorithm is required to optimize the Supply chain link hierarchy.

This project discusses the application of Neural Network to propose a co-operation model for SCM. This model constructs a relevant Supply Chain through iterated Match-Making process. The Match Making process makes connection between service provider and service requestor for each link of the supply chain. Effective supply chain is made when each link in the Supply Chain is connected properly. The proposed model uses Neural Network to establish proper connection between each link.

The developed Neural Network model predicts the optimal solution for any set of problem instances. Back propagation approach is used for training the Neural Network. Feed Forward Back Propagation approach is found to be effective in finding optimum chain connection from the procurement to the customer. Decisions are made based on the optimum solution obtained using neural network approach for selecting suppliers.

ஆய்வு சுருக்கம்

மாபெரும் நிறுவனங்கள் பல இன்று, தங்கள் வணிகத்தின் மிக முக்கிய கூறான, "தேவையை நிறைவு" செய்யும் "வளங்கள் தொடர் மேலாண்மையில்" தடுமாறிக் கொண்டிருக்கின்றன. இந்நிலையில் இம்மேலாண்மைக்கான, வளர்ச்சி யுத்திகளை சில நிறுவனங்கள் வகுத்தளிக்கின்றன.

இந்த தேவைகளை நிறைவு செய்யும் "சங்கிலித் தொடர் இணைப்பு மேலாண்மை" என்பது ஒன்றோடொன்று இணைந்த பல கண்ணிகள் கொண்ட சங்கிலி போல, நிறுவனத்தின் செயல் நடவடிக்கைகள் ஒன்றுடன் ஒன்று இணைத்து செயல்படுத்துவதாகும்.

இந்த ஆய்வுக் கட்டுரையானது, இம்மேலாண்மையின் முதுகெலும்பாக கருதப்படும் மைய இணைப்புத் தொடரின் பயன்பாடு குறித்து விளக்குவதாகும்.

இம்முறையில் "தகுந்த பொருந்து முறைகளை" கொண்டு தேவையான வழங்கல் தொடர் உருவாக்கப்படுகிறது. இந்த தேவையை நிறைவு செய்யும் சங்கிலி இணைப்புத் தொடரின் ஒவ்வொரு இணைப்பின் இரு புறமும் உள்ள சேவை அளிப்பவர், சேவையை பெறுபவர் என இரண்டையும் இந்த "பொருந்து முறைகள்" சரியாக இணைக்கின்றன.

வழங்கல் சங்கிலித் தொடரின் ஒவ்வொரு இணைப்பும் சரியான முறையில் இணைக்கப்படும் போது, இம்முறையானது மிகுந்த பயனளிக்கும் ஒன்றாகத் திகழும். அவ்வாறு பொருந்த இந்த ஆய்வு மைய இணைப்புத் தொடர் எனும் நுயூரல் நெட்ஒர்க் ஐ பயன்படுத்துகிறது.

கண்டறியப்பட்டுள்ள இம்மைய இணைப்புத் தொடர் மாதிரியானது, நடைமுறையில் எழும் எல்லா சிக்கல்களையும் அதிகபட்சம் சாமளிக்கும் வண்ணம் வடிவமைக்கப்பட்டு உள்ளது.

இந்த ஆய்வு இம்மைய இணைப்புத் தொடர் முறையை பயிற்றுவிக்க, விரிவானதொரு அணுகு முறையை பயன்படுகிறது. இந்த அணுகுமுறையானது, கொள்முதல் தொடங்கி வாடிக்கையாளர் வரை வழங்கல் சங்கிலித் தொடர் மேலாண்மை உறுதியாக திகழ, இந்த அணுகு முறை நன்கு உதவும் என்பதை இந்த

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LIST OF SYMBOLS & ABBREVIATIONS

SCM	Supply chain Management
MAS	Multi Agent System
Y_t	Actual value of period t
F_t	Forecasted value for the same period.
α	Smoothing constant
ANN	Artificial Neural Network
BP	Back Propagation
RMS	Root Mean Square Value
B	Buyer
S	Seller
B_j	Interacting with Buyer
S_i	Interacting with seller
τ_B	Maximum tolerance level
τ_s	Minimum tolerance level
N_{BSi}	Number of trades with the seller
N_{BSj}	Number of trades with the buyer
D_{SBj}	Order from the buyer
U_{BSi}	Expected price from the seller
S_{BSi}	Number of successful trades with the seller
S_{SBj}	Number of successful trades with the buyer
W_{BSi}	Trade-off weight
W_{SBj}	Buyer-Weight
P_{BSi}	Current price from the seller
P_{SBj}	Current price from the Buyer
EOD_{BSi}	Delivery dead line for the seller
C_P	Capacity
P_P	Cost
T_L	Lead Time
PE	Production Expectation

CHAPTER 1
INTRODUCTION

1.1 FUNDAMENTALS OF SUPPLY CHAIN MANAGEMENT

The supply chain generally consists of five elements; procurement, manufacturing, distribution, retail, consuming. By reducing inventory, lead times and cost at each link between elements that has requesting-providing relationship, the supply chain can provide the benefit of SCM to the all constituents.

The construction process of supply chain is not an easy task. A proper connection for each link should guarantee the gratification of each side on that link. In the retail consuming link, a proper connection should ensure the best profit to the retailer, and satisfy the customer's desire with low price, fast delivery, and good quality of product. The supply chain has four links such as procurement-manufacturing, manufacturing distribution, distribution-retail and retail-consuming. Since each of this process is independent and the whole process is complex, a Multi-Agent System (MAS) can be a suitable solution for SCM

Supply chain represents a coordinated network of firms interaction to provide a product or service to the end user. An inter-organizational supply chain strategy is needed to ensure that the flow of materials, manufacturing operations, and downstream distribution are aligned in a manner responsive to changes in customer demand without creating surplus inventory .This model constructs an optimum supply chain by finding the best connection between requesting and providing parts for each link. In order to find the most suitable connection, the MAS used the matchmaking method that employs neural networks.

A company's supply chain comprises geographically dispersed facilities where raw materials, intermediate products, of finished products are acquired, transformed, stored, or sold and transportation links that connect facilities along which products flow.

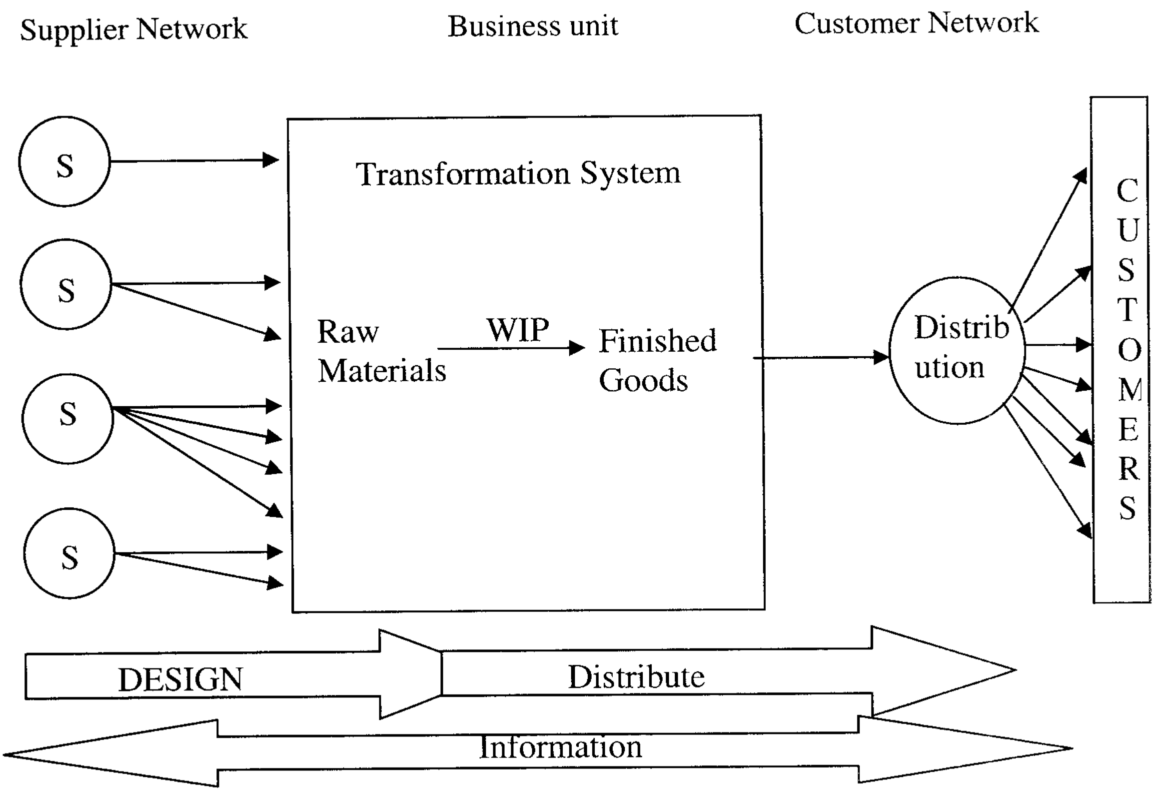


FIG 1.1 SUPPLY CHAIN

The facilities may be operated by the company, or they may operated by vendors, customers, third-party providers, or other firms with which the company has business arrangements. The company's goal is to add value to its products as they pass through its supply chain and transport them to geographically dispersed markets in the correct quantities, with the correct specifications, at the correct time, and at a competitive cost.

We distinguish between plants, which are manufacturing facilities where physical product transformations take place, and distribution centers, as shown in figure 1.1, which are facilities where products are received, sorted, put away in inventory, picked from inventory, and dispatched but not physically transformed. Of course, we shall occasionally consider hybrid facilities, either plants with distribution capabilities or distribution centers with physical product transformation capabilities.

1.2 SUPPLY CHAIN NETWORKS

A supply network is a pattern of temporal and spatial processes carried out at facility nodes and over distribution links, which adds value for customers through the manufacture and delivery of products. It comprises the general state of business affairs in which all kinds of material (work-in-process material as well as finished products) are transformed and moved between various value-add points to maximize the value added for customers.

A supply chain is a special instance of a supply network in which raw material, intermediate materials and finished goods are procured exclusively as products through a chain of processes that supply one another.

The supply chain is often represented as a network similar to the one displayed Figure 1.2. The nodes in the network represent facilities, which are connected by links that represent direct transportation connections permitted by the company in managing its supply chain. Although networks are a useful device for depicting and discussing models, keep in mind that the one displayed Figure 1.2 provides only high-level view of a supply chain. Meaningful analysis requires the addition of considerable detail about transformation activities and processes, resources, and capacities and costs that describe facilities and transportation links.

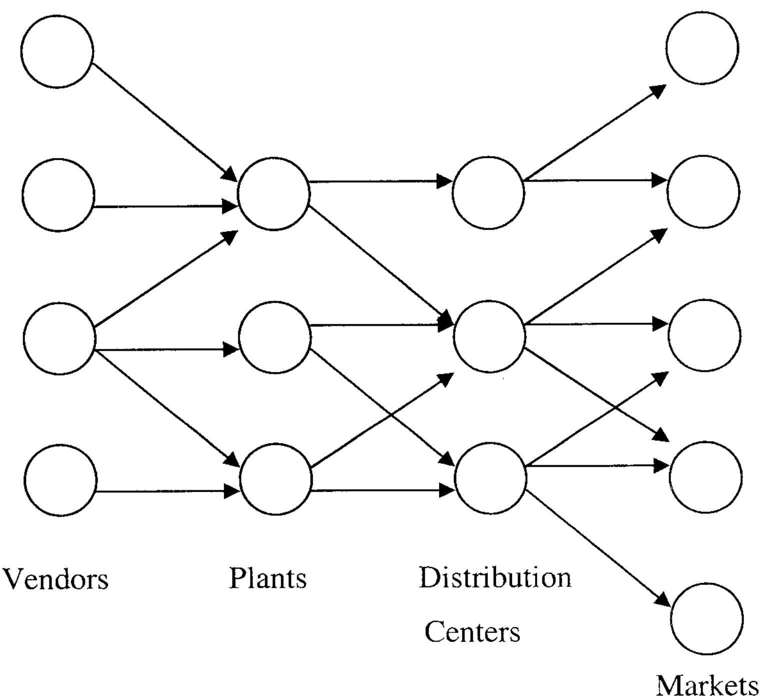


FIG 1.2 SUPPLY CHAIN NETWORK

The network of Figure 1.2 has four levels of faculties. Products flow down stream from vendors to plants, plants to distribution centers, and distribution centers to markets. In general, a supply chain network may have an arbitrary number of levels. Moreover, products may sometimes flow upstream when intermediate products are returned to plants for rework or reusable products are returned from markets to distribution centers for recycling.

1.3 ACTIVITIES

Resolution to supply chain problems span Strategic, Tactical, and Operational levels of activities.

1.3.1 Strategic

Strategic planning involves resource acquisition decisions to be taken over long-term planning horizons

- Strategic network optimization, including the number, location, and size of warehouses, distribution centers and facilities.
- Strategic partnership with suppliers, distributors, and customers, creating communication channels for critical information and operational improvements such as cross docking, direct shipping, and third-party logistics.
- Product designs coordination, so that new and existing products can be optimally integrated into the supply chain.
- Information Technology infrastructure, to support supply chain operations.
- Where to make what and make or buy decisions

1.3.2 Tactical

Tactical planning involves resource allocation decisions over medium-term planning horizons

- Sourcing contracts and other purchasing decisions.
- Production decisions, including contracting, locations, scheduling, and

- Inventory decisions, including quantity, location, and quality of inventory.
- Transportation strategy, including frequency, routes, and contracting.
- Benchmarking of all operations against competitors and implementation of best practices throughout the enterprise.
- Milestone Payments

1.3.3 Operational

Operational planning involves decisions affecting the short-term execution of the company's business.

