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Green Supply Chain Management with Artificial Intelligence Based Optimization

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***Abstract* - Green supply chain management is one kind of modern management patterns which changes the relationships between the traditional environment government and enterprise development, its development has the important influence on promoting the enterprise and society's sustainable development. According to the circular economy theory and the structure of traditional supply chain, this paper constructs the green supply chain's system structure based on the circular economy, which includes four cycles from small to large and from partial to whole as follows: Reuse cycle, Remanufacture cycle, Recycle, And analyzes the viewpoint that the own activity of human being only could pursue the semi-closed circulation, the completely closed macro cycle could only be realized by the union with nature, then proposes the way how to implement the green supply chain management in our country based on the idea of circular economy.**

***Keywords*- circular economy; green supply chain management (GSCM), sustainable development**

I. INTRODUCTION

The Supply Chain is the movement of materials as they move from their source to the end customer. According to Christopher (2005) the Supply Chain produce value in the form of products and service to the end customers through different processes and activities, which are performed by the network of organizations from the upstream and downstream linkages. Often a supply chain also is described by the term value chain, which reflects the concept that value is added along the chain The network, process and activities may consists of suppliers, purchasing, manufacturing centers, warehouses, transportation, distribution centers, and retail outlets, as well as raw material, work-in-process inventory, and finished products that flow between the facilities. A simplified example of a supply chain might look something figure 1.

Fig .1 Supply chain management.

Here you can see how information, materials and services flow from raw material suppliers through manufactures and distribution centers, to the end customer. According to Stevenson every organization is part of at least one supply chain, but many are part of multiple supply chains. One type of a supply chain is a divergent supply chain. A divergent supply chain at the process level has typically one or few raw materials, which later downstream in the supply chain, may turn into several thousand different types of end products and products with quality differences.

1. Green Supply Chain Management

Green supply chain management (GSCM) has emerged the last few years as a result of enterprises wanting to make their businesses environmentally sustainable. GSCM covers every stage in the supply chain from product design, procurement, sourcing and supplier selection, manufacturing and production processes, logistics and the delivery of the final product to the consumers, along with the end-of-life management of the product Altogether, these stages cover: upstream, downstream, within the organizations and the connecting logistic processes.

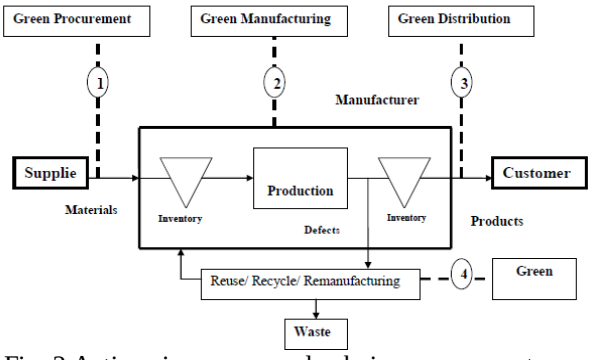

Fig. 2 Actions in green supply chain management.

II. LITERATURE REVIEW

Bo Li and Yushan Jiang(2017):- This paper investigates the optimal decision-making problem in a green supply chain with a risk-aversion retailer, which a risk-neutral manufacturer produces green products through

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innovation. Due to the market uncertainty, the retailer faces stochastic demand. Adopting CVaR value as the risk measurement criterion, we effectively estimate the retailer's risk-averse behaviors. In the centralized and decentralized decision-making modes, we obtain the optimal decisions of supply chain members, and analyze the impacts of the retailer's risk-averse behaviors on the optimal decisions. The results show that the impacts of the retailer's risk-averse behaviors on the green degree, the wholesale price, the retail price and the order quantity of green products are multifaceted.

Wang et al. (2011) introduced a multi objective green supply chain model based on theclassical facility location problem for the firm's strategic planning. The distinguished feature of this model is its consideration of this model is its consideration of environment element which includes environmental level of facility in the handling and transportation process. This model aims to minimize total cost and environmental influence.

Sarkis et aL (2011) realized that GSCM has gained increasing attention within both academia and industry. As the literature grows, finding new directions by critically evaluating the research and identifying future direction becomes important in advancing knowledge for the field. Using organizational theory to help categorized the literature provides opportunities to address and for future direction.

