

J. Basic. Appl. Sci. Res., 2(4)3920-3925, 2012 © 2012, TextRoad Publication ISSN 2090-4304 Journal of Basic and Applied Scientific Research www.textroad.com

Forecasting Supply Chain Demand by using Fuzzy Neural Network Approach, The Case Study of Kaleh Company

KosarMostafaviShahandasht^a, Hassan Shavandi^b

^aDepartment of Industrial and Mechanical Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran ^bDepartment of Industrial Engineering, Sharif University of Technology, Tehran, Iran

ABSTRACT

The aim of this paper is introduce a new model as modulation both of fuzzy logic and Neural Network for forecasting supply chain demand of Kaleh Production. This paper has forecasted demand by using three methods of ANFIS, FSOM and Neural Network. We have used MSE, MAD and MAPE for assessment of forecasting models. Results indicate that the ANFIS model with modulation both of fuzzy logic and Neural Network has a better performance in forecasting demand rather than other models.

KEYWORDS: Forecasting, Supply Chain Demand, Fuzzy Neural Network, Kaleh Company.

INTRODUCTION

There are many researches about supply chain demand. The most studies in this area are: Lummus and Alber, (1997), Quinn (1997), Ellram and Cooper (1993) and Monczka and Morgan (1997). In recent decade, there are a rapidly growing numbers of hybrids fuzzy with neural network studies in the engineering field, estimation, modeling and control. Proper operation of these models was incentive for the researches.

Neural and fuzzy applications have been successfully applied to the chemical engineering processes [1], and several control strategies have been reported in literature for the distillation plant modeling and control tasks [2]. Recent years have seen a rapidly growing number of neurofuzzy control applications [3]. Beside this, several software products are currently available to help with neurofuzzy problems.

A fuzzy system is composed of if-then rules. An Adaptive Neuro Fuzzy Inference System is a type of network in which each node acts a specific function of the inputing signals, with parameters upgrated according to given data and a gradient-descent learning method. This hybrid system has been applied to the control of nonlinear systems.

The aim of this paper is introduce a new model as modulation both of fuzzy logic and Neural Network for forecasting supply chain demand of Kaleh Production. This paper has forecasted demand by using three methods of ANFIS, FSOM and Neural Network.

RESEARCH METHOD

First of all, we have used following model for considering effective factors on demand of Kaleh Production (Cheese):

 $Y = a + b_1X1 + b_2X2 + b_3X3 + b_4X4 + b_5X5 + b_6X6 + b_7X7 + b_8X8$

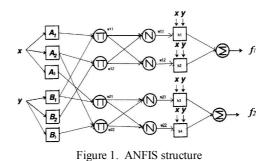
Y is quantity of demand of Kaleh Production. X1 is quantity of produced goods, x2 is total of production cost, x3 is price of these goods relative to other prices of similar goods, x4 is the number of candidates of corporation in cities, x5 is total of marketing cost, x6 is the number of competitive productions, x7 is the total of competitive production and x8 is the quantity of exported goods.

ANFIS structure

ANFIS is a type of network in which each node acts a specific function of the inputing signals, with parameters upgrated according to given data and a gradient-descent learning method. This hybrid system has been applied to the modeling and control of multiple-input single-output systems. [1, 2]

* Corresponding Author: KosarMostafaviShahandasht, Department of Industrial and Mechanical Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran.

Shahandasht and Shavandi, 2012



The structure of the ANFIS is produced by several layers as figure 2.

we consider two inputs *a* and *b* and two outputs f_i and f_2 for a fuzzy model, with X_i and Y_j being the linguistic label associated with *a* and *b* respectively, every node in first layer represents a bell-shaped membership function $\mu_{X_i}(a)$ or $\mu_{Y_i}(b)$ with variable membership parameters. Usually we choose the bell-shaped functions. Nodes of second layer output the firing strength defined as the product $\omega_{ji} = \mu_{X_i}(a) \times \mu_{Y_i}(b)$, where the set of nodes in this layer are grouped for each output *j*.[3, 4]

