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Forecasting of Demand for Small Medium Enterprises Using Fuzzy Logic

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Abstract: ***Demand prediction is very important research area now days as it significantly affects the revenue growth of industries specifically SMEs. In this paper, a framework is proposed using fuzzy logic and tested with a case of demand forecasting of generator (7.5 KVA) for Prakash Diesels Private Limited, Agra. The supply networks consist of suppliers, manufacturers, distributors and customers. Models for demand prediction has been prepared using last one year historical data and configured into fuzzy background by building different membership functions. The membership functions for input variables (Month, Area, & Cost) and output variables (Demand) are plotted. The first input variable 'month' is associated with twelve sub parameters (January, February, march, April, May, June, July, August, September, October, November & December). The second and third input variables 'area' and 'cost' are associated with three sub parameters (rural, urban & mix) and (high, low & equal) respectively. The output variable is mapped to demand of generator. Results show that demand prediction using fuzzy logic are in tune with demands collected from supply chain managers of Prakash Generators.***

Keywords: Fuzzy, Membership function, prediction, forecasting, Inference, Mamdani

1. Introduction

The supply chain management (SCM) is a network of facilities, information, transportation, distribution and customers. A supply chain starts with the delivery of raw material from the supplier to the end customer. J. A. Momoh SM and K.Tomsovic [1] told that fuzzy set theory is a useful supplement to the mathematical methods in solving the power system problem. Anbuky et al. [2] used fuzzy logic in providing the data and information of the demand prediction to the power generator. Petrovic et al. [3] applied the fuzzy logic when the supply chain is under uncertain demand of the generator .Uncertain demand is associated with customer demand. Tah and Carr [4] informed the different methods and techniques for dealing with risk analysis, risk management and different results. Carr and Tah [5] describe a method for risk assessment based on fuzzy logic. It uses linguistic term for mapping of the membership function. Rodriguez et al. [6] suggested that mamdani inferences are the main types of inference model of the fuzzy. The mamdani inferences combine fuzzy rules into a mapping from fuzzy input to fuzzy output. Chen and Lee [7] explained the membership function is used in fuzzy decision, fuzzification, defuzzification and fuzzy product prices of the overall decision. Pandian et al. [8] has studied the load forecasting for generator dispatch, etc. Arshinder et al. [9] told that the different coordination are information sharing, information technology. Kim et al. [10] applied the demand analysis method are average of 50% of accuracy with fuzzification and 50% of accuracy with defuzzification. Mamlook et al.

[11] informed the load forecasting in providing the generator cost of the capacity. Demand forecasting is the most important of the electric, dispatch and loading of the generator used in the demand forecasting. Peidro et al. [12] informed fuzzy logic model for supply chain which considers the demand , supply and process uncertainties. Ko et al. [13] informed the fuzzy logic operates (such as if, and, or, not and then) and defuzzification (transformation of fuzzy set into a fuzzy crisp value). Tah and Carr [14] has studied the risk management of the considers is time, cost, delivery and customer satisfaction. Morote and Vila [15] presented the use of fuzzy inference system (FIS) with compare the fuzzification and defuzzification with the help of membership function of the fuzzy logic. Shaw et al. [16] applied the considers of multi factors is fuzzy multi – objective linear programming for the supplier selection of the demand forecasting. Chen et al. [17] informed the proposed fuzzy controller is dealing with uncertainties in data collection to provide the product of the demand prediction of the fuzzy logic. Wang et al. [18] commonly used in triangular fuzzy number shapes. This paper presents the case study of Prakash Diesels Private Limited. The demand of generator has been predicted using fuzzy logic. Introduction of fuzzy logic is provided in section 2. Data collection is shown in section 3. Section 4 determines the design of membership function for input and output variables. Section 5 presented the result and discussion. The conclusion and future scope in Section 6.