Mazumder &Chatterjee (2010) studied that when more and more companies are treading the path of greening their supply chains, the adoption is still in its initial is still in its initial stages. Companies in the FMCG sector need to understand the key role that environment plays in their business e.g. cost reduction/risk mitigation/product differentiation and then identify and select initiatives that are in line with their business strategy and objectives. The success of these graining programs became leading indicator of business success.

Chen et al. (2010) studied to designate the appropriate GSCM strategies for electronic industries to control their business functions and activities effectively. The integrated network model has been proposed from the aspect of product development so that four business function that is design, purchasing, marketing and manufacturing and their activities can be identified.

Arimura et al. (2009) used Japanese facility-level data, estimates the effect of ISO 14001 certification on the promotion of more advanced practices namely green supply chain management. The results show that ISO 14001 promotes GSCM practices in that facilities with environmental management systems (EMS) certified to ISO 14001 are 40% more likely to access their supplier environment performance and 50% more likely to acquire that their supplier undertake specific environmental practices. We fiirther found that government approaches to encourage EMS adoption in directly promote GSCM practices.

Yeh &Chuang (2010) introduced green criteria into the frame work of supplier selection criteria. The aim of this research was develop an optimum mathematical planning model for green partner selection which involved for objective such as cost, time, product quality and green appraisal score.

III. GREEN SUPPLY CHAIN MANAGEMENT AN EMPIRICAL STUDY

Companies in many industries, competition among networks have experienced an increase in globalization and a shifting focus. Supply Chain Management (SCM) for organizations in this environment has become an important competitive approach. Multinational enterprises to build competitive advantage for the country to take advantage of industry- specific characteristics that have established global network of suppliers. Good logistics and supply chain management environment (ecology) maintaining performance while reducing costs and new efforts to balance Green Supply Chain Management (GSCM) to balance these competing requirements has emerged as an approach. Green Supply Chain Management (GSCM) to balance these competing requirements has emerged as an approach [10]. Recoverable product environment and these products and materials; the overall push toward environmentally conscious manufacturing and logistics industry within the design of the CLSC and GSCM practices have become an increasingly important area [11]. The intent of CLSC significant environmental, regulatory, competitive and economic pressures despite industry plays a role in its adoption [12]. Meanwhile, in particular eco-practices and pressures and what they mean to manage CLSC have examined the role. Because of Indian enterprises are related to such institutional and stakeholder theories, many of which exports and sales to foreign customers, legislative and institutional stakeholder environmental pressures such as motivational drivers began implementation of a number of practices.

IV. METHOLOGY

ANN is the term used for systems which try to work the way the human brain works. Means system tries to perform a certain task the way humans do. Normally computers do any work the way it is educated in the form of code, but it does not have the capability of completing works which it was never taught of. But if we consider a human brain, it has self-learning capability which makes it perform many processes which it has been neither performed nor taught. So, ANN basically tries to inherit this capability of the human brain to self-train itself for

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tasks which are never been performed by it that too very efficiently. Human brain's structure consists of neurons which are interconnected with each other and there by forming a very large network which is well connected thereby helps in performing a very complex task like voice and image recognition very easily. The same task when performed using normal computer won't give an accurate result. Hence ANN mimics neurons structure of the human brain to discover the link between input and targets. Neurons have this ability to save previous experimental data. The speed of human brain is several thousand-time faster than a traditional computer because in brain unlike traditional computer as whole information is not passed from neuron to neuron they are rather encoded in the neuro3n network. This is the reason why the neural network is also named as connectionism.
A biological model of a neuron is basically comprised of dendrites, a cell body or soma, and an axon as shown in Figure 3 The cell body, also called the soma, holds the nucleus of neurons.

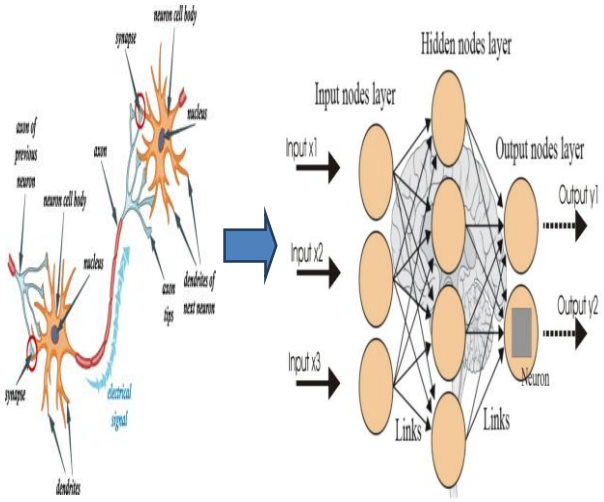

Fig. 3 Concept of ANN.