- Daily production and distribution planning, including all nodes in the supply chain.
- Production scheduling for each manufacturing facility in the supply chain (minute by minute).
- Demand planning and forecasting, coordinating the demand forecast of all customers and sharing the forecast with all suppliers.
- Sourcing planning, including current inventory and forecast demand, in collaboration with all suppliers.
- Inbound operations, including transportation from suppliers and receiving inventory.
- Production operations, including the consumption of materials and flow of finished goods.
- Outbound operations, including all fulfillment activities and transportation to customers.
- Order promising, accounting for all constraints in the supply chain, including all suppliers, manufacturing facilities, distribution centers, and other customers.

1.4 PROJECT OBJECTIVE

In present manufacturing scenario, industries are facing serious challenge to meet the growing demand for diversified products. Today's customers want a variety of product in just the right quantities. They expect high quality products at

The objective of this project work to optimize the Supply Chain Link Using Neural Network in Attur Textile Pvt Ltd. (ATPL) Steps followed in this project work are:

(i) A detailed study has been made in ATPL.

(ii) The link between the buyer and the seller has been identified.

(iii) The past record of suppliers has been taken to calculate the weightage of the suppliers.

(iv) With the help of that, the suppliers are ranked. For proper Supply Chain Link, we have to maintain the right time, right quantity, right quality, right customer and at right condition.

(v) Simulation model has to be developing for the ordering quantities from each supplier. Using this simulation model the optimum ordering quantity of raw material from each suppliers are calculated.

CHAPTER 2
LITERATURE REVIEW

2 .1 THE SUPPLY CHAIN IN THE TEXTILE SECTOR

The textiles sectors can be seen as a supply chain consisting of a number of discrete activities. Increasingly the supply chain from sourcing of raw materials via design and production to distribution and marketing is being organized as an integrated production network where the production is sliced into specialized activities and each activity is located where it can contribute the most to the value of the end product. When the location decision of each activity is being made, costs, quality, reliability of delivery, access to quality inputs and transport and transaction costs are important variables. The supply chain in the textile sector is illustrated by figure 2.1. The dotted lines represent the flow of information, while the solid lines represent the flow of goods. The direction of the arrows indicates a demand-pull-driven system. The information flow starts with the customer and forms the basis of what is being produced and when. It is also worth noticing that information flows directly from the retailers to the textile plants in many cases. The textile sector produces for the clothing sector and for household use. In the former case there is direct communication between retailers and textile mills when decisions are made on patterns, colors and material. In the second case textile mills often deliver household appliances directly to the retailers.

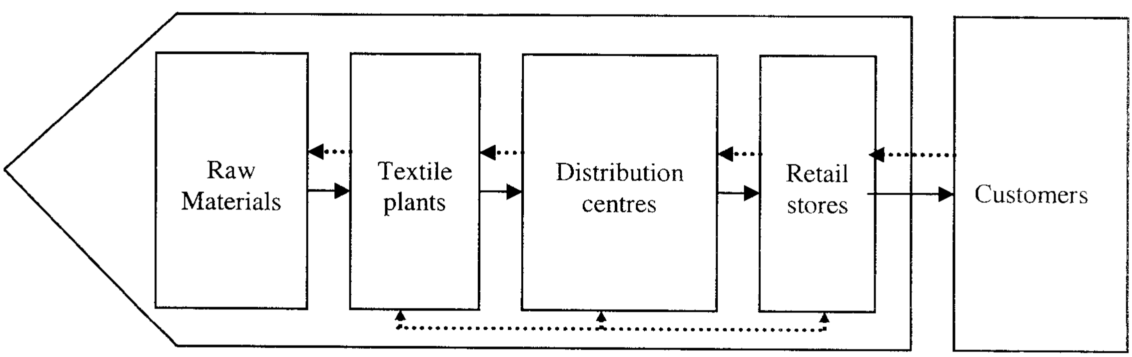


FIG 2.1 THE SUPPLY CHAIN IN THE TEXTILE SECTOR

At each link in the production chain to the left of the distribution centre in Figure 2.1, there are usually several companies. In order to make goods services are needed. Depending on the size and development of the host economy, such services are provided by the lead firm in the supply chain or independent service providers in the more advanced countries. An illustration of how a supply chain operates is as follows: lean retailers will typically replenish their stores on a weekly basis. Point of sales data are extracted and analyzed over the weekend and replenishment orders placed with the manufacturer. The manufacturer is typically required to fill the order within a week, which implies that the manufacturer will always have to carry larger inventories of finished goods than the retailer. How much larger depends on his own lead time and demand volatility. The larger the fluctuations in demand, and the larger the number of varieties (e.g. style, size, colour) the larger the inventory has to be. On the other hand, the shorter the manufacturer's lead time, the better the demand forecasts and the larger. The market, the less the inventory needed relative to sales. The size of the market matters, since the variation of aggregate demand from a large number of consumers are less than the variation over time of a few consumers. Upon receiving the replenishment order, the manufacturer will fill it from its inventory and then on the basis of the gap between remaining inventory and the desired inventory level, will make a production order to the production plant, of which the manufacturer may have several in different locations. The retailers may order large quantities of, elastic tapes spread over a number of producers in several low-wage companies. In order to ensure that the elastic tapes are similar and can sell under the same label, the buyer often buys rubber and accessories in bulk and provides its suppliers with these inputs. In addition, buyers often also specify the design and assist the producers in providing the desired quality (Abernathy et al., 1999; Kelegama and Foley, 1999).

2.2 VENDOR RATING

There are many different types of vendor ratings, which meet the requirements of these characteristics to fit the varying needs of the plants and companies. A principal difference among these plans is the factors they include in the vendor ratings. However, there are three key factors that experience shows are essential in vendor ratings:

3. Vendor service

A basic vendor rating plan that has been widely used is based upon the foundation of these factors. It weights these factors as follows:

Quality	40 points
Price	35 points
Service	25 points
Total	100 points

This weighting should be flexible from one type of business to another and may be varied to fit a given type of business. The use of this plan is as follows:

1. Its quality rating is based upon the fraction of total lots received that are acceptable for a given part. For example, if supplier A had 54 lots accepted out of a total of 60 lots delivered, 54/60 or 90%, of the lots were accepted. The quality rating would be 0.90*40 (weighting factor) = 36 points.
2. On price, the vendor with the lowest net price receives the full 35 points (or whatever weighting factor was chosen for price). If, for example, supplier B had the lowest net price of 93 cents per 100 pieces, the rating on price would be 35 points. If A's price was $1.16, then supplier A's rating would be

$$\frac{0.93}{1.16} * 35 = (0.80)(35) = 28 \text{ points}$$

3. The service rating can be based upon the percentage of promises kept. If supplier A kept 90 percent of his promises, his service rating would be (0.90) (25) = 22.5 points.

4. Supplier A's total rating would therefore be:

Quality	36.0 points
Price	28.0 points

Total 86.5 points

This rating can be compared with comparable vendors on the basis of single-part number or catalog number. These comparisons are then a basis for company-purchasing action in placing future purchase orders.

This basic rating may be expanded to include further specific vendor quality results information, as required by the particular plant and company needs.

2.2.1 With regards to quality

The rating may include indicators of the detailed percent nonconformities found in the lots received. Other inclusions may be indicators of the criticality of the lot nonconformities in incoming material which are found in production and in the field; nonconforming lot trends and trend projections; and vendor certification.

2.2.2 With regard to service

The rating may include indicators of the specific days late deliveries have been received. It may also include indicators of vendor cooperation in such areas as surveys, corrective action, and providing advance notification of lot defectives. Measurements themselves may be reported either in terms of points achieved by vendors-the positive-performance-oriented approach as shown above-or demerits incurred by vendors-the approach that makes clear that there are deficiencies. Plants have different philosophies on these measurement concepts and both approaches are widely and effectively used.

2.3 INVENTORY MANAGEMENT

A company may hold inventories of raw materials, parts, work-in-process, or finished products for a variety of reasons. Inventories can serve to hedge against the uncertainties of supply and demand or to take advantage of economies of scale associated with manufacturing or acquiring products in large batches. Inventories are also essential to build up reserves for seasonal demands or promotional sales.

uncertainties that make them necessary. These efforts have been motivated in part by the recognition that metrics describing the performance of a company's inventory management practices can be important signals to shareholders regarding the efficiency of the company's operations and hence its profitability. Just-in-time inventory practices, which found widespread application in recent years, have been tempered by the realization that they may incur significant hidden costs in some situations, such as those realized by small suppliers to large companies in the automotive and aerospace industries.

Inventory management problems are characterized by holding costs, shortage costs, and demand distributions for products specified at a detailed stock keeping unit (SKU) level. Models for optimizing inventory policies for individual items use arguments and methods from statistics and applied probability theory. As such, they are structurally very different from deterministic optimization models, which broadly consider products, facilities, and transportation flows in analyzing resource acquisition and allocation decisions.

The models for inventory management with an emphasis on approaches for integrating inventory decisions with other supply chain decisions. This perspective, which is sometimes overlooked by mangers responsible for controlling inventories, is crucial because holding costs are only one element of total supply chain cost. As we shall see, incorporating inventory decisions in supply chain optimization models is difficult because they involve parameters and relationships, such as variances of market demands and delivery times and their impact on stock outages, which are not easily represented in optimization models. Nevertheless, depending on the scope of analysis, acceptable approximations of inventory costs can be developed. Improving these approximations is an important area of applied research.

2.4 DEMAND FORECASTING AND MARKETING SCIENCE

Demand forecasting refers to quantitative methods for predicting future demand for products sold by the company. Such forecasts are obviously essential for the construction of a supply chain model, either a total cost minimization model to meet a specific demand forecast or a net revenue maximization model in constructing multiple demand scenarios to be optimized by the supply chain model.

Demand forecasting techniques are primarily statistical methods. Analysts apply them to project future sales pattern from historical data about past sales and possibly other data about the company, its industry, the national economy, and the global economy. Time series analysis is a large class of methods for developing forecasts exclusively from historical databases. The well-known technique of exponential smoothing is a simple type of time series model.

In constructing a time series model, the practitioner attempts to find patterns in the historical data, such as seasonal effects or trends that produce a good fit to the data as measured by the variance of the forecast. Sometimes patterns causing variability in the data are subtle. In such cases, considerable expertise by the modeling practitioner may be needed to produce a good model. In short, in addition to its mathematical underpinnings, demand forecasting has a decided artistic side, which may be difficult to document or explain to a non expert.

Time series models have a fatalistic aspect to them in that they assume the past will repeat itself without being influenced by external factors. Thus, the company may be well advised to combine statistical analysis with managerial judgment about the short-, medium-, and long-term outlooks for company sales to customers and markets. At the other extreme, supply chain planning based purely on intuitive, managerial judgments without recourse to formal predictive methods using data is not recommended.

Another large class of forecasting models, which includes regression and econometric methods, goes somewhat beyond the fatalism of time series techniques in seeking to provide insights into the product demand process through causal relationships, or at least explanatory factors that link independent variables to demand forecasts. Examples are forecasting the increase in product demand as a function of the increase in product demand as a function of the increase in gross domestic product (GDP) and the decrease in demand as a function of an increase in product price. But even causal models are susceptible to an over reliance on historical data, which again suggests the need to combine them with managerial

Once we open up our analysis of demand forecasts to causal modeling, a natural next step is to investigate marketing science models that relate forecasted sales to values of decision variables determined by the marketing department such as price, promotion, advertising, and sales forecast effort. Because the cost of marketing strategies involving these decision variables will be significant, we must consider extended models that integrate supply chain management decisions with demand management decisions. Although such models have not yet been widely implemented, there is growing interest in them.

When a company faces the introduction of a new product, it has no historical data upon which to base its forecasts. In many instances, though, historical data is available for similar products. The challenge is to develop initial forecasts of the new product based on forecasting parameters extracted from historical data of these similar products. For example, the diffusion model for new products relates sales to parameters describing the rates at which two types of customers, innovators and imitators, decide to buy the product. This model has been used successfully to forecast new sales of new consumer durable electronic and high-tech products. Once a profile of the new product sales begins to emerge, the a priori parameters can be revised.

CHAPTER 3
METHODOLOGY

3.1 ARTIFICIAL NEURAL NETWORKS

The concept of ANN analysis has been discovered nearly 50 years ago, but it is only in the last 20 years that applications software has been developed to handle practical problems. The history and theory of neural networks have been described in a large number of published literatures and will not be covered in this project work except for a very brief overview of how neural networks operate. The basic features of some of the mostly used neural network architectures would also be described. ANNs are good for some tasks while lacking in some others.

Specifically, they are good for tasks involving incomplete data sets, fuzzy or incomplete information, and for highly complex and ill-defined problems, where humans usually decide on an intuitional basis. They can learn from examples, and are able to deal with non-linear problems. Furthermore, they exhibit robustness and fault tolerance. The tasks that ANNs cannot handle effectively are those requiring high accuracy and precision as in logic and arithmetic. ANNs have been applied successfully in a number of application areas.

Some of the most important applications are

1. Function approximation. Mapping of a multiple input to a single output is established. Unlike most statistical techniques, this can be done with adaptive model-free estimation of parameters.

2. Pattern association and pattern recognition. This is a problem of pattern classification. ANN scan be effectively used to solve difficult problems in this field, like for instance in sound, image, or video recognition. This task can even be made without an a priori definition of the pattern. In such cases, the network learns to identify totally new patterns.

3. Associative memories. This is the problem of recalling a pattern when given only a subset clue. In such applications, the network structures used are usually complicated, composed of many interacting dynamical neurons.

4. Generation of new meaningful patterns. This general field of application is relatively new. Some claims are made that suitable neuronal structures can exhibit rudimentary elements of creativity.

ANNs have been applied successfully in a various fields of mathematics, engineering, medicine, economics, meteorology, psychology, neurology, and many others. Some of the most important ones are: in pattern, sound and speech the identification of military targets and in the identification of explosives in passenger suitcases.