2 Fuzzy Logic

Fuzzy Logic was developed by Lofti A. Zadeh in 1965. Fuzzy logic is based on many-valued logic rather than binary logic .The binary logic is considers either zero or one. Whereas fuzzy logic can accept any value between zero and one a fuzzy logic membership function of each input and output variable are decided using the linguistic term. Structure of fuzzy logic is shown in figure 1.

Features of Membership functions –

- Core
- Support
- Boundary

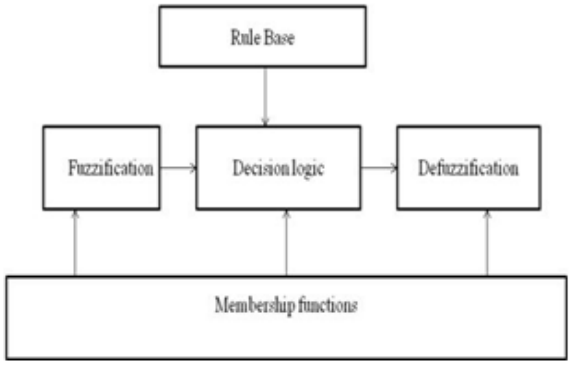

Figure 1: Structure of Fuzzy logic

Membership functions of many shapes like triangular, trapezoidal etc. A sample membership function of triangular nature is shown in figure 2.

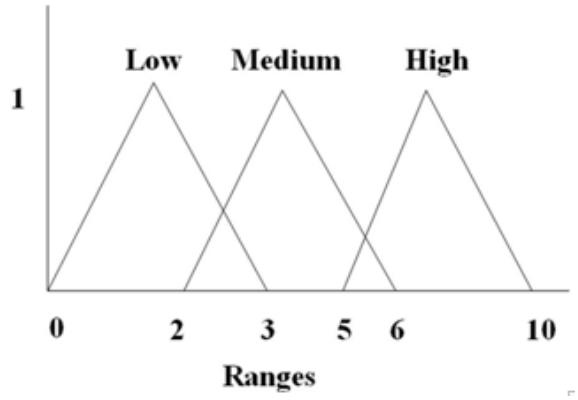

Figure 2: Structure of Membership Function

This parameter is mapped with three linguistic terms like low, medium and high.

3. Data collection

The data has been collected as shown in table 1 for last one year i.e. 2016-2017. This data is utilized for building membership function for generator (7.5 KVA).

Table 1: Demand data for 1 year

Data (7.5kva) 2016-17	Target demand
January	108
February	137
March	151
April	168
May	177
June	186
July	99
August	119
September	135
October	178
November	204
December	225

The minimum demand is observed in month of July and maximum demand is observed in month of December.

4. Membership Function

A fuzzy inference system (FIS) is developed by using mamdami or Matlab™ software. The mapping of linguistic term for input parameter month, cost, and area are shown in table 2.

Table 2: Linguistic term for mapping **(**Input**)**

Input	sub parameters	
Month	Cost	Area
January	Low	Rural
February	Equal	Mix
March	High	Urban
April		
May		
June		
July		
August		
September		
October		
November		
December		

The month is associated with twelve linguistic term is January, February, march, April, May, June, July, August, September, October, November & December. Cost is mapped with three linguistic term is high, low and equal. Area is mapped with three linguistic term is rural, urban and mix.

Table 3: Linguistic term for mapping (Output)

Output	Sub parameters
Demand	very very low
	very low
	low
	medium
	high
	very high
	very very high

The demand is associated with seven linguistic term is very low, very low, low, medium, high, very high, very very high. The mapping of linguistic term for output variable is shown in table 3.

