Research Article

Modeling Customer KM Using Neural Networks

Massoud Moballegh[a], Nasser Safaei[b]

[a] MS Graduate, Industrial Engineering - Large Scale Modelling Systems, K. N. Toosi University of Technology, Industrial Engineering Faculty, Masoud.mobalegh@yahoo.com
[b] Assistant Professor, Industrial Engineering - Large Scale Modelling Systems, K. N. Toosi University of Technology, Industrial Engineering Faculty, safaie@kntu.ac.ir

Article History: Received: 14 July 2020; Accepted: 2 January 2021; Published online: 5 February 2021

Abstract: The purpose of this study is to model customer knowledge using artificial neural network. In terms of purpose, this research is an application that has been keyed by using a sample of 60 out of 70 organizations based on information technology in Tehran. Inputs were used for the parameters of organizational structure and process, human resources, communication and interaction, knowledge, customer, management, technology and infrastructure of information technology and organizational strategy, 36 neurons in the middle layer and one neuron in the output layer for the parameter of customer knowledge. The output of the neural network showed that the customer's knowledge was very accurately predicted by the neural network. Predicted values for customer knowledge had a mean square error of MSE = 0.015 compared to experimental values and in the test phase, the degree of conformity of the results obtained from the model with their actual value had a high correlation (R = 0.90512). This indicates the fact that the model produced through artificial neural network has the ability to predict the effectiveness of customer knowledge management in the organization, based on how to implement the effective factors in customer knowledge management.

Keywords: knowledge management, customer relationship management, customer knowledge management, artificial neural network

Introduction

Nowadays, knowledge is a key factor in management and economics, and besides intraorganizational knowledge, special attention has to be paid to the environment and potential knowledge in it to be successful in the market. Customers have a valuable source of knowledge needed by the organizations and this KM is called customer KM (CKM). CKM enables any organization to be more likely to identify opportunities in the market and increase its competitive advantage. Hence, it is not surprising that many companies spend a lot of money on CRM programs to use the knowledge and experience of customers for the organization's purposes and to fully cover customer needs (Tabanifar, 2012).

Thus, acquiring knowledge through customers can be a new perspective towards the concept of CKM. CKM designers tried to use the existing platform in organizations - customer relationship management (CRM) (Homayouni et al., 2006). CKM programs organize KM processes and systems so that all the basic and sub-knowledge is easily accessible in the needed fields and thus bring about value-added for the organization. Knowledge management (KM) brings about some tools, processes, and contexts for the staff to share knowledge according to customer needs. With the help of KM, employees realize the value of customers' integrated knowledge and thus can provide more complete services to more valuable customers. Thus, KM acts as a tool in the CRM environment (Amir Salehi, 2012).

Some studies have been carried out in this regard. Li and Kuan (2017) studied a neural network approach for predicting production performance using KM metrics. The results indicate that the neural network model is essential as a reliable but simple tool to predict the production performance of the company by considering different qualitative indices. Network forecasting is in line with real data. Ultimately, the prediction model will be useful for experts to determine future KM strategies and goals to enhance production performance. Ansari and Riasi (2016) carried out a study entitled "Modeling and evaluating customer loyalty using neural networks: Evidence from startup insurance companies." The findings indicated that customer satisfaction and perceived value are important predictors of customer loyalty. Moreover, it was found that trust, perceived quality, and empathy have a significant effect on customer satisfaction and perceived value. Fang et al. (2014) studied factor-based modeling and neural networks to meet the demand of residential customers. The findings indicated that each method has some advantages and disadvantages varying based on the application scenarios.

It has to be noted that CKM in management discussions, especially in Iran, is a relatively new and innovative issue in need of special attention given its significance and many benefits for organizations (Akhavan and Heidari, 2007). Due to the synergy from the integration of KM and CRM, the organization will manage to identify the needs of its customers and predict their behavior and thus will focus more on continuous innovation and development of new products and services and subsequently lead to enhanced organizational performance (Haji Karimi and Mansourian, 2012). On the other hand, there is currently no framework that shows the four-way interactions of electronic CRM systems, types of customer knowledge, knowledge creation processes, and social media. Thus, designing a model and scientific and basic theoretical framework for assessing the maturity of organizations is essential (Akhavan and Zare Moghadam, 2010). Considering the significance of CKM and that that many organizations in the country (Iran) are unaware of it, the study tried to plan a model for CKM using the neural network method.