Normalization process is calculated in third layer with the normalized $\overline{\omega}_{ji}$, and the Sugeno-type consequent of each rule with variable parameters p_i , q_i and r_i is implemented in fourth layer. Finally the single node of layer 5 calculates overall output as a summation of all incoming signals. [1, 5, 6, 7]

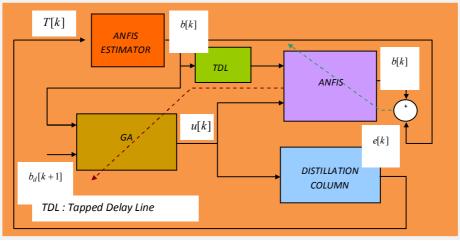


Figure 2. Estimation and Control ANFIS

EMPIRICAL RESULTS

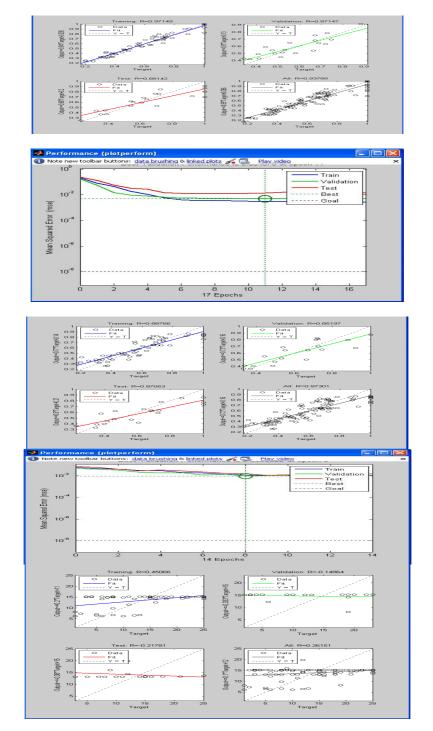
First of all, we have estimated the regression model for identifying the effective factors on demand of Kaleh production. Table 1 indicates estimation results of regression model.

Table 1. Estimation of Regression								
Model		Unstandardized Coefficients		Standardized Coefficients	Т	Sig.		
		В	Std. Error	Beta				
1	(Constant)	3.435	.869		3.955	.000		
	X1	.682	.284	.599	3.390	.001		
	X2	.540	.500	.481	4.108	.000		
	X3	742	.270	693	-3.995	.000		
	X4	.512	.379	.480	5.357	.000		
	X5	.211	.495	.181	1.310	.094		
	X6	433	.360	392	-2.975	.009		
	X7	321	.495	277	3.310	.004		
	X8	.054	.1112	.044	0.975	.834		

Based on above results, after remove the redundant variables, we have written regression model as following: Y=3.43+0.68 X1+0.54 X2-0.74 X3+0.51 X4-0.43 X6-0.32 X7

X5 and x6 have not significant effect on demand. Other variables have a significant effect on demand. So, quantity of produced goods, total of production cost, price of these goods relative to other prices of similar goods, the number of candidates of corporation in cities, the number of competitive productions and the total of competitive production have a significant impact on demand. X1, x2 and x4 have a positive impact on demand but x3, x6 and x7 have a negative impact on demand.

Second, we forecasted demand based on ANFIS method as following:



Shahandasht and Shavandi, 2012

	w toolbar button	s: data prusi	ning o linker	B . Elev y	1000 poor.	-	
10	* 	-		 		- Train - ∨alidatio	n 🗧
10 چ						– Test - Best - Goal	
Mean Squared Error (mse)	2						-
10 Square	4						-
eaw 10	•						-
10				 			

Table 2. Comparative results between three functions of Neural Networks

Average Time of Test	Average Time of Education	Average percent of Error	Structure of Network
0.104	11.48	4.5	Newff
0.127	13.72	8.8	Newelm
0.201	12.30	9.7	Newcf