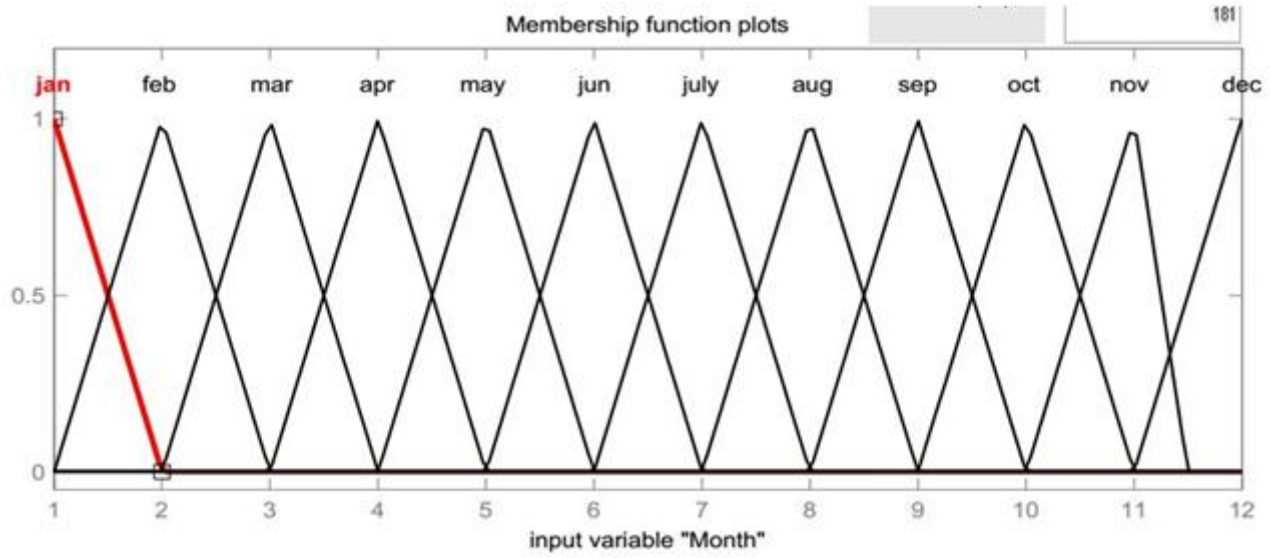

Figure 3: Membership function "Month"

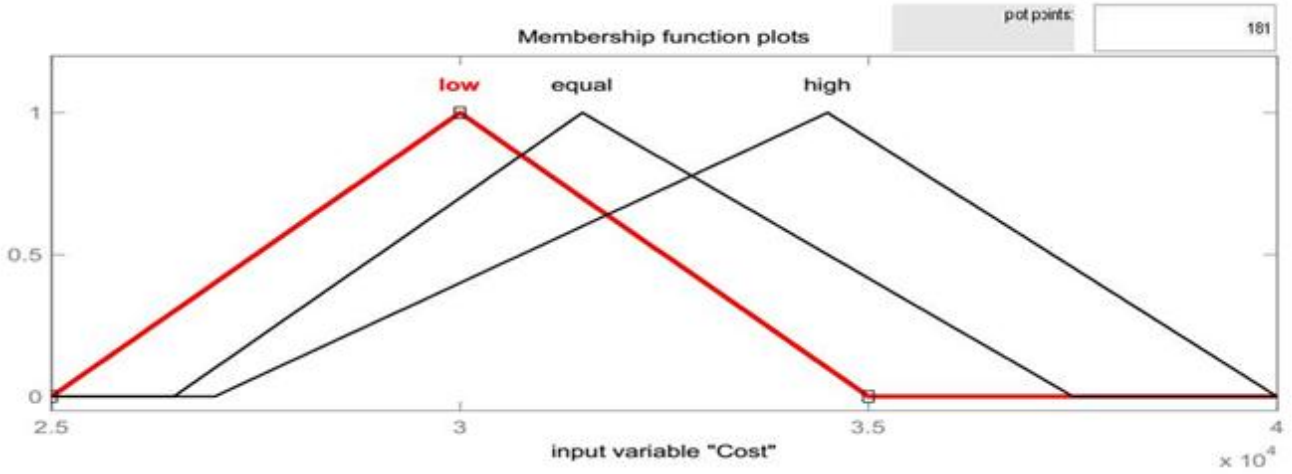

Figure 4: Membership function "Cost"