Theoretical foundations

Knowledge management

Knowledge is rooted in information and information is in data. Knowledge is an organized combination of data obtained through rules, processes, practices, and experience. In other words, knowledge is a meaning and concept that has emerged from thought, without which it is considered information and data. It is only through this concept that information comes to life and turns into knowledge. Knowledge is created and used in the mind of the scientist. Knowledge in organizations is embodied not only in documents and knowledge stores but also in work procedures, organizational processes, practices, and norms. When information is analyzed to reveal hidden patterns and tendencies, it becomes knowledge (Zahedi and Najjari, 2006).

Probst et al. (2002) suggested a model called the “KM building foundation model.” They consider KM as a dynamic cycle that is always in rotation. The steps of this model include eight components, consisting of two cycles; Internal and external. The internal cycle is made by blocks - discovery, acquisition, development, sharing, application, exploitation, and maintenance of knowledge. The external cycle includes blocks of knowledge goals and its evaluation that the management cycle knowledge shows that it completes these two cycles of feedback (Probst et al., 2002). Japanese management researchers, Nonaka and Takuchi have had a great effect on the foundations of KM. The concept of implicit knowledge and tacit knowledge has been introduced by Nonaka to design organizational learning theory. In this classification, given the convergence between the implicit and tacit forms of knowledge, they have established a model that is known by their name. Unlike previous models, this one focuses on two types of explicit and tacit knowledge, focusing on how they are transformed into each other and how it is created at all levels of individual, group, and organizational (Nonaka and Takuchi, 1995).

The culture of knowledge sharing should be encouraged as the first element in knowledge sharing success. The commitment and support of the senior managers of the organization to design a proper executive structure as well as the support for the knowledge project is the second success factor. The recruitment and engagement of expert and professional individuals in the organizational activities and using the expertise in KM projects could be effective in their success. The prerequisite to having skillful people is training them. Knowledge staff makes more effort in this regard for the successful implementation of KM. The organization could make trial and error with effective and experienced teams and share tasks among the staff. Empowering the individuals could enable the individuals to take steps to solve some problems. The seventh factor is the existence of the technical infrastructure to implement KM. As the eighth factor, performance evaluation shows the accuracy of the KM implementation. Benchmarking helps the successful implementation of the project by evaluating the implementation of KM and modeling the most successful organizations. Finally, the existence of organizational knowledge structure has been emphasized in the successful implementation of KM, removal of traditional systems, and the application of flexible systems.

Customer relation management

Customer relation management (CRM) is not a new concept in marketing but is based on three aspects of marketing management: customer orientation, relationship marketing, and database marketing. Indeed, CRM is a strategy and not a solution and can create many competitive advantages if implemented in a participatory environment (Khorramabadi and Hedayati, 2010).

CRM refers to a method assisting the organization so that it can systematically manage its relations with customers. One of the simple examples of CRM is a data bank with information related to the customers of an organization using which the management and the sales or service staff of the organization could in line the needs of the customers with their products, remind them of their service needs and so on. Regardless of these simple definitions, one has to know that CRM is a strategy that has been implemented with the help of technology. CRM is not merely a software tool that enables you to do your job more easily, rather it is a philosophy that tries to create a strategy that integrates all the components of an organization, shares all the information among all the staff, and prevents the useless repetition of the tasks. In this philosophy, it creates a space in the organization where the information is shared and when needed is given to the individuals - all the staff and everything are interconnected and the exit of an individual from the organization does not demolish the organization (Mahmoudi et al., 2016).

Indeed, CRM is all the processes and technologies that an organization uses to identify, select, persuade, expand, retain and serve the customer. CRM enables managers to use customer knowledge to increase sales, service, and development and increase the profitability of ongoing relationships (Niknia, 2007).

Customer knowledge management

Customer knowledge managers are more interested in customer knowledge than knowledge about the customer. Therefore, the leading companies have combined knowledge-seeking through direct customer relationships with knowledge-seeking through their sales representatives. CKM varies from traditional KM in the goals they pursue. Traditional KM tries to reach efficiency while CKM looks for innovation and growth. CKM looks for opportunities to engage its customers as partners in creating value for the organization. A famous proverb in the world of CRM states that customer retention is far better than gaining a new one, yet unfortunately in today's world, where competitors can quickly imitate, customer retention is very difficult. Hence, fewer customer knowledge managers face customer retention figures. Instead, they have to concentrate on how to grow and collaborate between the new customer and the company in an active environment (Gibbert et al., 2002).