Table 2 indicates Comparative results between three functions of Neural Networks. Then, we introduced final model for forecasting demand based on FSOM as following Code: function [optnet mse succratio]=test2(ner1,ner2);

```
p=xlsread('d:\data.xls',1);
T=xlsread('d:\data.xls',2);
for i=1:ner1
for j=1:ner2
  net(i,j) = \{newff(p,T,[i,j], \{'logsig', 'logsig'\})\};
  net{i,j}.trainparam.lr=0.1;
  net{i,j}.trainparam.lr inc=1.05;
  net{i,j}.trainparam.lr dec=0.7;
  net{i,j}.trainparam.epochs=200;
  net{i,j}.trainparam.show=100;
  net{i,j}.trainparam.goal=1e-8;
  trainednet(i,j)={train(net{i,j},p,T)};
  that=sim(trainednet{i,j},p);
   mse(i,j)=(sum((T-that).^2)/100)^{0.5};
end
end
   for i=1:ner1;
  for j=1:ner2;
    if mse(i,j)==min(min(mse));
optner1=i
       optner2=j
     end
  end
end
optnet=trainednet{optner1,optner2};
% dadehaye bron nemoneei%
that2=zeros(1,100);
succratio=1-sum(abs(T-that))/100;
```

Table 3. comparative forecasting assessment between three methods

\mathbb{R}^2	MAD	MAPE	NMSE	MSE	RMSE	Methods of Demand Forecasting
0.99999	4.0646	0.84830	0.000001	69.65	6.453	ANFIS
0.99998	8.774	2.655	0.000027	78.88	8.095	FSOM
0.99765	99.995	153.52	0.00775	1854.04	65.65	Neural Network

In following table, we shows bias of forecasting for the methods:

J. Basic. Appl. Sci. Res., 2(4)3920-3925, 2012

Table 4. Bias of Forecasting					
TS	bias	Methods of Demand Forecasting			
2.1	8.526	ANFIS			
4.32	36.5904	FSOM			
-10.65	-1060.63	Neural Network			