V. LEVENBERG–MARQUARDT (LM) ALGORITHM

In present study, we have utilized this algorithm because of its good ability to reduce error function. This algorithm is first proposed by K. Levenberg in 1944 and then later it is further modified by D. Marquardt in 1963 hence algorithm is named after both of them [23] [24].

When the performance function is in the form of a sum of squares, then the two techniques are computed by the following relations,Main advantages of this technique are that firstly it is very fast which makes processing large data set very fast and secondly convergence is very stable which take care of efficiency [25]. This algorithm is basic a well-organized blend of two different methods one is hessian and other is a gradient. When the performance function is in the form of a sum of squares, then the two techniques are computed by the following relations,

$$H = J_k^T J_k (5.2)$$
$$g = J_k^T e (5.3)$$

Where J_k is the Jacobian matrix, which comprises of first order derivatives of the network errors with reference to the weights and biases, is denoting network errors. Hence producing a Jacobian matrix with the help of a back propagation technique is far less complicated than forming the Hessian matrix. The Leven berg –Marquardt algorithm is a fine mixture of the steepest descent method and the Gauss–Newton algorithm. The following relation helps on understanding LM algorithm computation,

$$W_{k+1} = W_k - \left[J_K^T J_k + \mu I\right]^{-1} J_K^T e_k \ (5.4)$$

Where, W_k represents current weight, W_(k+1)represents next weight, I represent the identity matrix and e_k represents last error, μ represents combination coefficient [26] [27]. LM method attempts to combine the benefits of both the SD and GN methods hence it inherits the speed of the Gauss–Newton (GN) method and the stability of the Steepest Descent (SD) method. The factor μ is multiplied by some factor (β) whenever iteration/epochs would result in an increase in present error $e_{k+1}$and when epoch leads to reduction in present error$e_{k+1,}$ μ is divided by β. In this study, we have used value of β as l0. When μ is large the algorithm converts to steepest descent while for small μ the algorithm converts to Gauss-Newton [26].

Table 1 The table illustrates the comparison of three algorithms.

Algorithm	Rules	Convergence
Gradient Newton algorithm	$W_{k+1} = W_k - \alpha g_x , \ \alpha = \frac{1}{?}$	Stable, slow
Gauss – Newton algorithm	$W_{k+1} = W_k - [J_K{}^T J_k]^{-1} J_K{}^T e_k$	Unstable, fast
Levenberg – Marquardt (LM) algorithms	$W_{k+1} = W_k - [J^T{}_k J_k + ?I]^{-1} J_k e_k$	Stable, fast

In order to evaluate the performance of generated models in this project three Performance Functions are used.

Functions areMean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Mean Square Error (MSE). MAE is used to measure how close predicted load by generated/trained model is to the actual loads. It is given by:

$$MAE = \frac{1}{N}\sum_{t=1}^{N} |A_t - \hat{A}_t| = \frac{1}{N}\sum_{t=1}^{N} |e_t| \quad (5.5)$$

The mean absolute percentage error (MAPE) is used to calculate prediction accuracy of a generated/trained model. It is given by.

$$MAPE = \frac{100}{N}\sum_{t=1}^{N} \frac{|A_t - \hat{A}_t|}{A_t} \quad (6.1)$$

The Mean Square Error (MSE) is given by

$$MSE = \frac{1}{N}\sum_{t=1}^{N} {e_t}^2 \quad (6.2)$$

Where, N is the number of test samples, A_t is the actual value and $\hat{A}_t$is the forecasted value [28].

Figure 3.6 shows the working of LM algorithm using block diagram. Initially, M=1 is considered and random initial values of weights and bias values are taken in calculations. Now for this weights and bias value, the respective output is generated and error is calculated. According to this error matrix, Jacobian matrix (J_k) is computed and on the basis of this Jacobian matrix, next values or updated values of weights are calculated using equation 5.4. Now based on this updated weights and bias values updated or current error (e_{k+1}) is calculated.