They have also being used in weather and market trends forecasting, in the prediction of mineral exploration sites, in electrical and thermal load prediction, in adaptive and robotic control and many others. Neural networks are also used for process control because they can build predictive models of the process from multi-dimensional data routinely collected from sensors.

Neural networks obviate the need to use complex mathematically explicit formulas, computer models, and impractical and costly physical models. Some of the characteristics that support the success of ANNs and distinguish them from the conventional computational techniques are:

- The direct manner in which ANNs acquire information and knowledge about a given problem domain (learning interesting and possibly non-linear relationships) through the 'training' phase.

- Neural networks can work with numerical or analogue data that would be difficult to deal with by other means because of the form of the data or because there are so many variables.

- Neural network analysis can be conceived of as a 'black box' approach and the user does not require sophisticated mathematical knowledge.

- The compact form in which the acquired information and knowledge is stored within the trained network and the ease with which it can be accessed and used.

- Neural network solutions can be robust even in the presence of 'noise' in the input data.

- The high degree of accuracy reported when ANNs are used to generalize over a set of previously unseen data (not used in the 'training' process) from the problem domain.

While neural networks can be used to solve complex problems they do suffer from a number of shortcomings. The most important of them are:

- The data used to train neural nets should contain information, which ideally, is spread evenly throughout the entire range of the system. There is limited theory to assist in the design of neural networks.

- There is no guarantee of finding an acceptable solution to a problem.

In the following sections it is briefly explained how from a biological neuron the artificial one is visualized and the steps required to set-up a neural network. Additionally, the characteristics of some of the mostly used neural network architectures are described.

3.2 BIOLOGICAL AND ARTIFICIAL NEURONS

A biological neuron is shown in figure 3.1 in brain; there is a flow of coded information (using electrochemical media, the so-called neurotransmitters) from the synapses towards the axon. The axon of each neuron transmits information to a number of other neurons. The neuron receives information at the synapses from a large number of other neurons. It is estimated that each neuron may receive stimuli from as many as 10,000 other neurons. Groups of neurons are organized into sub-systems and the integration of these subsystems forms the brain. It is estimated that the human brain has got around 100 billion interconnected neurons.

Figure 3.2 shows a highly simplified model of an artificial neuron, which may be used to stimulate some important aspects of the real biological neuron. An ANN is a group of interconnected artificial neurons, interacting with one another in a concerted manner. In such a system, excitation is applied to the input of the network. Following some suitable operation, it results in a desired output. At the synapses, there is an accumulation of some potential, which in the case of the artificial neurons is modeled as a connection weight. These weights are continuously modified, based on suitable learning rules.

3.3 ARTIFICIAL NEURAL NETWORK PRINCIPLES

According to Haykin a neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the human brain in two respects: the knowledge is acquired by the network through a learning process, and inter-neuron connection strengths known as synaptic weights are used to store the knowledge. ANN models may be used as an alternative method in engineering analysis and predictions. ANNs mimic somewhat the learning process of a human and the controlled and uncontrolled variables by studying previously recorded data, similar to the way a non-linear regression might perform. Another advantage of using ANNs is their ability to handle large and complex systems with many interrelated parameters. They seem to simply ignore excess input parameters that are of minimal significance and concentrate instead on the more important inputs.

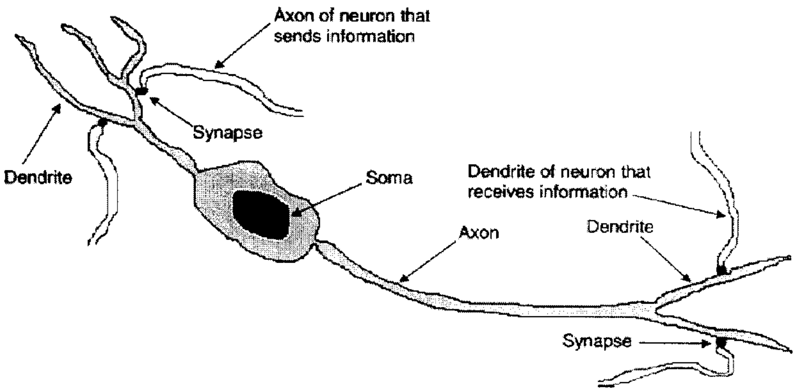


FIG 3.1 A SIMPLIFIED MODEL OF A BIOLOGICAL NEURON

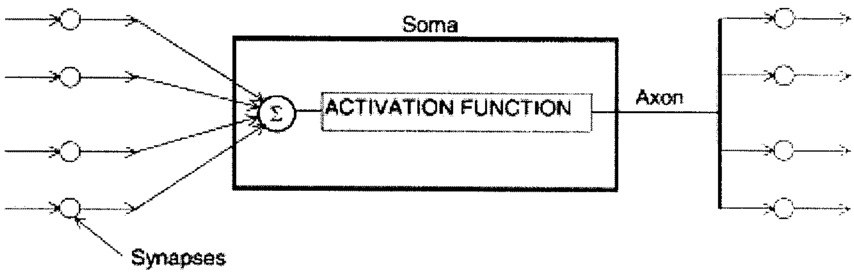


FIG 3.2 A SIMPLIFIED MODEL OF AN ARTIFICIAL NEURON

Figure 3.3 shows how information is processed through a single node. The node receives weighted activation of other nodes through its incoming connections. First, these are added up (summation). The result is then passed through an outgoing connections, this activation value is multiplied with the specific weight and transferred to the next node

A training set is a group of matched input and output patterns used for training the network, usually by suitable adaptation of the synaptic weights. The outputs are the dependent variables that the network produces for the corresponding input. It is important that all the information the network needs to learn is supplied to the network as a data set.

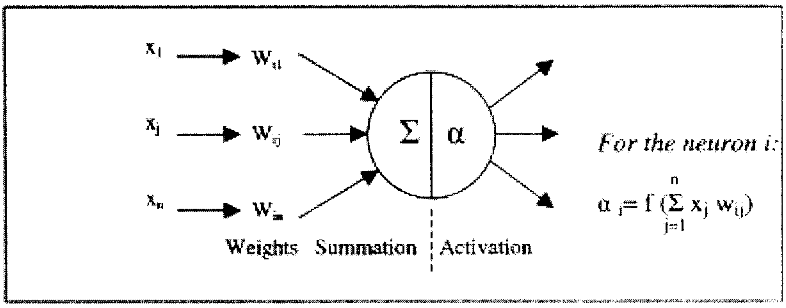


FIG 3.3 INFORMATION PROCESSING IN A NEURAL NETWORK UNIT

When each pattern is read, the network uses the input data to produce an output, which is then compared to the training pattern, i.e. the correct or desired output. If there is a difference, the connection weights (usually but not always) are altered in such a direction that the error is decreased. After the network has run through all the input patterns, if the error is still greater than the maximum desired tolerance, the ANN runs again through all the input patterns repeatedly until all the errors are within the required tolerance. When the training reaches a satisfactory level, the network holds the weights constant and the trained network can be used to make decisions, identify patterns, or define associations in new input data sets not used to train it.

By learning, it is meant that the system adapts (usually by changing suitable controllable parameters) in a specified manner so that, some parts of the system suggest a meaningful behavior, projected as output. The controllable parameters have different names such as synaptic weights, synaptic efficiencies, free parameters and others.

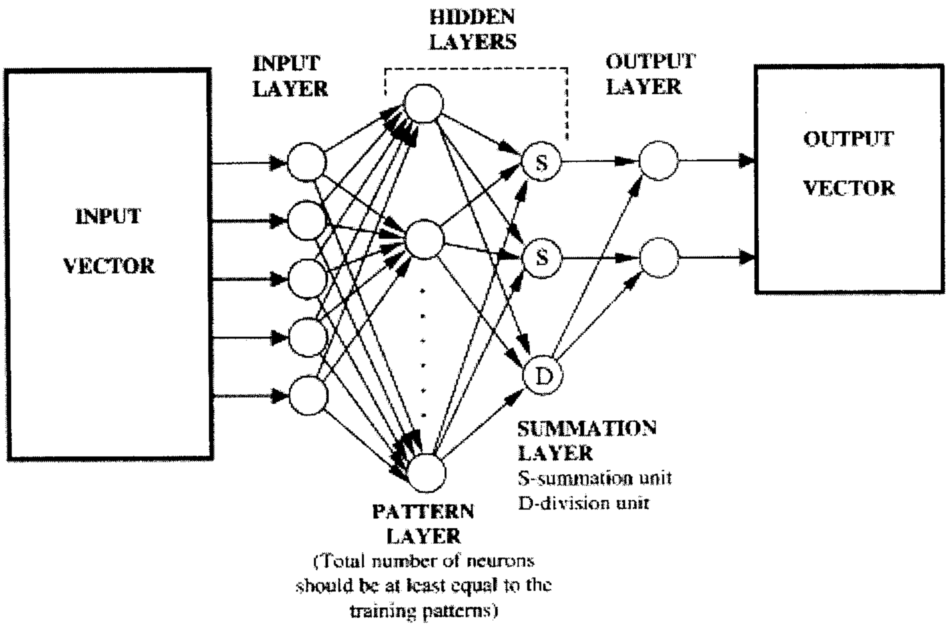


FIG 3.4 GENERAL MLP MODEL

3.4 MULTI-LAYER PERCEPTIONS (MLP) MODEL

An artificial neural network is a collection of highly inter connected processing units that have the ability to learn and store patterns as well as to generalize when presented with new patterns. Figure 3.4 shows MLP model in which learnt information is stored in the form of numerical values, called weights that are assigned to the connections between the processing units of the net. A neural network usually consists of an input layer, one or more hidden layers and an output layer. Before the network is trained the weights are assigned small, randomly determined values. Through a training procedure such as back propagation, the network's weights are modified incrementally until the network is deemed to have learnt the relationship. This type of learning is a supervised type of learning. When a pattern is applied at the input layer, the stimulus is fed forward until final outputs are calculated at the output layer. The network's outputs are compared with the desired results for the pattern considered and the errors are computed. The errors are then propagated backwards through the networks as feedback to the proceeding layers to determine the changes in the connection weights in the effort to minimize the errors. The series of such input-output training examples is presented acceptable minimum. At this point the network is considered 'trained'. Data presented at the input layer of a trained network will result in values from the output layer consistent with the relationship learnt by the network from the training examples.

3.5 LEARNING IN A MULTI-LAYER NEURAL NETWORK

All neural networks are of the feed forward type with two hidden layer. They were trained using back propagation. In a feed forward network, each unit has an activity level that is determined by the input received from units in the layer below. The total input, x_j, received by unit j is defined is defined to be

$$x_j = \Sigma\, y_i\, w_{ji} - b_j$$

Where y_i is the state of i^{th} unit (which is in a lower layer), w_{ji} is the weight on the connection from the i^{th} to the j^{th} unit and b_j is the bias of the j^{th} unit. Biases can be viewed as the weights on extra input lines whose activity level is always one, so they can be learned in just the same way as the other weights. The lowest layer contains the input units and an external input vector is supplied to the network by clamping the states of these units. The state of any other unit in the network is determined by its activation function. One example is a monotonic nonlinear function of its total input (sigmoid unit).

$$Y_i = \quad 1/(1 + e^{-xj})$$

The activity levels of the output units of the root or ending networks represent probability distributions across mutually exclusive alternatives. To ensure that these activity levels sum to one, the output value, y_i, of each output unit, i, is derived from the total input received by that unit , x_i , using the following non local nonlinearity;

$$Y_i = 1 / \Sigma\, je^{xj}$$

Many different error functions can be used. The most common is the sum of the squared error which is simply the sum of the squared difference between networks, but for the root and ending networks we use a different error function that is appropriate to the special behavior of the output units in these two networks, the error function is

$$E = - \sum_{j=1}^{n} dj \log (y_j)$$

Where $d_j = 1$, for correct output unit

$d_j = 0$, for incorrect output unit

3.6 TYPES OF ANN

3.6.1 Supervised Networks

Supervised neural networks are trained to produce desired outputs in response to sample inputs, making them particularly well suited to modeling and controlling dynamic systems, classifying noisy data, and predicting future events. Some of the supervised networks available are Feed-forward networks, Radial basis networks, Recurrent networks, Learning Vector Quantification (LVQ), etc.

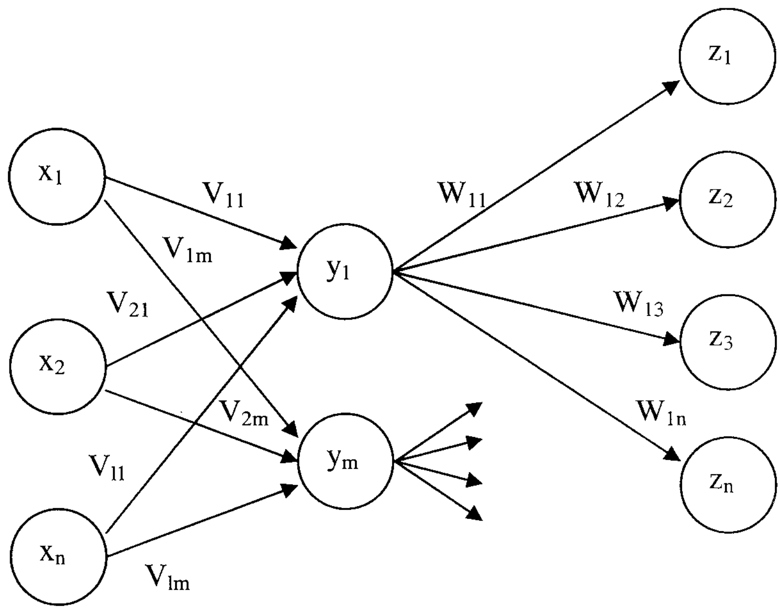
3.6.2 Unsupervised Networks

Unsupervised neural networks are trained by letting the network continually adjust itself to new inputs. They find relationships within data and can automatically define classification schemes. Some of the available such type of networks are competitive layers, self-organizing maps, etc.