Table 5. comparative forecasting for three methods with actual demand

1 137604 130718.034 127808.8012 173683.315 2 158669 150814.044 147194.5069 199837.11 3 179734 170910.054 166808.2127 226020.905 4 200799 191006.064 186421.9185 252204.7 5 221864 211102.074 206035.6242 278388.495 6 242929 231198.084 225649.33 304572.29 7 263994 251294.094 245263.0357 330756.085 8 285059 271390.104 264876.7415 355039.88 9 306124 291486.114 28490.4473 383123.675 10 327189 311582.124 304104.153 40907.077 11 290933.4 276479.1216 269843.6227 365570.5392 12 313564.3 320690.3436 312993.7754 421774.8882 14 359907.9 342795.9546 334508.817 449977.0627 15 319432.74 304182.822 34966.8388 4048				g for three methods wi		
2 15869 150814.044 147194.5069 199837.11 3 179734 170910.054 166808.2127 22602.905 4 200799 191006.064 186421.9185 2522.04.7 5 221864 211102.074 206035.6242 27838.495 6 242929 231198.084 225649.33 304572.29 7 263994 251294.094 245263.0357 330756.085 8 285059 271390.104 264876.7415 356998.8 9 306124 291486.114 284490.4473 383123.675 10 327189 311582.124 304104.153 409307.47 11 290393.4 276479.1216 269848.6227 363570.5392 12 313564.9 29858.7326 291418.699 32572.1137 13 336736.4 320690.3436 312993.7754 421174.5882 14 359907.9 342795.9546 3349421.4363 463031.227 15 319432.74 304182.652 296882.2683 39	Week	Real Demand	ANFIS	FSOM	Neural Network	
3 179734 170910.054 166808.2127 226020.905 4 200799 191006.064 186421.9185 225204.7 5 221864 211102.074 206005.6242 278388.495 6 242929 231198.084 225649.33 304572.29 7 263994 251294.094 245263.0357 303766.085 8 285059 271390.104 264876.7415 365939.88 9 306124 291486.114 284490.4473 333123.675 10 327189 311382.124 304104.153 409307.47 11 290393.4 276479.1216 269843.6227 363570.5392 13 336736.4 32007.9 342785.9346 312939.7754 421174.8882 14 359907.9 342785.9346 334588.817 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.3 361485308 217 374110.04 35281.49662 344347.4363 46301.2227						
4 200799 191006.064 186421.9185 252247. 5 221864 211102.074 206035.6242 278388.495 6 242929 231198.084 225649.33 304572.29 7 263994 251294.094 245263.0357 330756.085 8 285059 271390.104 264876.7415 356939.88 9 306124 291486.114 284490.4473 383123.675 10 327189 311582.124 304104.153 40937.47 11 290393.4 276479.1216 269848.6227 363570.5392 12 313564.9 298584.7326 291418.699 392372.7137 13 36376.4 320690.3436 312993.7754 421174.8882 14 359907.9 342795.9546 334568.817 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 44138.8308 17 370410.04 352814.942062 443447.4363						
5 221864 211102.074 206035.6242 278388.495 6 242929 231198.084 225649.33 304572.29 7 263994 251294.094 42563.0357 330756.085 8 285059 271390.104 264876.7415 356939.88 9 306124 291486.114 284490.4473 38123.675 10 327189 311582.124 304104.153 409307.47 11 290393.4 276479.1216 269843.6227 363570.5392 12 31356.4 320690.3436 312993.7754 421174.8882 14 35907.9 342785.9546 334568.817 449971.0627 15 319432.74 304182.652 296682.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 35281.9962 344347.4363 46503.1227 18 395898.6 377131.1633 363080.0202 494713.6147 20 391429.0016 372867.0855 363918.27			170910.054			
6 242929 231198.084 225649.33 304572.29 7 263994 251294.094 245265.0357 330756.085 8 285059 271390.104 264376.7415 356939.88 9 306124 291486.114 284490.4473 383123.675 10 327189 311582.124 304104.153 409307.47 11 290393.4 276479.1216 209843.6227 363570.5392 12 313564.9 298584.7326 291418.699 392372.7137 13 336736.4 320690.3436 31293.7754 421174.8822 14 359907.9 342795.9546 334568.817 44997.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 43148.8308 17 370410.04 352814.9962 3444347.4363 463031.2227 18 395898.69 37131.1683 366808.022 449413.6147 20 391429.0016 372847.0855 36	4	200799	191006.064	186421.9185	252204.7	
7 263994 251294.094 245263.0357 330756.085 8 285059 271390.104 264876.7415 356939.88 9 306124 291486.114 284490.4473 383123.675 10 327189 311582.124 304104.153 409307.47 11 290393.4 276479.1216 206843.6227 36370.5392 12 313564 320690.3436 312933.7754 421174.8882 14 35907.9 342795.9546 334688.517 449977.0627 15 319432.74 3041182.652 296882.2683 399666.4388 16 344921.39 32849.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344347.4363 463031.2277 18 39588.69 377131.1683 360800.020 49471.3 6147 20 391429.0016 372867.0855 363918.2755 489157.792 21 41797.1976 388155.9045 384600.1628 522107.4796 22 385720.1978 367420.8867	5				278388.495	