As a characteristic, customer knowledge managers are more interested in customer knowledge than knowledge about the customer. In other words, smart organizations have figured out that the customers are more aware than the staff they look for knowledge from among the direct interaction with the customer and query about the customers from the sales agents.

Likewise, common knowledge managers focus on the efforts to change staff from collectors of knowledge to those who share it. This is usually implemented by knowledge-sharing maps based on the internet (Salomann et al., 2005).

The specific focus of customer knowledge is on encouraging and strengthening the constructive and participatory relations in line with the slogan “If just we knew what we know, CRM suggests another aspect; if we just knew what customers want.” However, why do the customers want to share their knowledge to create value for the company and then pay for their knowledge that is expanded in the products and services of the company? This is because of the change towards the customers as the knowledge base. This attitude change has a great meaning. Most importantly, the customer is freed from the passive receptor of products and services in the traditional KM. Moreover, the customer is freed from captivity in the chain of the common customer loyalty program in CRM (Gibert et al., 2002).

CKM differs in the pursuit of goals from traditional KM. As KM looks for efficiency and profitability (avoiding the re-invention of the wheel), CKM is in line with innovation and progress. Customer knowledge managers look for opportunities to partner with customers as co-builders of the organization's value, together and consistent. This can be seen compared to the desire to maintain and cultivate the existing customer position in CRM. Remember the famous proverb of CRM that says "retaining a customer is cheaper than finding it." Unfortunately, in a time when competitors' products, usually imitations, are only a few clicks away from the customer, customer retention becomes extremely difficult. Thus, customer knowledge managers are less concerned with customer retention. Instead, they focus on how the organization develops and thrives by gaining new customers and engaging in active and value-added dialogue with them (Davenport and Glaser, 2002).

Neural network

Artificial neural networks (ANNs), shown great value in many applications today, are based on the biological model of the animal brain. These networks are an information data processing system with special executive properties similar to animal neural networks that have emerged from the generalization of their mathematical models (Kevin, 1999).

Neural networks can solve problems difficult to simulate with common software standards. This technique can provide a logical answer when the data is in conditions of uncertainty, whether the data is fuzzy or received incompletely and with noise. Furthermore, they contain high processing speeds because of technical advances. Neural calculators are very flexible when conditions change. They are very easy to maintain too (Zhang, 2002).

Moradian (2016) studied the possibility of implementing KM in the Court of Audit using a neural network. In a study on the presentation of the social CKM model in e-service organizations, Rezaei Nour and Lak (2015) stated that the social CKM model has six main aspects - causal conditions, main phenomenon, strategies, outcome, governing context, and the intervening conditions - and the factors affecting this model based on the concepts of KM, knowledge flow, CKM, electronic CRM, and social media.

As Figure (1) shows, the conceptual model of the research is taken from 8 inputs, 36 middle layer neurons, and one output neuron with all the relationships of each variable and neurons with each other shown in the figure.