3.7 MULTILAYER FEEDFORWARD NETWORK

This network, as its name indicates is made up of multiple layers. Thus, architectures of this class besides possessing an input and an output layer also have one or more intermediary layers called hidden layers. The computational units of the hidden layer are known as the hidden neurons or hidden units. The hidden aids in performing useful intermediary computations before directing the input to the output layer. The input layer neurons are linked to the hidden layer neurons and the weights on these links are referred to as input-hidden layer weights. Again, the hidden layer neurons are linked to the output layer neurons and the corresponding weights are referred to as hidden layer weights. A hidden layer, m2 neurons in the second hidden layer and n output neurons in the output layer is written as 1-m1-m2-n.

Figure 3.5illustrates a multilayer feedforward network with a configuration 1-m-n.



Input layer Hidden layer Output layer

X_i : Input neurons

Yj : Hidden neurons

Zk : Output neurons

Vij : Input hidden layer weights

Wjk : Output hidden layer weights

P-1685

FIG 3.5 A MULTILAYER FEEDFORWARD NETWORK

3.8 THE McCULLOH-PITTS NEURON

The McCulloh-pitts neuron is perhaps the earliest artificial neuron [McCulloh & Pitts, 1943]. It displays several important features found in many neural networks. The requirements for McCulloh-pitts neurons may be summarized as follows:

1. The activation function of a McCulloh-pitts neuron is binary. That is, at any time step, the neuron either fires (has an activation of 1) or does not fire (has an activation of 0).

3. A connection path is excitatory if the weight on the path is positive; otherwise it is inhibitory. All excitatory connections into a particular neuron have the same weights.

4. Each neuron has a fixed threshold such that if the net input to the neuron is greater than the threshold, the neuron fires.

5. The threshold is set so that inhibition is absolute. That is, any nonzero inhibitory input will prevent the neuron from firing.

6. It takes one time step for a signal to pass over one connection link.

The simple example of a McCulloch-pitts neuron shown in the figure illustrates several of these requirements. The connection from X1 to Y is excitatory as is the connection from X2 to Y. these excitatory connections have the same (positive) weight because they are going into the same unit.

The threshold for unit Y is 4; for the values of the excitatory and inhibitory weights shown, this is the only integer value of the threshold that will allow Y to fire sometimes, but will prevent it from firing if it receives a nonzero signal over the inhibitory connection.

It takes one time step for the signals to pass from the X units to Y; the activation of Y at time t is determined by the activations of X1, X2, and X3 at the previous time, t-1. The use of discrete time steps enables a network of McCulloch-pitts neurons to model a physiological phenomenon in which there is a time delay.

3.8.1 Architecture

In general, a McCulloch-Pitts neuron Y may receive signals from any number of other neurons. Each connection path is either excitatory, with weight w>0, or inhibitory, with weight - p (p>0). For convenience, in figure 3.6 we assume there are n units, $X_1 \ldots X_n$, which send excitatory signals to unit Y, and m units, $X_{n+1}, \ldots X_{n+m}$, which send inhibitory signals. The activation function for unit Y is

$$f(y\_in) = \begin{cases} 1 & \text{if } y\_in \geq \theta \\ 0 & \text{if } y\_in < \theta \end{cases}$$

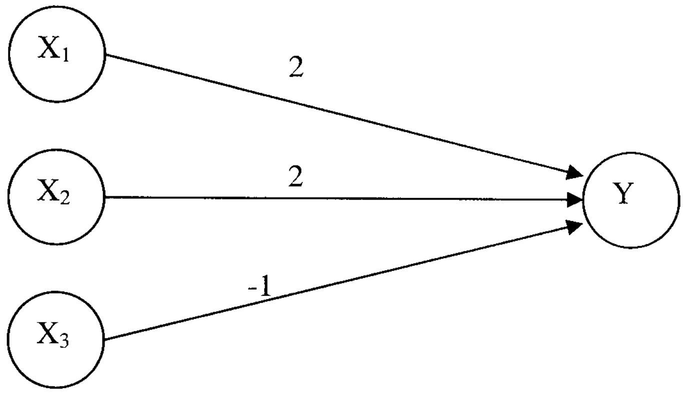


FIG 3.6 A SIMPLE McCULLOCH-PITTS NEURON Y

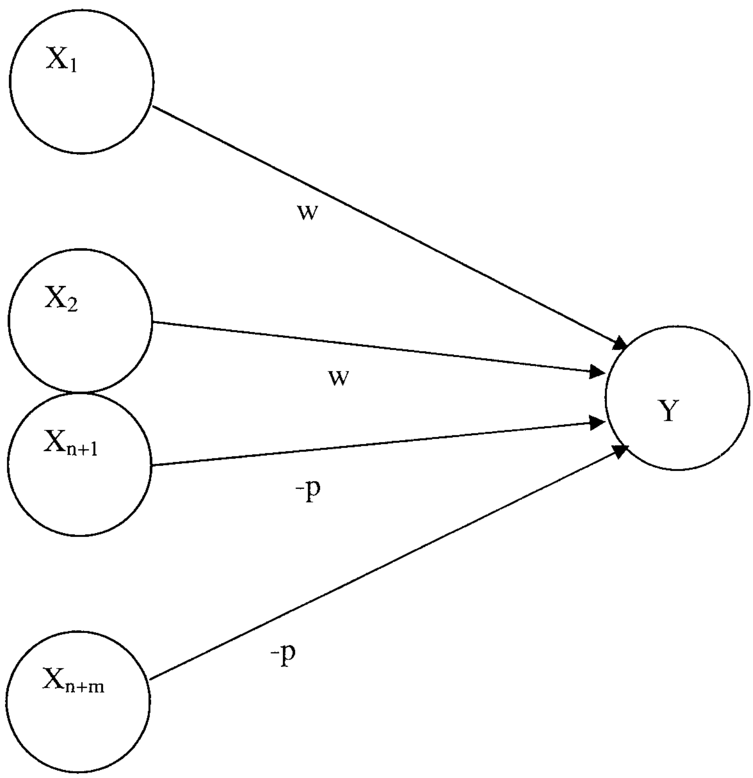


FIG 3.7 ARCHITECTURE OF A MCCULLOCH-PITTS NEURON Y

where y in is the total input signal received and θ is the threshold. The condition

$$\theta > nw - p$$

Y will fire if it receives k or more excitatory inputs and no inhibitory inputs, where

$$kw \geq \theta > (k-1)\, w$$

Although all excitatory weights coming into any particular unit must be the same, the weights coming into one unit, say, Y_1, do not have to be the same as the weights coming into another unit, say Y_2

3.9 FEED FORWARD BACK PROPAGATION NETWORK

Several ANN topologies have been developed for different applications, the most popular being the Feed Forward Back Propagation Network. It is a gradient descent error-correcting algorithm, which updates the weights in such a way that the network output error is minimized. The way that the neurons are organized forms the structure of the neural network, such as single-layer feed forward networks, multilayer-feed forward networks, etc. A feed forward back propagation network consists of an input layer (where the inputs of the problem are received), hidden layers (where the relationship between the inputs and outputs are determined and represented by synaptic weights) and an output layer (which emits the outputs of the problem). The network performs two phases of data flow. First the input pattern is propagated from the input layer to the output layer and, as a result of this forward flow of data it produces an output. Then the error signals resulting from the difference between the computed and the actual are back propagated from the output layer to the previous layers for them to update their weights.

3.9.1 Training

The training algorithm using backpropagation in time for a recurrent net of the form illustrated in Figure is based on the observation that the performance of such a net for a fixed number of time steps N is identical to the results obtained from a feedforward net with 2N layers of adjustable weights. For example, the

The training process consists of a feed forward pass through the entire expanded network (for the desired number of time steps). The weight adjustments for each copy of the net are determined individually (i.e., computed) and totaled (or averaged) over the number of time steps used in the training. Finally, all copies of each weight are updated. Training continues in this way for each training pattern, to complete an epoch. As with standard back propagation, typically, many epochs are required.

Note that it is not necessary actually to simulate the expanded form of the net for training. The net can run for several time steps, determining the information on errors and the weight updates at each step and then totaling the weight corrections and applying them after the specified number of steps.

In addition, information on errors does not need to be available for all output units at all time steps. Weight corrections are computed using whatever information is available and then are averaged over the appropriate number of time steps. In the example in the next section, information on errors is supplied only at the second time step; no responses are specified after the first time step.

CHAPTER 4
SCM MODEL

4.1 SUPPLY CHAIN LINKS

Figure 4.1 shows the Supply Chain Link.

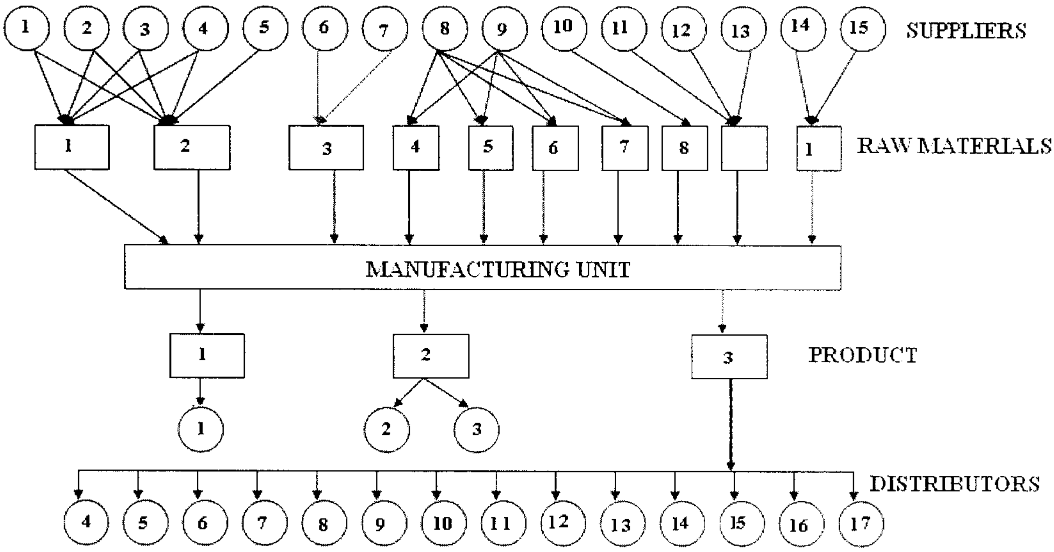


FIG 4.1 SUPPLY CHAIN LINK

4.1.1 Suppliers

1. Regal Crimptex.
2. Benlon India.
3. Amline Textiles.
4. Haritha Enterprises.
5. Dixcy.
6. Manju Traders.
7. Kamalam Handloom.
8. Ganesh Associates.
9. National Synthesis.
10. A.F.Textiles.
11. Tharun Agency.
12. Filaments India.
13. Jambu
14. Rubfila.
15. Filatex.

4.1.2 Raw Materials

1. Nylon Yarn.
2. 210 D Sterlon.
3. 300/330 Bleach White Colours.
4. 155/1/0 Black.
5. 300/330 Grey Twisted.
6. 155/1/0 Grey.
7. 300/330 Black Twisted.
8. Cotton Yarn.
9. P.P.Yarn.
10. 38 gg Rubbers.

4.1.3 Product

1. Leather tapes.
2. Plain tapes.
3. Branded tapes.

4.1.4 Distributors

1. Chennai tapes.
2. RR tapes.
3. Chennai tapes.
4. Eswar hoisery.
5. Sun knitting company.
6. Chandra knitting company.
7. SRF enterprises.
8. GBJ tapes.
9. Priya hoisseries.
10. R&R textile
11. Veeraswari garments.
12. Faretex hoisery mills.
13. Dixcy textiles.
14. DG tex.
15. Two tex.
16. Katar knitting.

4.2 EXPONENTIAL SMOOTHING

$F_{t+1} = F_t + \alpha (Y_t - F_t)$.

Y_t is the actual value of period t

F_t forecasted value for the same period.

The difference between the $(Y_t - F_t)$ is the forecast error.

α is the smoothing constant.

4.2.1 Steps to calculate

To begin with the process of forecasting an initial forecast value is given is used as to forecast for period one. If no such value is given then the first forecast obtain is for period 2, which is taken as the actual value. For the period 1 subsequent forecast are made based on the forecast. The smoothing constant may be altered to change the relative weightage of different values entered into forecast a high value of the constant give high weightage to the recent value while a low value give a relatively large weightage to the past data.