8 28509 271390.104 264876.7415 356939.88 9 306124 291486.114 284490.4473 383123.675 10 327189 311582.124 304104.153 409307.47 11 290393.4 276479.1216 269843.6227 363570.5392 12 3135614 220609.3436 312993.7754 421174.8882 14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 32849.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 360800.0202 499413.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391432.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 52107.4796 22 385720.1978 367420.8	6	242929		225649.33	304572.29	
9 306124 291486.114 284490.4473 383123.675 10 327189 311582.124 304104.153 409307.47 11 290393.4 276479.1216 2069843.6227 363570.5392 12 313564.9 298584.7326 291418.699 392372.7137 13 336736.4 320600.3436 312993.7754 421174.8882 14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344437.4363 46301.2227 18 395898.69 377131.1683 368080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155 9453 384271.9483 516329.424 24 40827.1978 </th <td>7</td> <td>263994</td> <td>251294.094</td> <td>245263.0357</td> <td>330756.085</td> <td></td>	7	263994	251294.094	245263.0357	330756.085	
10 327189 311582.124 304104.153 409307.47 11 200393.4 276479.1216 269843.6227 363570.5392 12 313564 298584.7326 291418.699 392237.2137 13 336736.4 320690.3436 312993.7754 421174.8882 14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 3444347.4363 463031.2227 18 395898.69 377131.1683 366080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 38572.0178 46720.8867 388602.1784 48206.17489 23 413288.7217	8	285059		264876.7415	356939.88	
11 290393.4 276479.1216 269843.6227 363570.5392 12 313564.9 298584.7326 291418.699 392372.7137 13 33676.4 320609.3436 312993.7754 421174.8882 14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 441348.8308 17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 366800.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.711 3973721.2585 384271.9483 516329.424 24 440857.2455 </th <td>9</td> <td>306124</td> <td>291486.114</td> <td>284490.4473</td> <td>383123.675</td> <td></td>	9	306124	291486.114	284490.4473	383123.675	
12 313564.9 298584.7326 291418.699 392372.7137 13 336736.4 320690.3436 312993.7754 421174.882 14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344437.4363 463031.2227 18 395898.69 377131.1683 366080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388602.7854 482061.7489 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 393721.2855 384271.9483 516329.442 24 440857.2455 420021.6302 409941.111 550597.0992 25 470731.5657	10	327189	311582.124	304104.153	409307.47	
13 336736.4 320690.3436 312993.7754 421174.8882 14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 366800.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456028.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 393721.2585 384271.9483 516329.424 24 440857.2455 420021.6302 409941.111 550597.0992 25 407351.5657 388057.2117 378743.886 508494.9392 26 436022.	11	290393.4	276479.1216	269843.6227	363570.5392	
14 359907.9 342795.9546 334568.8517 449977.0627 15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 368080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391422.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 393721.2585 384271.9483 516329.424 24 440857.2455 420021.6302 40941.1111 55057.0992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.8305 415409.5983 405439.768 544587.9213 27 46464	12	313564.9	298584.7326	291418.699	392372.7137	
15 319432.74 304182.652 296882.2683 399666.4388 16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 366080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 393721.2585 384271.9483 516329.424 24 440857.2455 420021.6302 409941.1111 55057.0992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.805 415409.5983 405439.768 544587.9213 27 464694.0953 442761.9849 432135.6973 580226.3035 28 42	13	336736.4	320690.3436	312993.7754	421174.8882	
16 344921.39 328498.8241 320614.8523 431348.8308 17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 366080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 39371.2585 384271.9483 516329.424 24 440857.2455 420021.6302 409941.1111 55097.0992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.8305 415409.5983 405439.768 544587.9213 27 46694.0953 442761.9849 432135.6973 580226.3035 28 429848.1984 409518.9897 399690.5339 5369128.411 29	14	359907.9	342795.9546	334568.8517	449977.0627	
17 370410.04 352814.9962 344347.4363 463031.2227 18 395898.69 377131.1683 368080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 23 413288.7217 393721.2585 384271.9483 516329.424 24 440857.2455 40021.6302 409941.1111 550597.0992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.8305 415409.5983 405439.768 544587.9213 27 464694.0953 442761.9849 432135.6973 580226.3035 28 429848.1884 409518.9897 399690.5339 536912.8411 29 459666.3038 437965.4718 421457.0971 565994.6751 31 453244.6759 431839.2388 421475.0971 565994.6751 32	15	319432.74	304182.652	296882.2683	399666.4388	