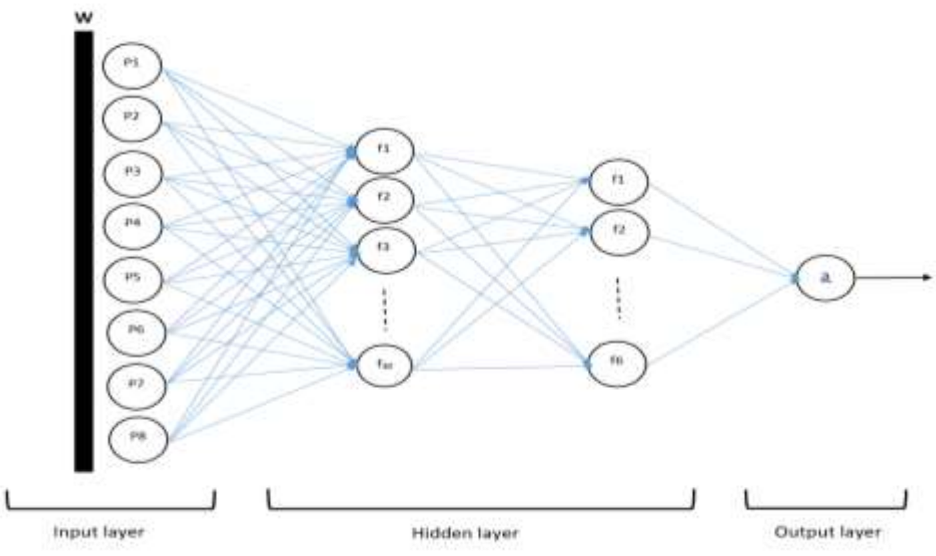

Figure 1. Conceptual model

Methods

The study was applied in terms of purpose, descriptive-analytical in terms of the method based on the scientific method, and non-field and library in terms of data collection. The study method can be divided into several basic steps. In the first stage, by examining the background and research-related studies, effective inputs on CKM consisting of eight factors were identified. After selecting inputs and outputs (CKM), raw data and the information needed were obtained from statistics and archived information in information technology-based organizations. In the next step, the problem was coded in MATLAB software and the results were obtained.

The population was information technology-based organizations in Tehran whose data were available. These companies were 70. The sample size was calculated as 60 using the Cochran formula.

In determining the input and output indices, it was tried to select the main and most effective factors on CKM to relatively and accurately evaluate the relative performance with a small number of factors. The variables used were divided into two general categories, including inputs (data or inputs) and outputs (outputs).

Inputs were organizational structure and process, human resources, communication and interaction, knowledge, customer, management, technology, and IT infrastructure, and organizational strategy. The output included CKM.

After determining the inputs and outputs of the study, we have used MATLAB software (7.10 V.2017a) to design the neural network and the associated calculations. In Table (1) the inputs and outputs of the present study are coded below for simplicity.

Table 1. Coding of the inputs and outputs

Input/ Output	Input								Output
	Structure, organizational process	human resources	Communication and interaction	Knowledge	Customer	Management		Organizational strategy	CKM
Relevant code	Ln1	Ln2	Ln3	Ln4	Ln5	Ln6	Relevant code	Ln8	Out1

The input data (independent variables) of the study are as described in Table (2).

Table 2. Input data

Input / Company	In1	In2	In3	In4	In5	In6	In7	In8
1	52	71	30	988	1743	988	71	7
2	440	426	255	1174	2274	1174	426	9
3	244	482	115	1029	2540	1029	482	10
4	771	3648	848	1292	3709	1292	3648	14
5	15	2743	187	1100	2282	1100	2743	8
6	90	6113	1031	1770	5684	1770	6113	24
7	34	263	11	1323	2229	1323	263	8
8	357	393	98	1123	2396	1123	393	10

9	243	1590	82	1424	4536	1424	1590	17
10	829	2354	645	3134	7501	3134	2354	29
11	264	1856	128	1288	4094	1288	1856	17
12	9	2150	14	1429	2525	1429	2150	9
13	475	586	173	839	2181	839	586	8
14	165	461	54	1143	3096	1143	461	11
15	752	34	0	721	1333	721	34	7
16	91	755	286	821	2450	821	755	9
17	198	524	78	928	2227	928	524	9
18	367	1010	292	1555	4707	1555	1010	19
19	70	1238	30	1345	2796	1345	1238	9
20	142	339	99	867	2642	867	339	10
21	535	316	165	812	1666	812	316	6
22	129	1142	142	962	2496	962	1142	9
23	25	758	142	2825	3924	2825	758	11
24	7364	239	53	1288	3358	1288	239	13
25	2872	41662	6404	5206	21211	2506	41662	95
26	4019	1344	498	3191	6410	3191	1344	23
27	1410	14343	1336	1741	5370	1714	14343	23
28	81	343	68	957	2838	975	343	11
29	4	48	0	821	1448	821	48	6
30	194	1137	216	1053	2964	1053	1137	11
31	58	16	51	109	1996	109	16	7
32	409	66	284	156	2636	156	66	11
39	442	97	276	169	5464	169	97	17
40	1023	227	776	364	9219	364	227	31
41	149	721	186	140	4674	140	721	15
42	9	277	18	155	3250	155	277	10
43	258	39	272	87	2501	87	39	9
44	180	41	103	114	3556	114	41	11
45	15	6	7	88	1712	88	6	6
46	447	155	285	89	2929	89	155	10
47	246	51	146	96	2723	96	51	10
48	406	125	431	184	5975	184	125	20
49	15	136	32	151	3200	151	136	9
50	231	41	170	100	3071	100	41	10