4.2.2 Measuring The Forecast Error

1. Mean absolute deviation (MAD)

   It is a measure of overall error of the forecast

   $$MAD = \Sigma (Y_t - F_t) / n.$$

2. Mean absolute percentage error (MAPE)

   It is the mean of the absolute difference between the actual and forecasted values. Expressed as the percentage of the actual value.

   $$MAPE = ((Y_t - F_t) / Y_t) * 100.$$

3. Mean square error (MSE)

   The square difference between the actual and forecasted value.

   $$MSE = (Y_t - F_t)^2$$

The table 4.1 represents the demand forecasting for various smoothing constants (α)

TABLE 4.1 DEMAND FORECASTING BY EXPONENTIAL SMOOTHING

MONTH	DEMAND	Ft FOR 0.2	DIFFERENCE	Ft FOR 0.5	DIFFERENCE	Ft FOR 0.8	DIFFERENCE	Ft FOR 0.9	DIFFERENCE
1	153	170	-17	170	-17	170	-17	170	-17
2	124	168.3	-44.3	161.5	-37.5	156.4	-32.4	154.7	-30.7
3	135	163.87	-28.87	146.15	-11.15	132.86	2.14	128.43	6.57
4	173	160.983	12.017	149.435	23.565	140.774	32.226	137.887	35.113
5	172	162.1847	9.8153	166.9915	5.0085	170.5966	1.4034	171.7983	0.2017
6	163	163.16623	-0.16623	167.09235	-4.09235	170.03694	-7.03694	171.01847	-8.01847
7	152	163.149607	-11.149607	163.083115	-11.083115	163.033246	-11.033246	163.016623	-11.016623
8	173	162.034646	10.9653537	157.5748035	15.4251965	154.2299214	18.7700786	153.1149607	19.8850393
9	185	163.131182	21.86881833	167.5173232	17.48267685	170.8069293	14.19307074	171.9034646	13.09653537
10	183	165.318064	17.6819365	174.0655908	8.934409165	180.6262363	2.373763666	182.8131182	0.186881833
11	193	167.086257	25.91374285	174.1590318	18.84096825	179.4636127	13.5363873	181.2318064	11.76819365
12	199	169.677631	29.32236856	180.0431286	18.95687142	187.8172514	11.18274857	190.4086257	8.591374285
MAD			19.08		15.74		13.6		13.51

4.3 TIME SERIES MODEL

4.3.1 Trend Adjusted Exponential Smoothing (Or) Constant Level

TABLE 4.2 DEMAND FORECASTING BY TREND ADJUSTED EXPONENT IONAL SMOOTHING

MONTH	DEMAND	St	Bt
1	153	170	0.1
2	124	128.61	-4.049
3	135	133.9561	-3.10949
4	173	168.7847	0.684315
5	172	171.7469	0.912107
6	163	163.9659	0.042797
7	152	153.2009	-1.03799
8	173	170.9163	0.837355
9	185	183.6754	2.029527
10	183	183.2705	1.786086
11	193	192.2057	2.500995
12	199	198.5707	2.887396

$S_t = \alpha Y_t + (1-\alpha)(S_{t-1} + B_{t-1})$

$B_t = \beta (S_t - S_{t-1}) + (1-\beta) B_{t-1}$

$F_{t+m} = S_t + mB_t$

α - is the smoothing constant.

S_t - Smoothed level at time t

B_t. - Trend constant with value ranging from (0-1)

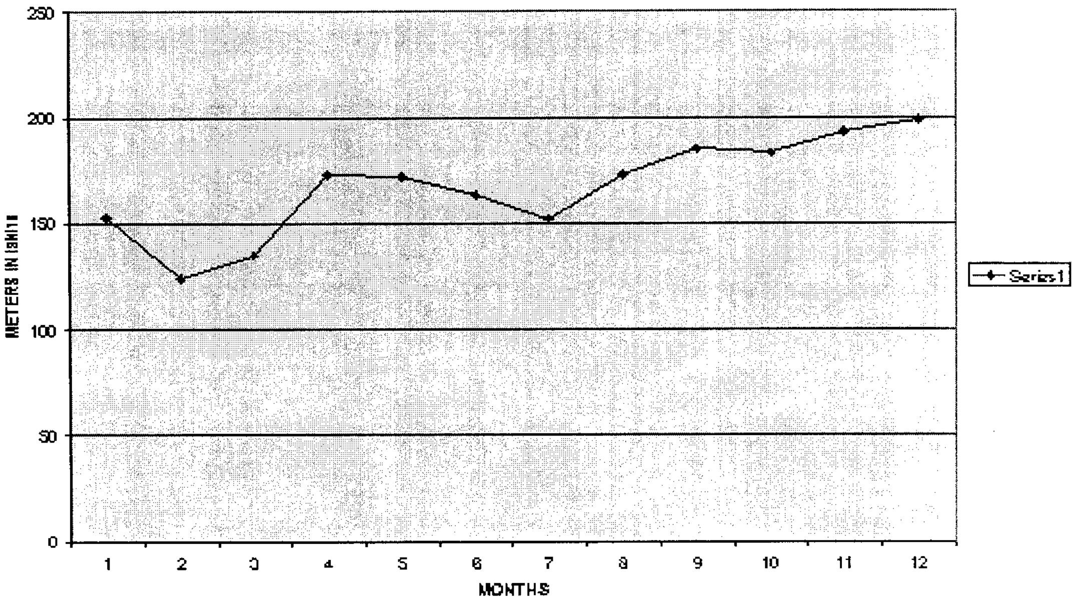
Y_t - is the observed value of time services at time "t"

The table 4.2 represents the demand forecasting by trend adjusted exponentional smoothing and the demand for 13th month is

$F_{(12+1)} = S_{12} + 1\ B_{12}$

$= 198.5707 + 1 * 2.887$

$= 201.4577$ lakhs of meters /month



DEMAND FLUCTUATION CHART

4.4 MODEL OF AN ORGANIZED BUSINESS AGENT

4.4.1 Defining an Organized Agent

The organized business-agent represents a conglomeration of active agents that can streamline the information flow within industry as well as initiate external negotiations with other business agents.

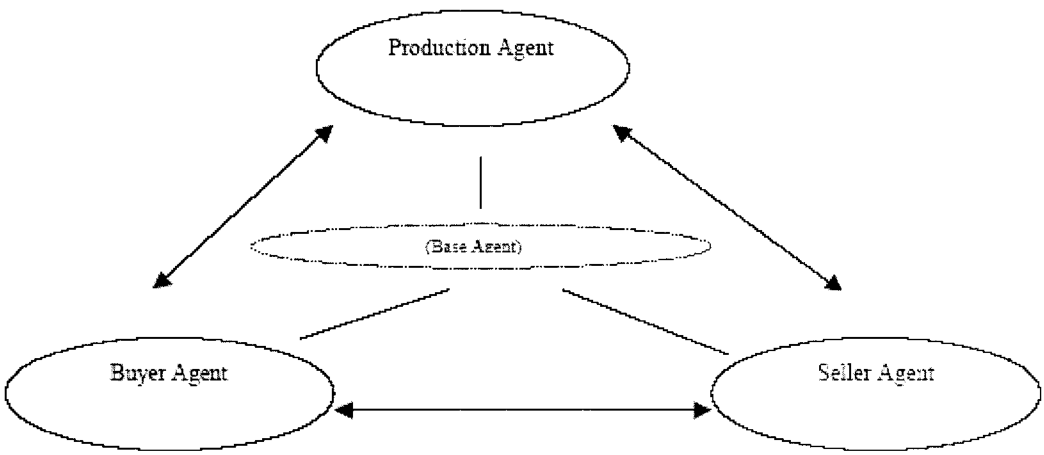


FIG 4.2 ORGANIZED BUSINESS-AGENT MODEL DIAGRAM

As shown in the figure 4.2, each of the organized agents have to link with a base agent (or) organized business-agent that creates multiple active agents, a

The base agent helps in inter-agent for passing the information through the unique identifiers generated during the creation of these agents.

TABLE 4.3 MODEL NOTATIONS

The model notations is represented in the table 4.3

For Buyer (B) interacting with seller (Si)		For Seller (S) interacting with buyer (Si)	
Maximum tolerance level	τ_B	Minimum tolerance level	τ_S
Number of trades with the seller	N_{BSi}	Number of trades with the buyer	N_{BSj}
Expected price from the seller	U_{BSi}	Order from the buyer	D_{SBj}
Number of successful trades with the seller	S_{BSi}	Number of successful trades with the buyer	S_{SBj}
Trade-off weight	W_{BSi}	Buyer-Weight	W_{SBj}
		Current price from the Buyer	P_{SBj}
Current price from the seller	P_{BSi}		
Delivery dead line for the seller	EOD_{BSi}		
For production Agent (P)			
Capacity	C_P		
Cost	P_P		
Lead Time	T_L		
Production Expectation	PE		

4.4.2 Responsibilities for Individual Agents

The responsibilities attached to each of the agents can be mapped to their respective traditional business process and the base agent (organized business-agent) defines the flow of information and provides filters so that each of the agents can interact and make decisions to form a proper supply chain link..

4.4.3 Responsibilities for organized business-agent

The base agent should set up a message protocol which is a message pattern for communicating between different active agents.

The order filter is used to get the orders at best price and also ensures to utilize the full production capacity.

Rank filter

The rank filter sorts the trading partners for each seller and buyer agents on the basis of price and the tolerance levels.

4.4.4 Responsibilities for buyer organized business-agent

Becoming aware of the unmet need

The buyer agent represents the purchasing department, so the main responsibility of this agent is to get information from the production department about their material requirement.

Evaluating alternative traders

To get the information on price, warranty and reputation of the traders and the information should be passed to rank filter.

Determine the terms of negotiation

To enumerate the procedures on how to settle the transaction.

Get material

To receive the ordered material on or before the delivery date and if not so, puts the trade on the defective trades' list.

4.4.5 Responsibilities for production organized business-agent

Get order list:

To get the order information and the delivery dates negotiated between production and sales department.

Evaluating cost and time:

This stage estimates the production or holding cost and lead-time.

Send updated information to purchasing department

This stage updates all the information using its internal state values and forwards the required information to the purchasing department.

4.4.6 Responsibilities for seller organized business-agent

Get orders

To evaluate the submitted orders from different buyer agents and complete the order submission using rank and order filters. The seller may negotiate with

To get the information on price, warranty and reputation of the trading partner and passing the information to rank filter.

Deliver orders

To ensure that the order is delivered on or before the delivery date.

Get payments

To get the payment from the trader on or before the payment date and if not so, put the trade on the defective trades' list.

4.4.7 The buyer organized business-agent

Current trade decision

The current trade decision is based on the maximum tolerance level (τ_B) i.e. what is the maximum amount the buyer is willing to pay during this trade and the demand deadlines.

In-memory merchant status

The buyer organized business-agent maintains a record of past trades/expected behavior for each of the sellers it has traded with. The key attributes to be registered in memory are: number of trades with the seller (N_{BSi}), expected price from the seller (U_{BSi}), weight (W_{BSi}).

Receive Quotations

The buyer organized business-agent will receive the current price from the seller (P_{BSi}), Capacity of the seller (C_{PSi}), the delivery time and payment deadlines.

Request Quotations

The buyer organized business-agent should send the order quantity, the current price at which it is willing to buy the item and delivery deadline (EOD_{Bsi}).

4.4.8 The seller organized business-agent

Current trade decision

The current trade decision is based on the minimum tolerance level (τ_S) i.e. what is the minimum price a seller will sell its product during this trade and the capacity of its production department (C_P).

In-memory merchant status

The seller organized business-agent maintains a record of past trades/expected behavior for each of its trading sellers. The key attributes to be registered in memory are: number of trades with the

Receive Messages

The seller organized business-agent will receive the order (D_{SBj}) and delivery deadline (EOD_{SBj}).

Send Message

The seller organized business-agent sends the current price (P_{SBj}), and the payment deadline (PD_{SBj}).

4.4.9 The prod organized business-agent

Receive Messages

The prod organized business-agent receives the order quantity and delivery date from seller organized business-agent. Attached information on production or holding cost (P_P) and lead time (T_L).

Send Messages

The prod organized business-agent sends the updated information to the buyer organized business-agent which evaluates its maximum tolerance level and the expected order date.

Filters

Seller filtration

This filter is used by the buyer agent to select the preferred sellers based on the comparison of their expected prices with its maximum tolerance level.

Buyer Filtration:

This filter is used by the seller agent to accept the orders so that all the orders together add up to the full capacity of its production.

Rank Filter

This filter is used to rank all the trade partners based on the percentage of number of successful trades.

4.5 WORKING MODEL APPLIED TO A SUPPLIER NETWORK

Consider a manufacturing process with N-stages of production. At each stage, there are multiple manufacturing companies, which serve as suppliers to downstream companies. The N^{th} stage supplier completes the final product and sends it to the distributor who then forwards it to the retailer and finally it goes to the customer as shown in figure 4.3. This forms a supply chain.

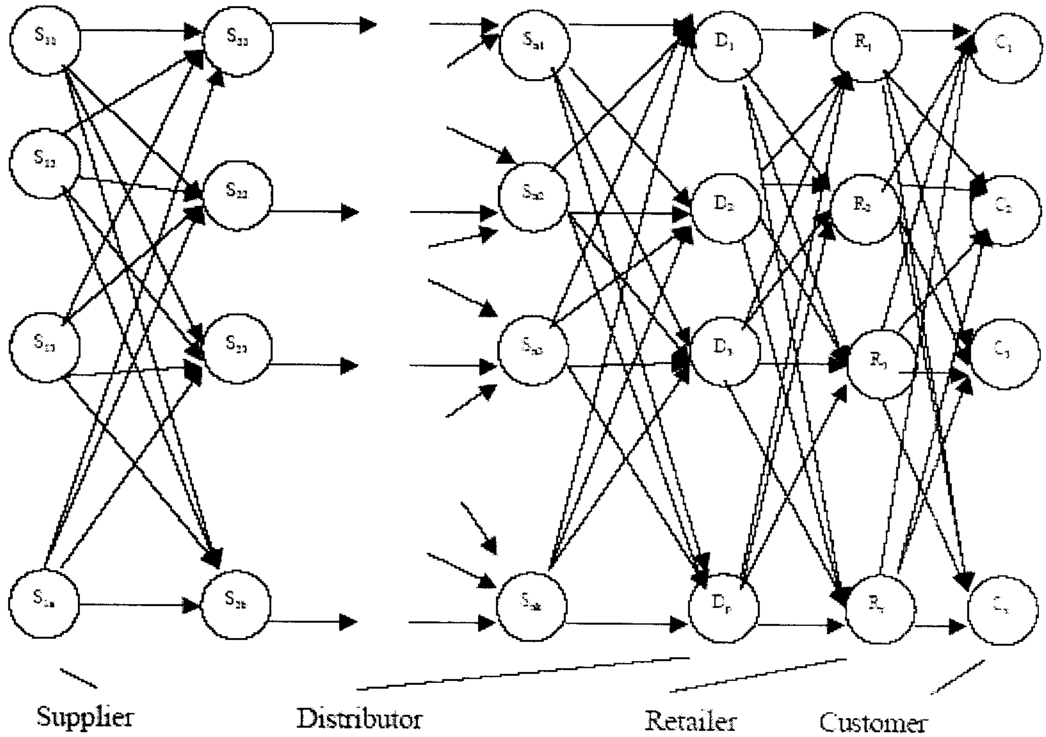


FIG 4.3 SUPPLIER NETWORK

4.5.1 WORKING METHOD

Each node in above figure 4.4 represents a supplier of some type. Let's allot our organized business-agent to each of the nodes in all stages. So, seller organized business-agent for stage-k supplier will be able to sell to buyer organized business-agent for stage k+1 supplier. It is valid for all the stages.