18 395898.69 377131.1683 368080.0202 494713.6147 19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 393721.2585 384271.9483 516329.424 24 440857.2455 420021.6302 409941.1111 550597.0992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.8305 415409.5983 405439.768 544587.9213 27 464694.0953 442761.9849 432135.6973 580226.3035 28 429848.1884 409518.9897 399690.5339 536912.8411 29 459666.3038 437965.4718 427454.3005 573976.7586 30 48944.4191 466411.9539 455218.067 611040.676 31	16	344921.39	328498.8241	320614.8523	431348.8308	
19 364920.8056 347578.2665 339236.3881 456208.1044 20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.721 393721.2585 384271.9483 516329.424 24 440857.2455 420021.6302 409941.1111 550597.0992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.8305 415409.5983 405439.768 544587.9213 27 464694.0953 442761.9849 432135.6973 580226.3035 28 429848.1884 409518.9897 399690.5339 536912.8411 29 459666.3038 437965.4718 427454.3005 573976.7586 30 489484.4191 466411.9539 455218.067 611040.676 31 45324.6159 431839.2388 421475.0971 565994.6751 32	17	370410.04	352814.9962	344347.4363	463031.2227	
20 391429.0016 372867.0855 363918.2755 489157.792 21 417937.1976 398155.9045 388600.1628 522107.4796 22 385720.1978 367420.8867 358602.7854 482061.7489 23 413288.7217 393721.2585 384271.9483 516329.424 24 440857.2455 420021.6302 409941.1111 550570.9992 25 407351.5657 388057.2117 378743.8386 508949.5392 26 436022.8305 415409.5983 405439.768 544587.9213 27 464694.0953 442761.9849 432135.6973 580226.3035 28 429848.1884 409518.9897 399605.339 536912.8411 29 459666.3038 437965.4718 427454.3005 573976.7586 30 489484.4191 466411.9539 455218.067 611040.676 31 453244.6759 431839.2388 421475.0971 565994.6751 32 484255.5159 401423.5802 450349.4142 604541.1493 33	18	395898.69	377131.1683	368080.0202	494713.6147	
21417937.1976398155.9045388600.1628522107.479622385720.1978367420.8867358602.7854482061.748923413288.7217393721.2585384271.9483516329.42424440857.2455420021.6302409941.1111550597.099225407351.5657388057.2117378743.8386508949.539226436022.8305415409.5983406439.768544587.921327464694.0953442761.9849432135.6973580226.303528429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675133515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.332663328.115636536423.9884511192.3029498923.6877669386.500639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.507953757.8451557157.2568747126.884442598966.4855570857.84515571461.6218739523.357545629127.704959963.1.6485585240.4889784617.280246627359.685459794.	19	364920.8056	347578.2665	339236.3881	456208.1044	
21417937.1976398155.9045388600.1628522107.479622385720.1978367420.8867358602.7854482061.748923413288.7217393721.2585384271.9483516329.42424440857.2455420021.6302409941.1111550597.099225407351.5657388057.2117378743.8386508949.539226436022.8305415409.5983406439.768544587.921327464694.0953442761.9849432135.6973580226.303528429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675133515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.332663328.115636536423.9884511192.3029498923.6877669386.500639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.507953757.8451557157.2568747126.884442598966.4855570857.84515571461.6218739523.357545629127.704959963.1.6485585240.4889784617.280246627359.685459794.	20	391429.0016	372867.0855	363918.2755	489157.792	
23413288.7217393721.2585384271.9483516329.42424440857.2455420021.6302409941.1111550597.099225407351.5657388057.2117378743.8386508949.539226436022.8305415409.5983405439.768544587.921327464694.0953442761.9849432135.6973580226.303528429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.01294774603.3262636328.115636542079.5701516587.7279504189.6224676416.44873750282.6639479193.8793467693.262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.	21	417937.1976	398155.9045	388600.1628	522107.4796	
24440857.2455420021.6302409941.1111550597.099225407351.5657388057.2117378743.8386508949.539226436022.8305415409.5983405439.768544587.921327464694.0953442761.9849432135.6973580226.303528429848.1884409518.989739960.5339536912.841129459666.3038437965.4718427454.3005573976.75863048948.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129476163.326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639471193.8793447693.2262627644.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.34344259896.64855570857.8451557157.2568747126.884443556571.1116530412.6585511662.7547694429.43484459896.64855570857.8	22	385720.1978	367420.8867	358602.7854	482061.7489	