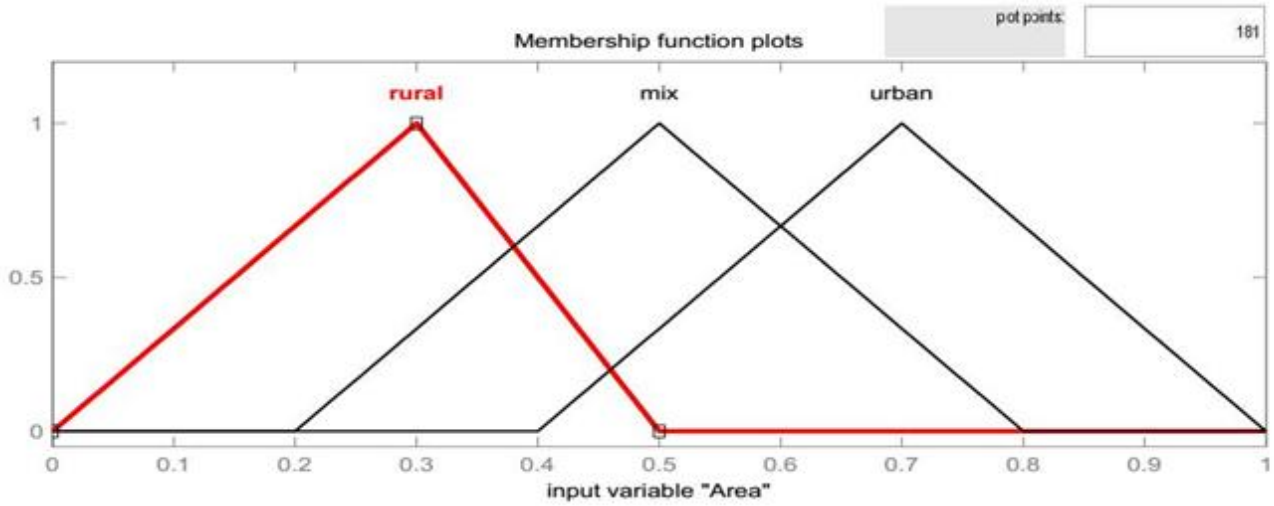

Figure 5: Membership function "Area"