VI. RESULTS AND DISCUSSION

1. Generate per day data collection our Production industry

1.1 Decided Input sample and Target value:

We collect 24 days data of industry. However, while the time component adds additional information, it also makes time series problems more difficult to handle compared to many other prediction tasks. This post will go through the task of time series forecasting using machine learning, and how to avoid some of the common pitfalls. Through a concrete example, I will demonstrate how one could seemingly have a good model and decide to put it into production, whereas in reality, the model might have no predictive power whatsoever, More specifically, I will focus on how to evaluate your model accuracy, and show how relying simply on common error metrics such as mean percentage error, R2 score etc. can be very misleading if they are applied without caution.

Table 2 Data Set.

DATA OF Shree Ram industries OF EACH STEP PD PROCESS								
Sr.	Base line	Workers	Assembly line	Total	Productivity	Storage	Drop	Target
no.	delay	T=300	in (days)	product	in %	time	Order	of PD
Days	(PD start)			developed	company	in days		
1	2	238	15	2	7.5	11	1	98.6281
2	2	280	37	5	12.7	23	0	98.6281
3	0	248	21	3	10.2	17	1	98.6281
4	0	243	29	3	10.6	19	1	98.6281
5	2	288	31	5	19	26	0	98.6281
6	0	279	32	5	14	24	0	98.6281
7	0	285	32	5	17.9	29	0	98.6281
8	2	284	31	5	10	26	1	98.6281
9	0	256	18	3	13	18	0	98.6281
10	0	283	19	5	12	27	1	98.6281
11	2	257	18	4	10	16	0	98.6281
12	0	239	16	2	17.5	10	1	98.6281
13	2	257	19	5	10	22	0	98.6281
14	0	239	9	2	11.6	28	1	98.6281
15	0	246	12	2	15.5	13	0	98.6281
16	0	192	7	1	15.8	6	0	98.6281
17	0	283	19	4	14.8	18	0	98.6281
18	0	245	16	2	19.9	14	0	98.6281
19	0	292	15	6	14.4	31	2	98.6281
20	0	283	18	5	18.7	27	1	98.6281
21	0	276	18	4	16.2	21	1	98.6281
22	0	272	18	4	10	21	0	98.6281
23	0	274	18	4	15.6	19	0	98.6281
24	0	275	18	4	12.7	18	0	98.6281

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2. Layered function of industrial data target and input sample

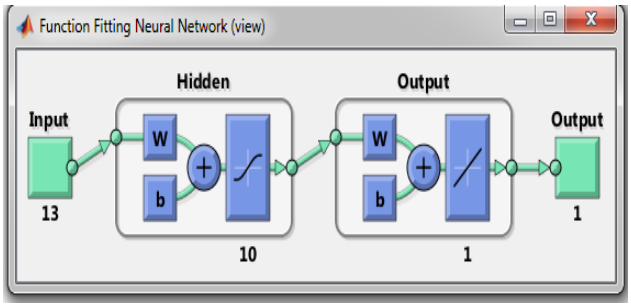

Fig. 5 Hidden and output layers Data sets.

3. Best validation performance of input data.

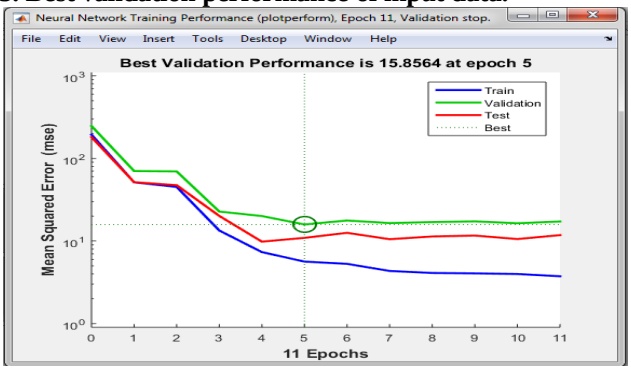

Fig. 6 MSE constant of input sequence Data sets.