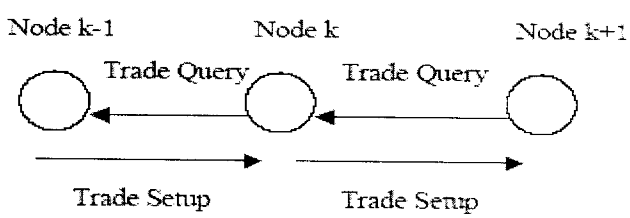


FIG 4.4 NODE SETUP DIAGRAM

Important to note here is that the buyer agent initiates the process and the seller agent completes the trading cycle. In our supplier network, the stage-1 suppliers manufactures and sells, the customer only buys, so for them some agents would be inactive but it will not affect the working of other active agents.

4.5.2 WORKING STEPS

To explain the implementation of organized business-agent we will consider the suppliers of stages k-1, k and k+1. As previously stated, each node is represented by one organized agent as shown in figure 4.5.

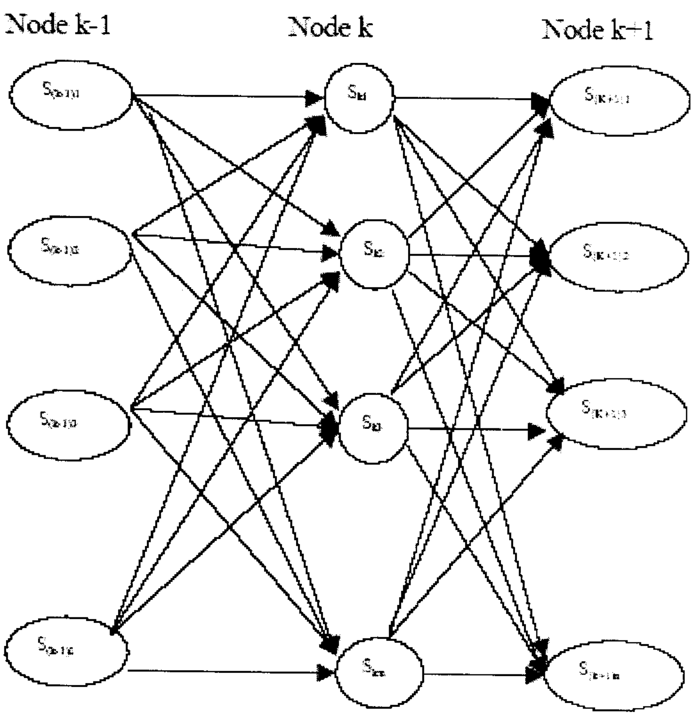


FIG 4.5 THREE-NODE SUPPLIER NETWORK

Let us assume, Stage k-1 has "l" suppliers; Stage k has "m" suppliers; Stage k+1 has "n" suppliers.

$$N_{Sij} \leftarrow N_{Sij} + 1 \qquad (1)$$

$$U_{BSkij} \leftarrow W_{kij} * U_{BSkij} + (1 - W_{kij}) * P_{BSkij} \quad \text{for } i = 1 \ldots m; \text{ for } j = 1 \ldots n \quad (2)$$

$U_{BSkij} = P_{BSkij}$ for the first time trading (2.1)

Equation 3 explains that each trader gives equal weight to each payoff that he has obtained in previous interactions with a potential trade partner k. It becomes increasingly difficult to affect the expected payoffs of traders as payoff histories accumulate (Testafasion 1995).

Each of the buyers at stage k+1 ranks all sellers from stage k by comparing expected price from the sellers and their own maximum tolerance level ($\tau_B[k+1]j$) using a rank filter.

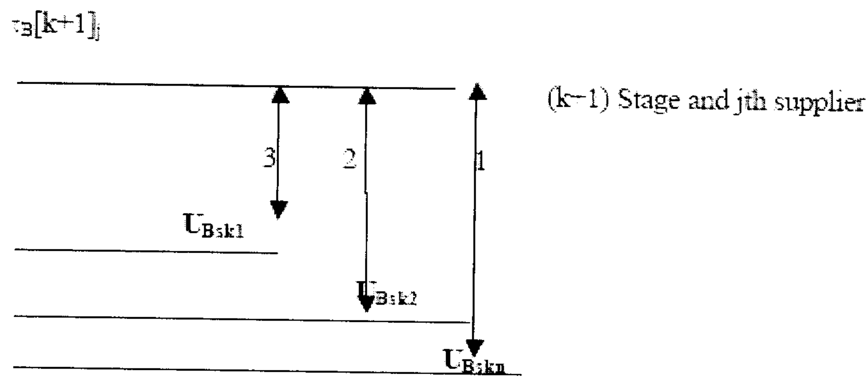
Select Criteria:

$$\tau_B[k+1]_j > U_{B;ki} \text{ , for } i=1\ldots m; \text{ for } j = 1\ldots n \qquad (4)$$

Rank Criteria

This means that all the sellers would be ranked by sorting out the difference between the tolerance level and the expected pay-off from the sellers as shown in figure 4.6. Now, each buyer at stage k+1 have a list of ranked sellers at stage k in terms of their own preferences. So, they pass on their trade offers according to their ranked list. Let's say, each buyer organized business-agent at stage k+1 has a demand (k+1)j (for j =1...n) and so each of the buyer agent will submit their order information according to their own rank lists. The following steps are defined in Figure 4.7

$$\text{Rank} = \text{Descending Sort } (\tau_B[k+1]_j - U_{B;k1}, \ldots, \tau_B[k+1]_j - U_{B;km}), \text{ for } j = 1\ldots n \quad (5)$$



Step 1:

Each of the seller organized business-agent receives offers to fulfill the respective demands from different buyers but it has a limitation on its capacity (C_P).

Capacity Criterion:

$$C_P >= D_{(k+1)a} + D_{(k+1)b} + \ldots + D_{(k+1)d} \ , \ a,b,d \in \{\text{selected buyers from stage } k+1\} \quad (6)$$

Obviously the organized business-agent at node k does not have a capacity to fulfill all the orders so it ranks these orders in terms of the its own buyer rank list. The rank list will be

$$\text{Buyer weight}(w_{SBij}) = \frac{(N_{SBij})}{(N_{Sbij}+1)} \qquad \text{for } j=1\ldots n \ ; \text{ for } i = 1\ldots m \qquad (7)$$

The buyers are ranked according to BR_j (buyer weights). Using this information, each seller organized business-agent ranks the offers of respective buyers and start accepting the orders till it is within capacity criterion. If the ranks of the buyers are same, then the seller will choose the buyer with a bigger order. As it reaches the capacity, the seller rejects all other offers and acknowledges the same to buyers.

Step 2:

The seller acknowledges its trade decisions to the buyers. But the rejected buyer agents from stage-k+1 may again submit an offer depending on their demand requirements.

If the seller agent in stage-k gets an order with a better price from any of the rejected buyers, the seller will have two options. One option is to prefer this buyer to its customers. And due to the capacity contsraint, it has to reject one or more customers. In that case, the recently rejected buyer will list the seller on defector's list and the seller weight will go down with respect to this particular

Negotiating Criteria: (Seller i in stage k ranking all buyers)

$$\textbf{Rank} = \textbf{Descending Sort } [(P_{SB1} - P_{Si}), \ldots, (P_{SBn} - P_{Si})], \textbf{ for } i = 1 \ldots m \qquad (8)$$

Note that the initial price from all the buyers will be the current price of the seller only. Only after first rejection, the buyer may submit a new price to buy the item, depending on their demand requirements.

Step 3:

The seller organized business-agent forwards the accepted order demands and the delivery deadlines (EOD_{SBj}) to the prod organized business-agent

Step 4:

Each of the prod organized business-agent updates this information with the information on production or holding cost (P_P) and lead-time (T_L) to evaluate the maximum tolerance and expected delivery deadlines for its buyer agent. PE is the profit expectation for a particular trader.

$$\tau_B[k]i >= P_{B;ki} - P_p - PE_{Bi}, \textbf{ for } i = 1 \ldots m \qquad (9)$$

$$EOD_{ki} >= T_L + EOD_{(k+1)j}, \textbf{ for } i = 1 \ldots m \textbf{ and } j \in \{\text{selected set}\} \qquad (10)$$

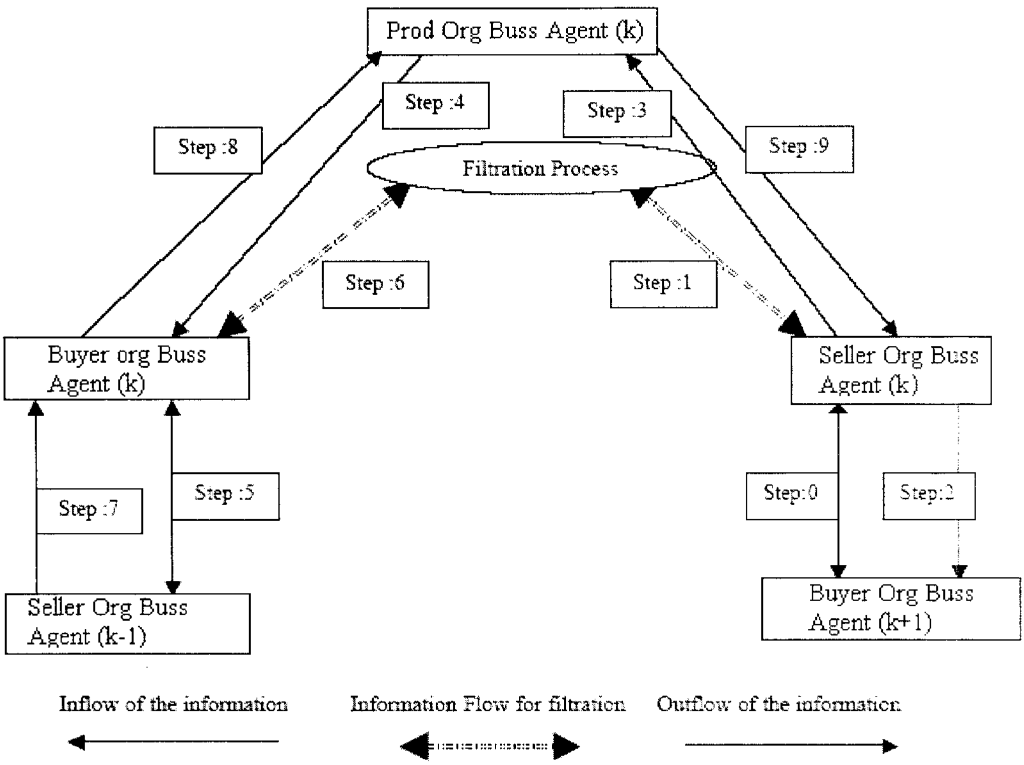


FIG 4.7 FLOW OF INFORMATION IN THE ORGANIZED BUSINESS-AGENT

Step 5:

The buyer organized business-agent sends a query to the external seller agents and gets their current price, capacities of the seller and the delivery days of the item. Then the agent ranks all sellers from stage k-1 by comparing expected price from the sellers and its own maximum tolerance level ($\tau_B[k]_j$) using a rank filter as defined in step 0.

Step 6:

The buyer uses the filter to select the preferred sellers based on the comparison of their expected prices with its maximum tolerance level.

Step 7:

The buyer-organized business-agent submits the offers to the ranked sellers. If the seller rejects the offer, the buyer agent has two options. One, it can submit the offer to the next ranked seller or the other option is that it can submit the offer to the same seller with a better price (P_{BS}) to get that seller. To evaluate a new price, the buyer agent will use the capacity information, the current price of the seller and its own maximum tolerance level.

Step 8:

This step activates after the trade-off has been set and buyer agent waits to receive the order. After the buyer organized business-agent receives the order it evaluates the delivery date and updates the information for the filters. If the delivery goes beyond the expected delivery date then it's a defect from the seller's side and the weight of that particular seller goes down. It also activates the payment process for the sellers.

Step 9:

This step activates after the production has completed the orders and then forwards the information to the seller organized business-agent to finally deliver the goods and communicate the payment information to the buyer. It activates the monitoring of the payment from the buyer. If the buyer does not pay for the goods on or before the payment deadline, it's a defect from the buyer's end and the weight of that particular buyer goes down.

4.6 VENDOR RATING

The vendor ratings are calculated by means of supplier's quality, price and service.