51	428	31	244	106	2452	106	31	10
52	154	102	120	97	3196	97	102	11
53	34	458	43	262	4614	262	458	11
54	213	28	105	148	3821	148	28	13
55	9075	3283	8052	547	25187	547	3283	86
56	906	148	596	242	6867	242	148	18
57	5386	3973	4102	179	7362	179	3973	24
58	148	39	93	101	3327	101	39	11
59	8	4	5	85	1692	85	4	7
60	408	179	328	186	3518	186	179	11

Table 3. Output data

Company	Output (target)	Company	Output (target)	Company	Output (target)
1	0.462	21	0.536	41	0.801
2	0.689	22	0.597	42	0.536
3	0.755	23	0.738	43	0.196
4	0.945	24	1	44	0.61
5	0.55	25	1	45	0.012
6	0.909	26	1	46	0.209
7	0.499	27	1	47	0.359
8	0.693	28	0.613	48	0.931
9	0.912	29	0.013	49	0.488
10	0.983	30	0.746	50	0.398
11	0.798	31	0.192	51	0.406
12	0.627	32	0.468	52	0.311
13	0.511	33	0.684	53	0.608
14	0.821	34	0.835	54	0.721
15	0.26	35	0.565	55	0.642
16	0.471	36	0.965	56	0.89
17	0.62	37	0.46	57	1
18	0.949	38	0.488	58	0.421
19	0.612	39	0.864	59	0.006
20	0.506	40	0.856	60	0.609

Results

Using ANNs, a model was presented that provides companies with very good information to organize and understand the customer management process by creating a relationship between the effective parameters in CKM. The first step in building a model for CKM is ANN architecture. The study used a three-layer perceptron neural network for modeling CKM with 8 neurons in the input layer for organizational structure and process parameters, human resources, communication and interaction, Knowledge, Customer, Management, IT technology and infrastructure, and the organization strategy of one neuron in the output layer to manage customer knowledge and 36 neurons in the middle layer (hidden) as feedforward algorithm.

A feedforward neural network has at least three layers - an input layer, a middle layer, and an output layer. The algorithm stops according to the initial stop method. The set of validations used in the initial stop method is unusually selected, finally, the training function occurs with predictive results based on minimizing the mean error of the criteria. In a complete cycle, the training process applies a set of input data to the input neuron. The goal output is CKM. The output signal is compared to the desired response or the target output, resulting in an error signal. At each stage of the iteration process, the error signal activates a control mechanism that applies a sequence of weight correction settings. Correction settings continue until the training data reaches the desired map and design to bring the target output as close as possible. After some iterations, the neural network is trained and weight is stored. Figure (2) indicates these steps.