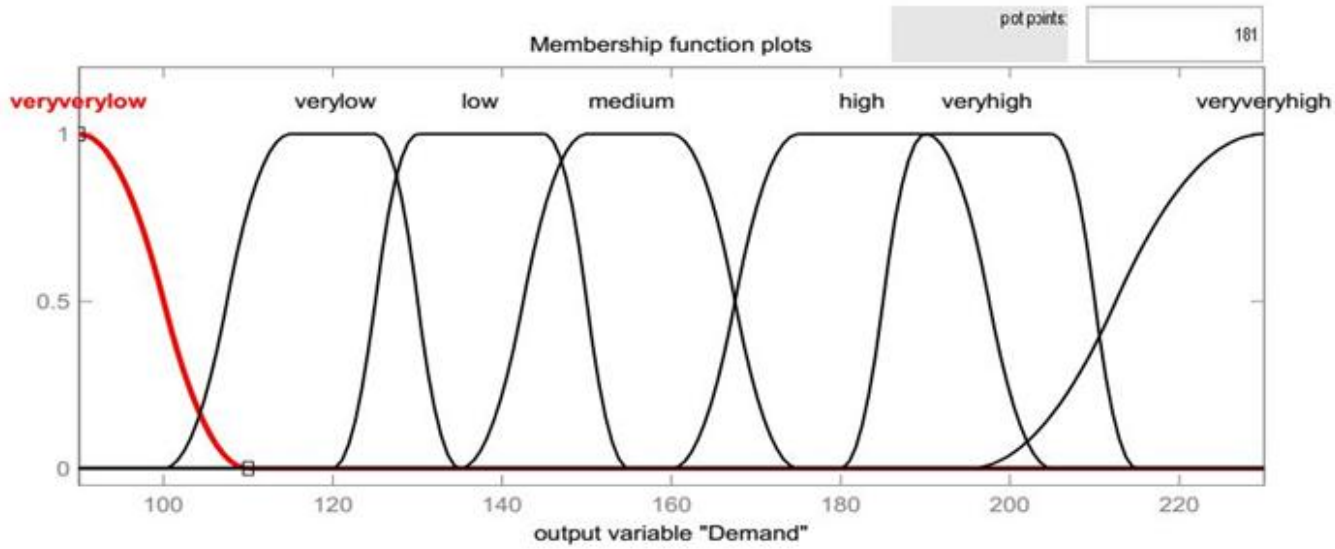

Figure 6: Membership function "Demand"

The first input membership function is “Month” is shown in figure 3. The second input membership function is “Cost” is shown in figure 4. The three input membership function is “Area” is shown in figure 5. The output membership function is “Demand” is shown in figure 6.

4. Fuzzy rules

The total 12*3*3 =108 rules are made some of this rules are shown in table 4. Fuzzy logic operates (such as if, and, or, not and then)

Table 4: Fuzzy rules

Rules	If(Month) is	And (Cost) is	And (Area) is	Then (Demand)
1	January	low	rural	low
2	February	low	urban	very high
3	March	low	mix	high
4	April	high	rural	very low
5	May	high	urban	medium
6	June	low	urban	very very high
7	July	equal	rural	very low
8	August	equal	urban	medium
9	September	high	rural	very very low

5. Result & Discussion

Table 5: Predicted demand with month, cost, area

S.no	Month(2016-17)	Cost	Area	Predicted
1	1 = January	32500	0.5	145
2	2 =February	32500	0.5	162
3	3 = March	32500	0.5	162
4	4 = April	32500	0.5	162
5	5 = May	32500	0.5	162
6	6 = June	32500	0.5	180
7	7 = July	32500	0.5	145
8	8 = August	32500	0.5	145
9	9=September	32500	0.5	145
10	10 = October	32500	0.5	180
11	11 =November	32500	0.5	180
12	12 = December	32500	0.5	180

The membership functions for the input parameters are shown in table 5. The range for this input is capacity between (1-12) in which January, February, march, April, May, June, July, August, September, October, November December. The output of demand at a certain input is (Month=12, Cost=32500, and Area=0.5) has been shown in figure 7.