25407351.5657388057.2117378743.8386508949.539226436022.8305415409.5983405439.768544587.921327464694.0953442761.9849432135.6973580226.303528429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.75863048948.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.56063956965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.507953757.8451557157.2568747126.88444259896.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.408356502.1535551461.6218739523.357545629127.7049599631.648	23	413288.7217	393721.2585	384271.9483	516329.424	
26436022.8305415409.5983405439.768544587.921327464694.0953442761.9849432135.6973580226.303528429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.33442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944	24	440857.2455	420021.6302	409941.1111	550597.0992	
27464694.0953442761.9849432135.6973580226.303528429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.33442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.408356502.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	25	407351.5657	388057.2117	378743.8386	508949.5392	
28429848.1884409518.9897399690.5339536912.841129459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	26	436022.8305	415409.5983	405439.768	544587.9213	
29459666.3038437965.4718427454.3005573976.758630489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.34344259896.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	27	464694.0953	442761.9849	432135.6973	580226.3035	
30489484.4191466411.9539455218.067611040.67631453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	28	429848.1884	409518.9897	399690.5339	536912.8411	
31453244.6759431839.2388421475.0971565994.675132484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	29	459666.3038	437965.4718	427454.3005	573976.7586	
32484255.5159461423.5802450349.4142604541.149333515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	30	489484.4191	466411.9539	455218.067	611040.676	
33515266.3559491007.9215479223.7314643087.623434477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	31	453244.6759	431839.2388	421475.0971	565994.6751	
34477577.0229455052.2979444131.0427596239.782535509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	32	484255.5159	461423.5802	450349.4142	604541.1493	
35509828.2965485820.0129474160.3326636328.115636542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	33	515266.3559	491007.9215	479223.7314	643087.6234	
36542079.5701516587.7279504189.6224676416.448737502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	34	477577.0229	455052.2979	444131.0427	596239.7825	
37502882.6639479193.8793467693.2262627694.694238536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	35	509828.2965	485820.0129	474160.3326	636328.1156	
38536423.9884511192.3029498923.6877669386.560639569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	36	542079.5701		504189.6224	676416.4487	
39569965.3129543190.7265530154.1491711078.42740529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	37	502882.6639	479193.8793	467693.2262	627694.6942	
40529200.5304504301.124492197.897660407.802341564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	38	536423.9884	511192.3029	498923.6877	669386.5606	
41564083.5079537579.4846524677.5769703767.343442598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319	39	569965.3129	543190.7265	530154.1491	711078.427	
42598966.4855570857.8451557157.2568747126.884443556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319						
43556571.1116530412.6585517682.7547694429.434844592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319						
44592849.4083565022.1535551461.6218739523.357545629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319						
45629127.7049599631.6485585240.4889784617.280246627359.6854597944.9578583594.2788782419.6319						
46 627359.6854 597944.9578 583594.2788 782419.6319	44		565022.1535		739523.3575	
	45					
	47	583415.2498	556021.9663	542677.4391	727796.6985	
48 621019.0996 591896.039 577690.534 774538.2837						
49 632748.7933 603086.1668 588612.0988 789118.2931						
50 587046.5803 559486.2556 546058.5855 732310.4424						
51 626154.5841 596795.2912 582472.2042 780921.691						
52 665262.5879 634104.3268 618885.823 829532.9397						
53 663356.6628 632286.0743 617111.2085 827163.8749						
54 615984.5613 587093.0894 573002.8553 768280.3527	54	615984.5613	587093.0894	573002.8553	768280.3527	