4. Production growth in 11 epoch input data.

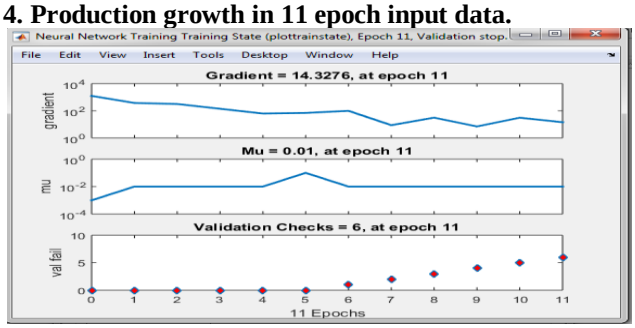

Fig. 7 Optimization all productivity rate.

5. Productivity improvement prediction sampling.

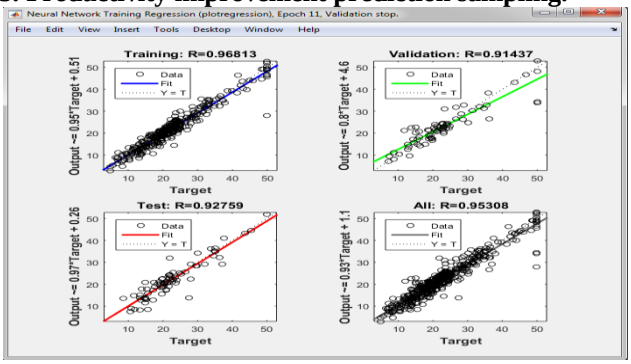

Fig. 8 Optimize result.

6. Time series Analysis Production.

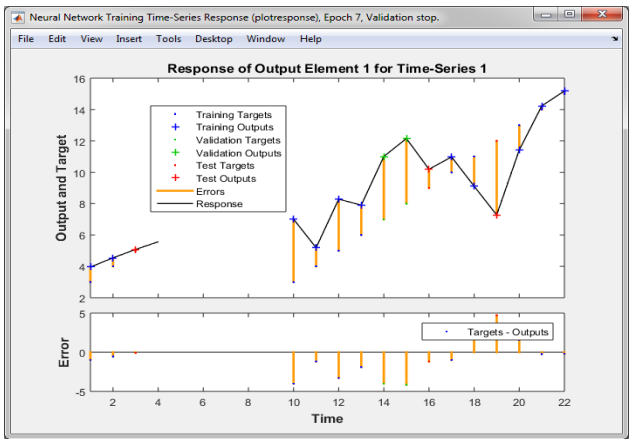

Fig. 9 Optimize result up to 5 year data sets in Shree Ram industries.

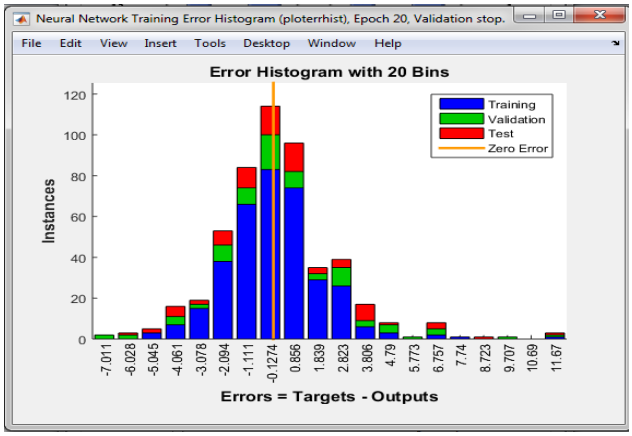

Fig. 10 Error histogram.

VII. CONCLUSION

Greening the supply chain is increasingly a concern for many business enterprises and a challenge for logistics managerial in the 21st century. Existing literature indicates that GSCM practices are positively or negatively associated with economic id environmental performance. The implementation of Green supply chain management technique has historically led in the manufacturing sectors. Dairy industry also considering customer satisfaction regarding products or services like other industries. Hence the focus of dairies is to improve the quality of service and product by implementing the various Green Supply Chain Management (GSCM) techniques i.e. Recovery of waste material. Green Manufacturing, Internal Environmental Management and Green Resources. In this work I have taken the case of vita milk plant and NDRI karnal. This study explains the practices and implementation of green supply chain among various dairy industries located in India. The green supply chain issues or strategies can be quantified with the help of the questionnaire which are filled by concerns

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authority in dairy industries. As the objective of this study is to justify the GSCM elements and benefits with the help of AHP methodology. This methodology can be used any of the other industries i.e. textile industries, chemical industries, agriculture industries etc.

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