The table 4.4 represents the weightage value for the raw material (rubber) supplier

TABLE 4.4 SUPPLIERS RATING FOR RAW MATERIAL RUBBER

S.No	Detail	Jambu Associates	Radhufil	Filatex
1	Lots received	451.4	5523.6	1300.3
2	% accepted	90	80	84
3	Quality rating	36	32	33.6
4	Net price	170	185	182
5	Lowest/net price *100	100	91.89	93.4
6	Price rating	35	32.1615	32.69
7	Delivery promise kept	90	80	85
8	Service rating	22.5	20	21.25
9	**Total rating**	**93.5**	**84.1615**	**87.54**

The table 4.5represents the weightage value for the raw material (polyester yarn) supplier

TABLE 4.5 SUPPLIERS RATING FOR RAW MATERIAL POLYESTER YARN (BLACK/GREY)

S. NO	Details	Ganesh Associates	National Synthesis	Ganesh Associates	National Synthesis
1	Lots received	2668.7	1300.4	1389.4	801.87
2	% accepted	97	93	97	93
3	Quality rating	38.8	37.2	38.8	37.2
4	Net price	108	109	95	95
5	Lowest/net price *100	100	99.08	100	100
6	Price rating	35	34.678	35	35
7	Delivery promise kept	100	95	100	[illegible]

The table 4.6 represents the weightage value for the raw material (crimped polyester yarn) supplier

TABLE 4.6 SUPPLIERS RATING FOR RAW MATERIAL CRIMPED POLYESTER YARN

S.No	Details	Benlon India	Regal Crimptex	Haritha Enterprises	Amline Textiles	Dixcy
1	Lots received	9710.3	569.2	7375.7	4422.6	831.17
2	% accepted	87	89	93	91	94
3	Quality rating	34.8	35.6	37.2	36.4	37.6
4	Net price	189	188	185	172	190
5	Lowest/net price *100	91	91.48	92.97	100	90.52
6	Price rating	31.85	32.01	32.53	35	31.68
7	Delivery promise kept	85	87	94	92	93
8	Service rating	21.25	21.75	23.5	23	23.25
9	**Total rating**	**87.9**	**89.3**	**93.2**	**94.4**	**92.53**

The table 4.7 represents the weightage value for the raw material (regular polyester yarn) supplier

TABLE 4.7 SUPPLIERS RATING FOR RAW MATERIAL REGULAR POLYESTER YARN

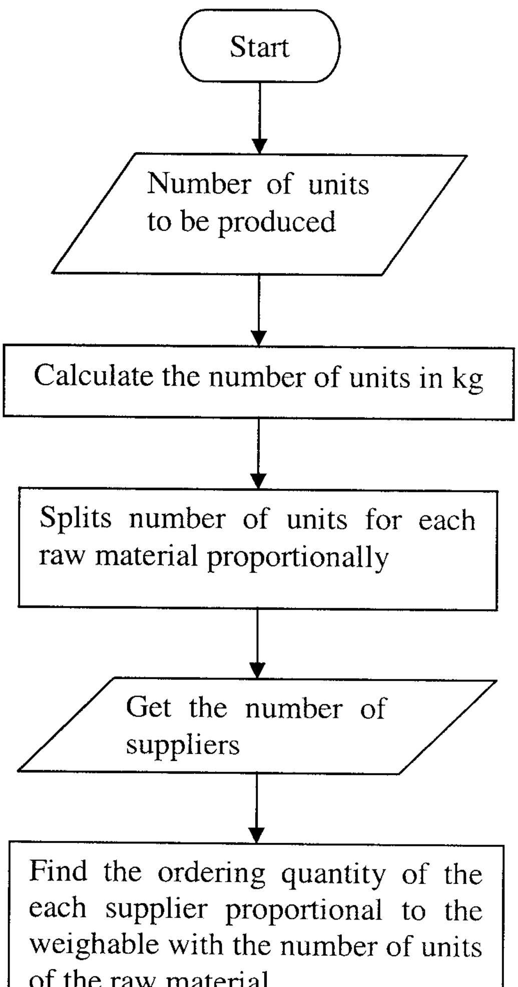
S. No	Details	Ganesh Associates	National Synthesis	Ganesh Associates	National Synthesis	Kamalam Handlooms	Manju Traders
1	Lots received	9142.1	933.3	2178	752.8	275.8	639.3
2	% accepted	97	93	97	93	98	77
3	Quality rating	38.8	37.2	38.8	37.2	39.2	30.8
4	Net price	115	116	96	95.7	154	172
5	Lowest/net price *100	100	99.13	99.68	100	100	89.5
6	Price rating	35	34.6955	34.888	35	35	31.325
7	Delivery promise kept	100	95	100	95	95	80
8	Service rating	25	23.75	25	23.75	23.75	20
9	**Total rating**	**98.8**	**95.6455**	**98.688**	**95.95**	**97.95**	**82.125**

CHAPTER 5
SIMULATION MODEL

5.1 PROPOSED ALGORITHM DEVELOPED FOR CALCULATING THE AMOUNT OF RAW MATERIALS TO BE ORDERED FROM EACH SUPPLIERS

1. Start the program.
2. Enter the number of units to be produced in meters.
3. Calculate the number of units in kg.
4. Split the number of units for raw material rubber, polyester yarn, crimped polyester yarn and regular polyester yarn.
5. Get the number of supplier for each raw material.
6. Get the weightage details for each raw material.
7. Find the ordering quantity of the supplier, with the number of units of each raw material proportional to each supplier's weightage.
8. Stop the program.

The figure 5.1 represents the flow chart for the proposed method.



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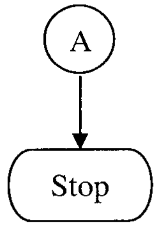
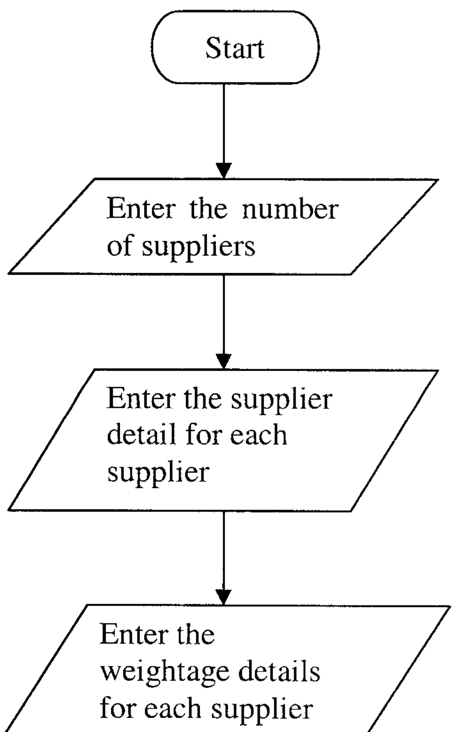


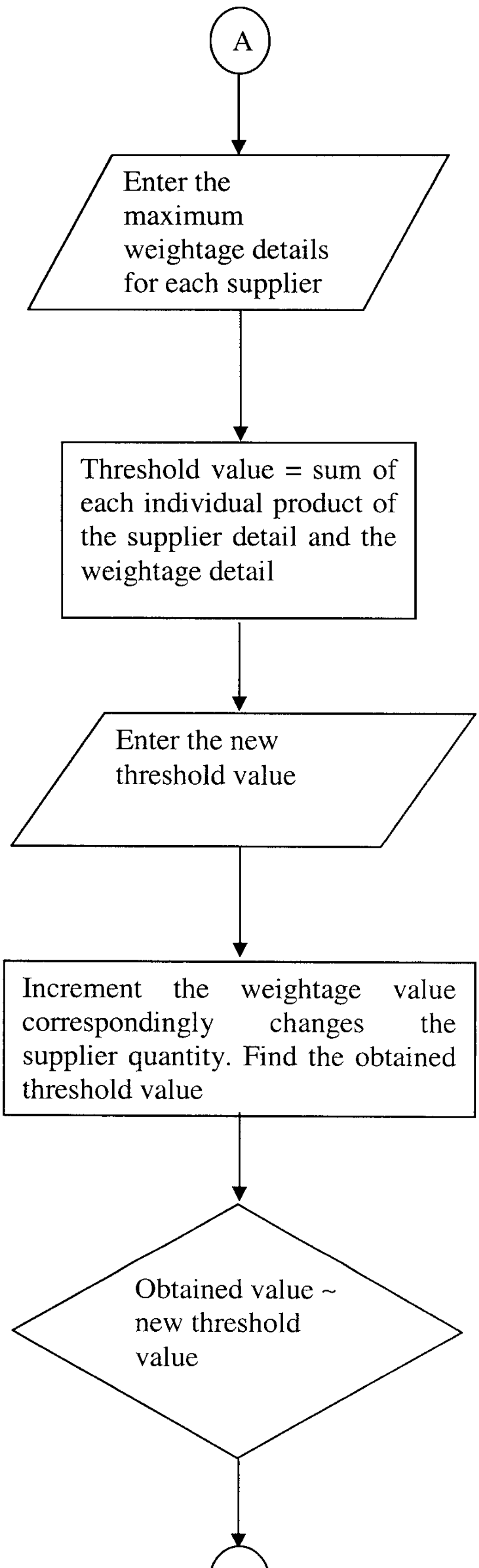
FIG 5.1 FLOW CHART

5.2 PROPOSED ALGORITHM DEVELOPED FOR OPTIMUM NUMBER OF QUANTITIES TO BE ORDERED USING BY NEURAL NETWORK AS A BASE OF C++

1) Start the program.
2) Declare the necessary variable.
3) Enter the number of suppliers.
4) Enter the supplier details for each supplier.
5) Enter the weightage for the number of suppliers.
6) Enter the maximum weightage details for all the suppliers.
7) To find the threshold value with the supplier and weightage details.
8) Create the new threshold value.
9) Calculate the new supplier and weightage details for the given threshold value without exceeding the maximum weightage.
10) Finding the optimal solution.
11) Stop the program.

The figure 4.9 represents the flow chart for the neural network program.

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Enter the maximum weightage details for each supplier
Threshold value = sum of each individual product of the supplier detail and the weightage detail
Enter the new threshold value
Increment the weightage value correspondingly changes the supplier quantity. Find the obtained threshold value
Obtained value ~ new threshold value

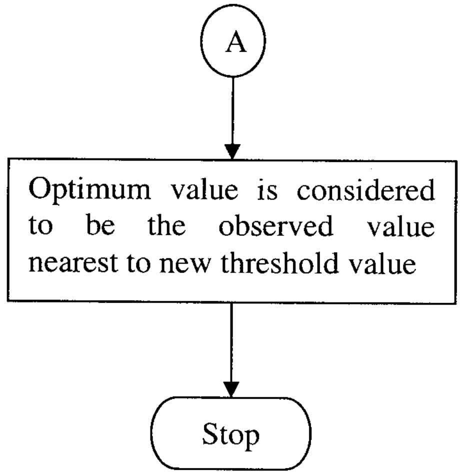

FIG 5.2 FLOW CHART

The proposed algorithm is developed to find the optimal solution for the ordering of raw materials to the suppliers by using Neural Network methodology implemented in c++

5.2.1 Working Steps

Input Layer

The number of suppliers will be varying for various raw materials, so initially we are getting the number of supplier as input. This input supplier will acting as an input neuron.

The details of the each input neuron have to be getting an input. The input for supplier will be given in the supplier detail. The weightage will be given in the weightage detail.

Supplier detail

For this the output obtained from the c++ program is given as input to the supplier detail

Weightage detail

The factors involved in calculating the weightage details are quality, price and the service.

Quality rating is the product of the percentage of accepted raw material and the quality rating points. Percentage of lots accepted is the ratio of lots accepted to the lots accepted.

Price rating is the product of rating points with the percentage of ratio of

Service rating is the product of delivery promise kept and the rating points. Total rating is the sum of quality rating, price rating and the service rating.

The ratings will be calculated for each and every raw material suppliers.

Maximum weightage detail

It is the best weightage of the supplier.

Hidden layer

The output from the input layer is entering into this layer. In this phase the threshold value is found. Threshold value is the sum of all individual supplier quantity and the corresponding weightage of the supplier.

Activation function

Creating the new threshold value. New threshold value is to find out the ordering quantity of raw materials from the supplier, with corresponding change in the supplier quantity and weightage. The weightage should not exceed the maximum weightage.

Working steps of an Activation function

The weightage of the each supplier is incremented, keeping the new threshold value as constant for the corresponding changes.

For the every corresponding change in the weightage, the corresponding changes are made in the supplier quantity, such that the threshold value is constant. Thus supplier and weightage are changed accordingly to get the new threshold value.

From the obtained results of different new threshold values, the threshold value which is very nearer to the new threshold value is consider as the best one.

CHAPTER 6
RESULTS AND DISCUSSIONS

The case study was made in Attur Textile Private Limited, by using c++ program for the forecasted value. In this project work the number of quantities of each raw material is be ordered from each suppliers are found, according to the weightage of each suppliers

Enter the no of Units to be produced in meters: 192852

No of units in kg is: 4435.622559

Rubber	=1108.90564kg
Polyester Yarn	=665.343384kg
Crimped Polyester Yarn	=1330.686768kg
Regular polyester yarn	=1330.686768kg

Enter the number of suppliers for rubber: 3

Weightage Details

****

1: 0.93

2: 0.84

3: 0.86

The supplier and weightage details:

Suppliers	Weightage:
*********	**********
1. 392.122498	0.93
2. 354.175171	0.84
3. 362.60791	0.86

Enter the number of suppliers for polyester yarn: 2

Weightage Details

****

1: 0.98

2: 0.95

The supplier and weightage details:

Suppliers Weightage:

********* **********

1. 337.842743 0.98
2. 327.50061 0.95

Enter the number of suppliers for crimped polyester yarn: 5

Weightage Details

****

1: 0.87

2: 0.89

3: 0.93

4: 0.94

5: 0.92The supplier and weightage details:

Suppliers Weightage:

********* **********

1. 254.43898 0.87
2. 260.288147 0.89
3. 271.986481 0.93
4. 274.911072 0.94
5. 269.06192 0.92

Enter the number of suppliers for regular polyester yarn: 4

Weightage Details

****

1: 0.98

2: 0.95

3: 0.97

4: 0.81

The supplier and weightage details:

Suppliers	Weightage:
*********	**********
1. 351.502167	0.98
2. 340.741882	0.95
3. 347.915405	0.97
4. 290.527283	0.81

The output obtained from the c++ program (i.e.) the number of quantities to be ordered for each supplier is given as the input to the Neural Network. And the Neural Network will calculate the ordering with corresponding weightage of each supplier and will give the optimum number of ordering quantities to be ordered. The results obtained for each raw material as shown below.