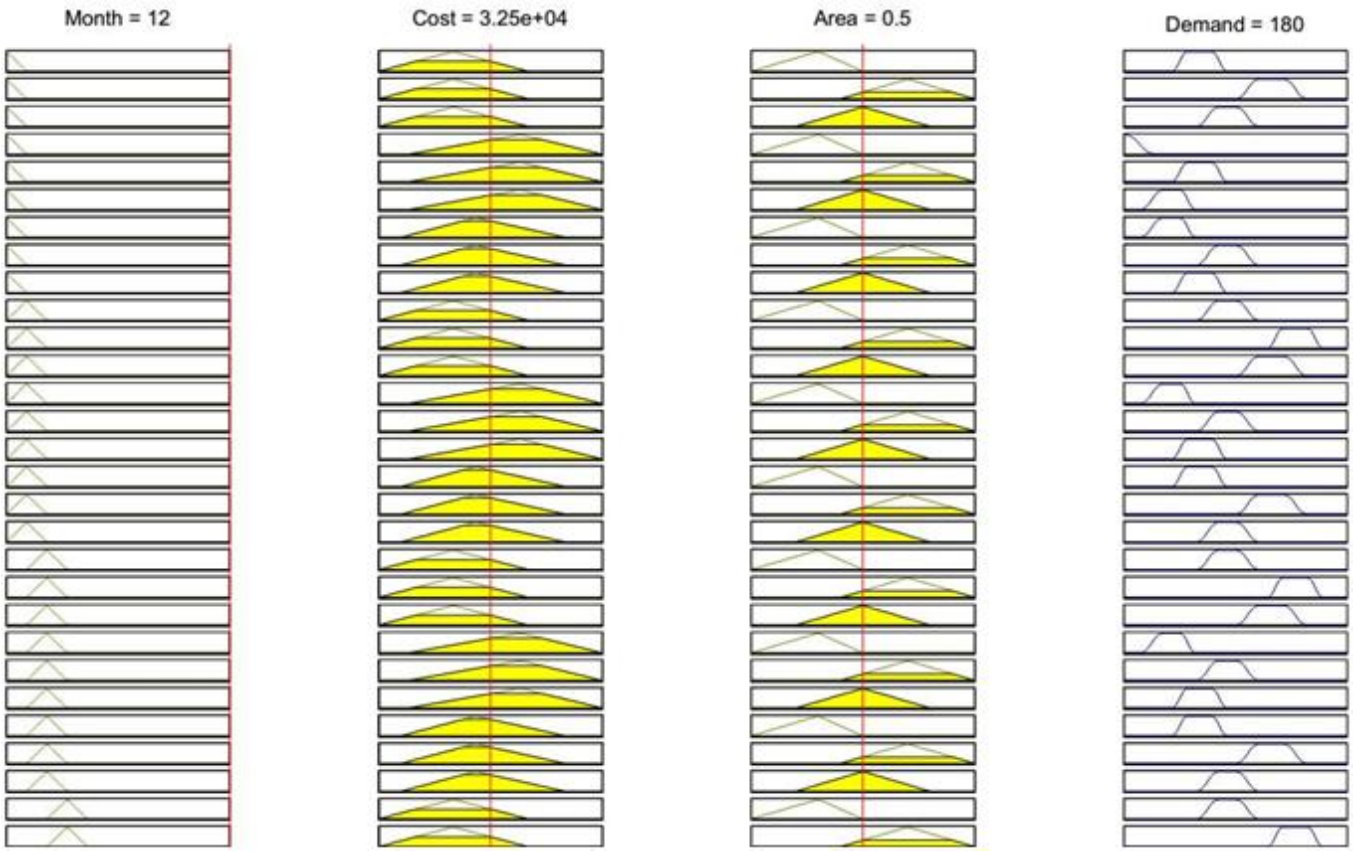

Figure 7: Demand

EA = Absolute error = (Target– Predicted) (1)
ER = Relative error = (Target – Predicted) / Target (2)
E% = Error % = [(Target – Predicted) / Target] * 100 (3)

Table 6: Predicted demand with absolute error, relative error, error %

S.No	Target value	Predicted value	Absolute value	Relative value	Error % value
1	108	145	145-108= 37	37/108=0.342	0.342*100=34.2
2	137	162	162-137= 25	25/137=0.182	0.182*100=18.2
3	151	162	162-151= 11	11/151=0.072	0.072*100=7.2
4	168	162	168-162= 6	6/168=0.035	0.035*100=3.5
5	177	162	177-162= 15	15/177=0.084	0.084*100=8.4
6	186	180	186-180= 6	6/186=0.032	0.032*100=3.2
7	99	145	145-99= 46	46/99=0.464	0.464*100=46.4
8	119	145	145-119=26	26/119=0.218	0.218*100=21.8
9	135	145	145-135= 10	10/135=0.074	0.074*100=7.4
10	178	180	180-178= 2	2/178=0.011	0.011*100=1.1
11	204	180	204-180= 24	24/204=0.117	0.117*100=11.7
12	225	180	225-180= 45	45/225=0.200	0.200*100=20