Shahandasht and Shavandi, 2012

55	656521.5113	625765.3398	610746.9716	818667.7816	
56	669166.1212	637828.2976	622520.4185	834385.0317	
57	619899.1356	590827.5934	576647.7311	773146.1685	
58	662057.5637	631046.7337	615901.6121	825549.0946	
59	704215.9917	671265.8741	655155.4931	877952.0207	
60	702161.4045	669305.7979	653242.4588	875398.1688	
61	651094.279	620587.7602	605693.654	811921.7318	
62	694793.1112	662276.4461	646381.8114	866239.3802	
63	708424.0007	675280.3146	659073.5871	883182.5758	
64	655314.1902	624613.5554	609622.8301	817167.0814	
65	732025.1316	697795.7936	681048.6945	912518.7816	
66	777471.9171	741152.0269	723364.3782	969009.1359	
67	775257.0721	739039.0647	721302.1272	966256.0836	
68	720206.7108	686521.0201	670044.5156	897828.4845	
69	767314.0519	731461.4235	713906.3493	956382.9095	
70	782008.1507	745479.5938	727588.0835	974647.6743	
71	724755.775	690860.8274	674280.1675	903482.9713	
72	807450.1699	769751.2801	751277.2494	1006272.104	
73	856441.8046	816489.2996	796893.5564	1067168.706	
74	769938.3945	733965.0463	716349.8852	959644.9673	
75	716099.1412	682602.3987	666219.9411	892722.7755	
76	762170.1207	726554.1132	709116.8145	949989.0031	
77	776540.9494	740263.8837	722497.5505	967851.9431	
78	720548.126	686846.7302	670362.4086	898252.8636	
79	801423.2442	764001.5929	745665.5547	998780.6355	
80	849337.0629	809711.376	790278.303	1058337.512	

In table 5, we show forecasting of three methods with comparative with actual demand. Results indicate that ANFIS method is the best model for forecasting of demand.

Conclusion

Supply chain is the processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user companies; and the functions within and outside a company that enable the value chain to make products and provide services to the customer.

The aim of this paper is introduce a new model as modulation both of fuzzy logic and Neural Network for forecasting supply chain demand of Kaleh Production. This paper has forecasted demand by using three methods of ANFIS, FSOM and Neural Network. We have used MSE, MAD and MAPE for assessment of forecasting models. Results indicate that the ANFIS model with modulation both of fuzzy logic and Neural Network has a better performance in forecasting demand rather than other models.

REFERENCES

- 1. Cox, J.F., Blackstone, J.H., Spencer, M.S., (1995). APICS Dictionary, American Production and Inventory Control Society, Falls Church, VA.
- 2. Ellram, L., Cooper, M., (1993). Characteristics of supply chain management and the implications for purchasing and logistics strategy", International Journal of Logistics Management, 4, 2, 1-10.
- 3. Lummus, R.R., Alber, K.L., (1997). Supply Chain Management: Balancing the Supply Chain with Customer Demand, the Educational and Resource Foundation of APICS, Falls Church, VA.
- 4. Monczka, R.M., Morgan, J., (1997). "What's wrong with supply chain management?", Purchasing, 122, 1, 69-73.
- 5. Mullin, T., (1994). A new frontier, Stores, 76, 7, 10.
- 6. Quinn, F.J., (1997). What's the buzz?, Logistics Management, 36, 2, 43-7.
- 7. The Supply Chain Council, (1997). http://www.supply-chain.com/info/faq.html.
- Wongn, W.K. Z.X.Guo. (2011) A hybrid intelligent model for medium-term sales forecasting in fashion retail supply chains using extreme learning machine and harmony search algorithm. Int. J.ProductionEconomics128, 614–624.
- 9. Wanga, Jui-Lin, Ju-Hsiu Kuo, Shih-yu Chou, Sheng-Zhi Wang (2011). A comparison of bullwhip effect in a single-stage supply chain for auto correlated demands when using Correct, MA, and EWMA methods. Expert Systems with Applications 37, 4726–4736.