The optimum number of ordering quantity (Kg) for raw material rubber from different suppliers is

1. 390.568298 0.94
2. 348.696198 0.85
3. 358.000305 0.87

Threshold: 974.986206

The optimum number of ordering quantity (Kg) for raw material crimped polyester yarn from different suppliers is

1. 333.96106 0.99
2. 318.732025 0.98

Threshold: 642.978821

The optimum number of ordering quantity (Kg) for raw material crimped polyester yarn from different suppliers is

1. 249.53595 0.88
2. 256.37561 0.9
3. 270.063599 0.94
4. 273.488434 0.95
5. 266.640137 0.93

The optimum number of ordering quantity (Kg) for raw material regular polyester yarn from different suppliers is

1. 350.66156 0.99
2. 338.02301 0.98
3. 345.223022 0.98
4. 263.801971 0.85

Threshold: 1240.967651

CHAPTER 7
CONCLUSION

A case study was conducted in Attur Textile Private Limited, and the suggestion was given for the company to form a proper supply chain link for that a model was developed, and c++ program was developed to find the ordering quantities, and to find the optimum number of quantities to be ordered is found by using neural network

The proposed model generates the proper chain as requested. The supply chain consists of relevant connections between service requester and provider. For entire supply chain, this model produces proper links from suppliers to customer. In partial supply chain, this model can be used for recommending products or sellers that can satisfy the buyer's request. The simulation shows that this model is capable of assisting decision making for choosing the suitable supplier and managing supplier relations

The proposed neural network framework can be used for solving the SCM Linking problem. The problem considered is about optimizing the supply chain link. By varying the weights of supplier and distributor the optimal Supply Chain link is found and the best-weighted combination is identified. Through weights assigned to the links between supplier and distributor and by adjusting the weights using an appropriate strategy, a significantly improved link is found using Neural Network.

APPENDIX 1
PROGRAM

C++ Program to Calculate The Number of Quantities to be Ordered from Each Supplier

```
#include <iostream.h>
#include <stdio.h>
#include <conio.h>

void main()
{
        int i,j;
        float unit=0,unit1=0,value=0;
        float n1,w1[10],x1=0,s[10],raw[4];
        clrscr();
        cout<<"\nEnter the no of Units to be Produced in meters:";
        cin>>unit;
        unit1=unit/43.478;
        cout<<"\n\nno of units in kg is:"<<unit1;
        raw[0]=unit1*.25;
        raw[1]=unit1*.15;
        raw[2]=unit1*.30;
        raw[3]=unit1*.30;
        cout<<"\n\nRubber="<<raw[0]<<"kg";
        cout<<"\n\nPolyester Yarn="<<raw[1]<<"kg";
        cout<<"\n\nCrimped Ply Yarn="<<raw[2]<<"kg";
        cout<<"\n\nRegular sply yarn="<<raw[3]<<"kg";
        for(j=0;j<4;j++)
        {
        cout<<"\n\nEnter the number of suppl-iers: ";
        int n1=0;
        cin>>n1;
        cout<<"\nWeightage Details";
        cout<<"\n****************\n";
```

```
            cout<<"\t"<< i+1<< " : ";
            cin>>w1[i];
      }
      x1=0;
      for(i=0;i<n1;i++)
            x1=x1+(w1[i]);
      for(i=0;i<n1;i++)
      {
            value=raw[j]*w1[i];
            s[i]=value/x1;
      }
            cout<<"\nThe  supplier and weightage details: \n";
            cout<<"\n Suppliers       Weightage:";
            cout<<"\n *********        **********";
      for(i=0;i<n1;i++)
            cout<<"\n "<<i+1<<".   "<< s[i] <<" \t "<< w1[i];
      }
      getch();
}
```

APPENDIX 2
PROGRAM

Neural Network Program for The Calculation of Optimum Ordering Quantity of Raw Materials From Each Supplier

```
#include <iostream.h>
#include <conio.h>

void main()
{
        int n1,n2,sum,i;
        float s1[10],s2[10],w1[10],w2[10],w3[10],d[10];
        float value=0,value1=0,value2=0,x2=0;
        float temp[10],t1=0,w;
        float a[10],loop=0;
        clrscr();
        cout<<"\n\n\n\t*********************************************";
        cout<<"\n\n\t\tThe Suppliers act as Input Neuron";
        cout<<"\n\n\t**********************************************";
        cout<<"\n\n\tEnter the number of suppliers: ";
        cin>>n1;
        cout<<"\n\t\t*****************";
        cout<<"\n\t\tSuppliers Details";
        cout<<"\n\t\t*****************\n\n";
        for(i=0;i<n1;i++)
        {
                cout<<"\t\t\t"<< i+1<< " : ";
                cin>>s1[i];
        }
        cout<<"\n\t\t*****************\n\n";
        cout<<"\n\n\t\tEntering the Weights\n";
        cout<<"\n\t\t*****************";
        cout<<"\n\t\tWeightage Details";
        cout<<"\n\t\t*****************\n\n";
```

```
		cout<<"\t\t\t"<< i+1<< " : ";
		cin>>w1[i];
	}
	cout<<"\n\t\t****************\n\n";
	cout<<"\n\t\t****************";
	cout<<"\n\t\tMaximum Weightage";
	cout<<"\n\t\t****************\n\n";
	for(i=0;i<n1;i++)
	{
		cout<<"\t\t\t"<< i+1<< " : ";
		cin>>w3[i];
	}
	cout<<"\n\t\t****************\n\n";
	getch();
	for(i=0;i<n1;i++)
		a[i]=w3[i]-w1[i];
	loop=a[i];
	for(i=0;i<n1;i++)
	{
	 if(a[i]<=a[i+1])
		loop=a[i+1];
	}
	loop=(loop*100);
	clrscr();
	cout<<"\n\n\n**********************************************";
cout<<"\n\n\tThe Output from the Input layer is Entering into the hidden layer \n";
	cout<<"\n\n**********************************************";
		cout<<"\n\t Suppliers       Weightage:";
		cout<<"\n\t *********       **********";
	for(i=0;i<n1;i++)
	{
		cout<<"\n\t "<<i+1<<".   "<< s1[i] <<" \t "<< w1[i];
```

```
        cout<<"\n\n\tThreshold Value = "<< value1;
        cout<<"\n\n\n***************************************************"
;
        cout<<"\n\n\n\tCreating the Treshold Value (i.e., Activation function)\n";
        cout<<"\n\n***************************************************";
        cout<<"\n\n\tIf the value is... ";
        cin>>value2;
        clrscr();
        cout<<"\n\n\tIf the value is... "<<value2;
        /*
        for(i=0;i<n1;i++)
                x1=x1+(w1[i]);
        for(i=0;i<n1;i++)
                a2[i]=(value2*(w1[i]))/x1;
                */
                cout<<"\n\n\n Suppliers      Weightage:";
                cout<<"\n *********       **********";
do
{
        w=w1[0];
        for(i=0;i<n1;i++)
          w=(w>w1[i+1] ? w : w1[i+1]);
        for(i=0;i<n1;i++)
        {
          temp[i]= s1[i]+(w1[i]/w);
                t1=t1+(temp[i]*w1[i]);
        }
        if(t1<=value2)
        {
         while(t1<value2)
         {
          t1=0;
```

```
            temp[i]=temp[i]+(w1[i]/w);
            t1=t1+(temp[i]*w1[i]);
//          cout<<"\t"<< temp[i];
          }
        }
      }
      else
      {
        while(t1>value2)
        {
          t1=0;
          for(i=0;i<n1;i++)
          {
            temp[i]=temp[i]-((1-w1[i])/w);
            t1=t1+(temp[i]*w1[i]);
//          cout<<"\t"<< temp[i];
          }
        }
      }
      t1=0;value=0;
      cout<<"\n";

      for(i=0;i<n1;i++)
      {
        cout<<"\n";
        cout.width(5);
        cout<<i+1<<".   "<< temp[i]<<"\t"<< w1[i];
              value=value+(temp[i]*w1[i]);
        if(w1[i]<w3[i])
              w1[i]=w1[i]+0.01;
      }
      cout<<"\n\n\t\t\t\tThreshold : "<< value;
```

```
        loop--;
}while(loop>0);
getch();
}
```

Output results

For raw material rubber

```
*********************************************
    The Suppliers act as Input Neuron
*********************************************

Enter the number of suppliers for rubber: 3

    *****************
    Suppliers Details
    *****************

        1 : 392.122
        2 : 354.175
        3 : 362.607

    *****************

    Entering the Weights

    *****************
    Weightage Details
    *****************

        1 : 0.93
        2 : 0.84
        3 : 0.86

    *****************

    *****************
    Maximum Weightage
    *****************

        1 : 0.95
        2 : 0.88
        3 : 0.90
    *****************
```

****

The Output from the Input layer is Entering into the hidden layer

****

Suppliers	Weightage:
*********	**********
1. 392.122009	0.93
2. 354.174988	0.84
3. 362.606995	0.86

Threshold Value = 974.022461

****

Creating the Threshold Value (i.e., Activation function)

****

If the value is... 975

Suppliers	Weightage:
*********	**********
1. 392.745728	0.93
2. 354.217926	0.84
3. 362.779022	0.86

Threshold : 974.78656

1. 390.568298	0.94
2. 348.696198	0.85
3. 358.000305	0.87

Threshold : 974.986206

1. 388.752655	0.95
2. 342.848602	0.86
3. 353.049408	0.88

Threshold : 974.848267

1. 387.120728	0.95
2. 339.490936	0.87
3. 350.344482	0.89

Threshold : 974.928345

1. 385.225586	0.95
2. 336.15448	0.88
3. 347.766083	0.9

For raw material polyester yarn

****
The Suppliers act as Input Neuron
****

Enter the number of suppliers: 2

****
Suppliers Details
****

1 : 337.84
2 : 327.50

****

Entering the Weights

****
Weightage Details
****

1 : 0.98
2 : 0.95

****

****
Maximum Weightage
****

1 : 0.99
2 : 0.98

****

****
The Output from the Input layer is Entering into the hidden layer
****

Suppliers	Weightage:
*********	**********
1. 337.839996	0.98
2. 327.5	0.95

Threshold Value = 642.208191

****

Creating the Threshold Value (i.e., Activation function)

****

If the value is... 643

Suppliers Weightage:

********* **********

1. 338.49292 0.98
2. 327.601959 0.95

Threshold : 642.944885

1. 337.223785 0.99
2. 322.004852 0.96

Threshold : 642.976196

1. 335.991425 0.99
2. 319.934082 0.97

Threshold : 642.967529

1. 333.96106 0.99
2. 318.732025 0.98

Threshold : 642.978821

****

The Suppliers act as Input Neuron

****

For raw material crimped polyester yarn

Enter the number of suppliers: 5

****

Suppliers Details

****

1 : 254.43
2 : 260.28
3 : 271.98
4 : 274.91
5 : 269.06

Entering the Weights

****

Weightage Details

****

1 : 0.87
2 : 0.89
3 : 0.93

4 : 0.94
5 : 0.92

****

****

Maximum Weightage

****

1 : 0.92
2 : 0.91
3 : 0.95
4 : 0.95
5 : 0.94

****

****

The Output from the Input layer is Entering into the hidden layer

****

Suppliers	Weightage:
*********	**********
1. 254.429993	0.87
2. 260.279999	0.89
3. 271.980011	0.93
4. 274.910004	0.94
5. 269.059998	0.92

Threshold Value = 1211.895264

****

Creating the Treshold Value (i.e., Activation function)

****

If the value is... 1212

Suppliers Weightage:
********* **********

1. 253.962631 0.87
2. 260.046448 0.89
3. 272.224731 0.93
4. 275.271576 0.94
5. 269.177582 0.92

Threshold : 1211.956543

1. 249.53595 0.88
2. 256.37561 0.9
3. 270.063599 0.94
4. 273.488434 0.95
5. 266.640137 0.93

Threshold : 1211.97876

1. 245.862579 0.89
2. 253.459885 0.91
3. 268.6633 0.95
4. 271.593292 0.95
5. 264.859406 0.94

Threshold : 1211.677734

1. 244.735062 0.9
2. 252.73381 0.92
3. 267.663086 0.95
4. 270.593079 0.95
5. 263.659149 0.94

Threshold : 1211.959595

1. 244.766815 0.91
2. 251.807465 0.92
3. 267.084015 0.95
4. 270.014008 0.95
5. 262.964264 0.94

Threshold : 1211.8302

1. 245.030182 0.92
2. 250.881119 0.92
3. 266.504944 0.95
4. 269.434937 0.95
5. 262.269379 0.94

For raw material regular polyester yarn

```
*******************************************
      The Suppliers act as Input Neuron
*******************************************

Enter the number of suppliers: 4

      ****************
      Suppliers Details
      ****************

            1 : 351.50
            2 : 340.71
            3 : 347.91
            4 : 290.52

      ****************

      Entering the Weights

      ****************
      Weightage Details
      ****************

            1 : 0.98
            2 : 0.95
            3 : 0.97
            4 : 0.81

      ****************

      ****************
      Maximum Weightage
      ****************

            1 : 0.99
            2 : 0.97
            3 : 0.98
            4 : 0.86

      ****************
```

****

The Output from the Input layer is Entering into the hidden layer

****

Suppliers Weightage:

********* **********

1. 351.5 0.98
2. 340.709991 0.95
3. 347.910004 0.97
4. 290.519989 0.81

Threshold Value = 1240.938354

****

Creating the Treshold Value (i.e., Activation function)

****

If the value is... 1241

Suppliers Weightage:

********* **********

1. 352.214172 0.98
2. 340.965027 0.95
3. 348.471283 0.97
4. 288.632233 0.81

Threshold : 1240.895874

1. 351.712097 0.99
2. 338.528076 0.96
3. 347.324097 0.98
4. 277.166016 0.82

Threshold : 1240.835693

1. 351.338348 0.99
2. 338.204834 0.97
3. 346.576599 0.98

4. 271.610291 0.83

Threshold : 1240.965332

1. 350.883789 0.99
2. 338.467468 0.98
3. 345.66748 0.98

1. 350.66156 0.99
2. 338.02301 0.98
3. 345.223022 0.98
4. 263.801971 0.85

Threshold : 1240.967651

1. 350.409027 0.99
2. 337.517944 0.98
3. 344.717957 0.98
4. 262.115051 0.86

Threshold : 1240.915039

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