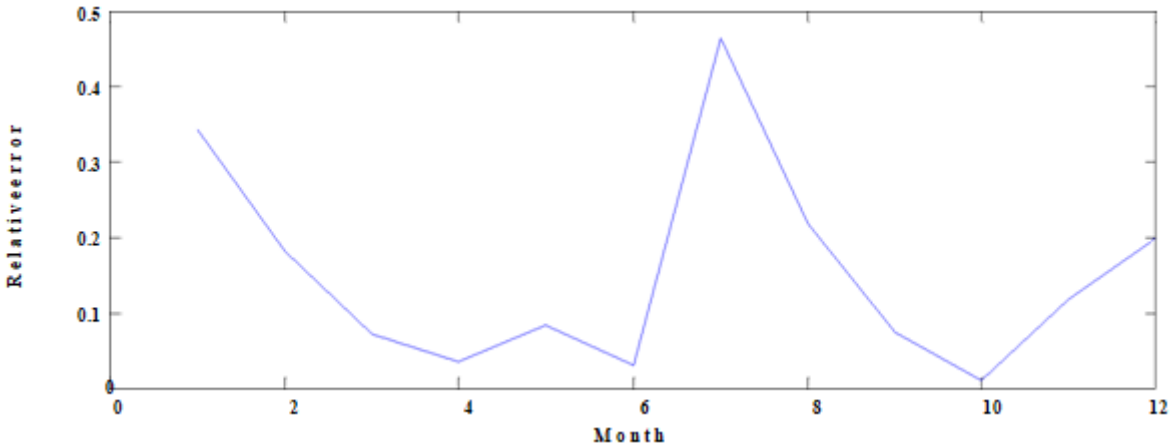

Figure 8: Month vs Relative error

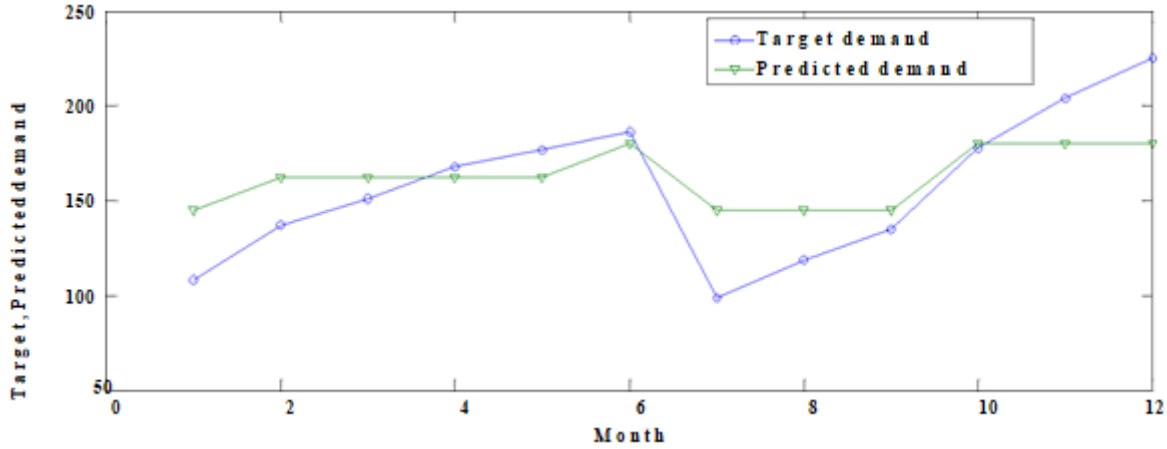

Figure 9: Month vs Target demand vs Predicted demand

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Author Profile

Shubham Garg is currently pursuing M.Tech (Production Engg) from GLA University Mathura. (His research interest is in the areas of demand predicted for supply chains). He has completed his graduation from Uttarakhand Technical University Dehradun in first division. He has been awarded, Republic motors.

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He has published around 15 peer reviewed research papers in renowned conferences held at IIT's & IIM's till date. He is also an active member of Alumni Association of GLA University. He has been awarded LEAN SIX SIGMA YELLOW BELT from Ministry of Micro, small & medium enterprises. He is also having online certification from NPTEL and also awarded with an online digital badge by AUTHOR AID available at http://moodle.inasp.info/badges/badge.php?hash=1ae69d27e 7267d1f528d8696dd637a7016b20147 with certificate of merit. Apart from that many students have completed and some are still pursuing their B.Tech project research work under his guidance and supervision.

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