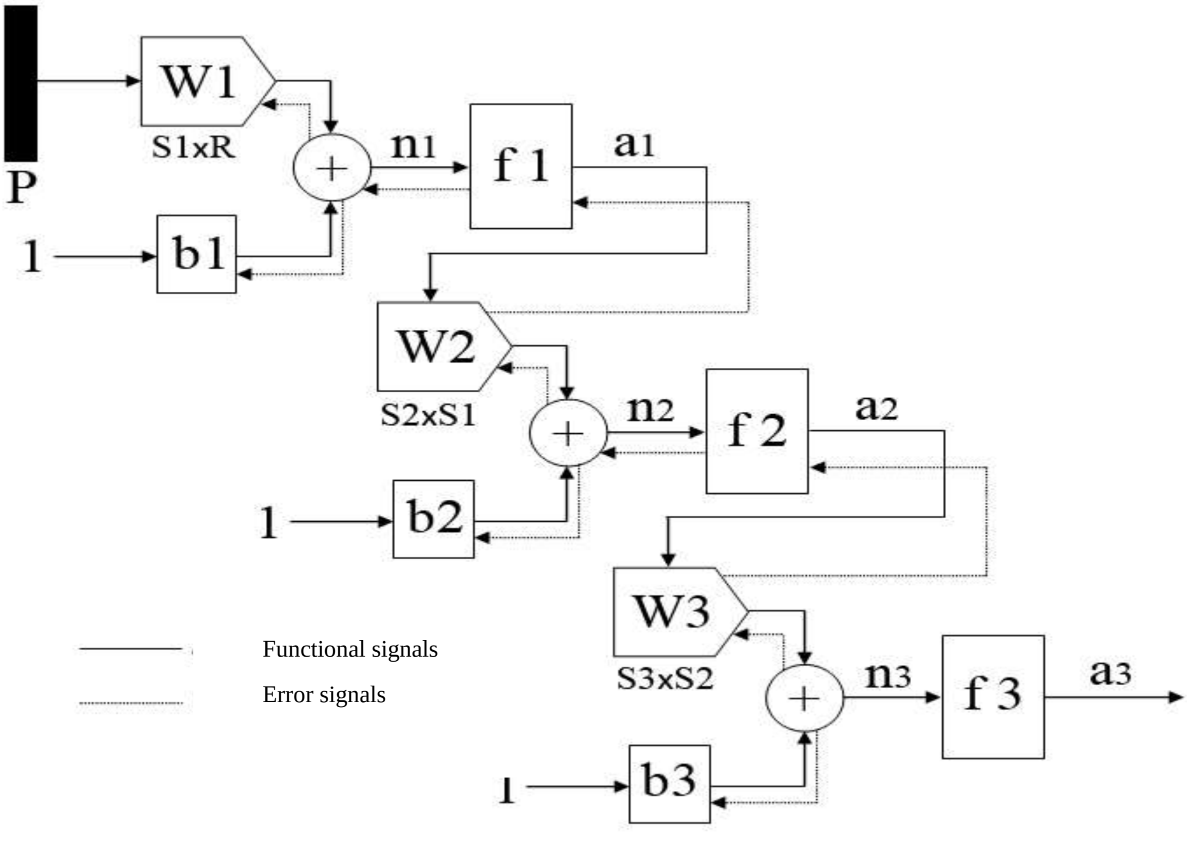

Figure 2. Three-layer perceptron network for predicting CKM

P: Network inputs

W: Data weight

B: Bias diagram (weight adjuster)

F: Stimulus diagrams

A: The problem output

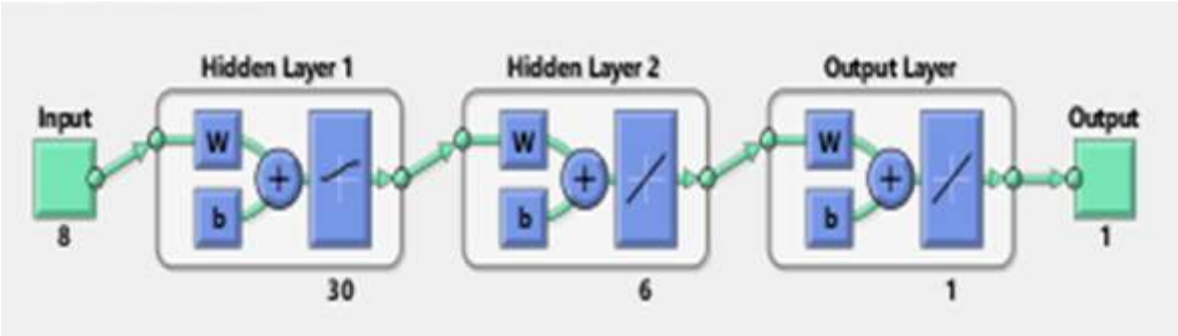

Figure 3. The structure of the neural network used in the study includes the number of layers and neurons

The proposed model of the study based on the general characteristics of the designed networks is shown in Figure (3). The model is based on an ANN system that includes several layers - one input layer, two hidden layers, and one output layer. The studies indicate that the number of neurons in the middle layer needs to be tested. Each suggested model needs selected values of input parameters that can be selected randomly and can be used to teach the model using the calculated outputs. Raw data was used for training to design the model, as their normalization makes the training process in sigmoid functions longer.

The number of middle layer neurons has been determined experimentally by considering the lowest Mean Squares Errors (MSE) for CKM value managed by the network relative to the experimental data. Figure (4) is the relationship between the number of neurons and MSE.

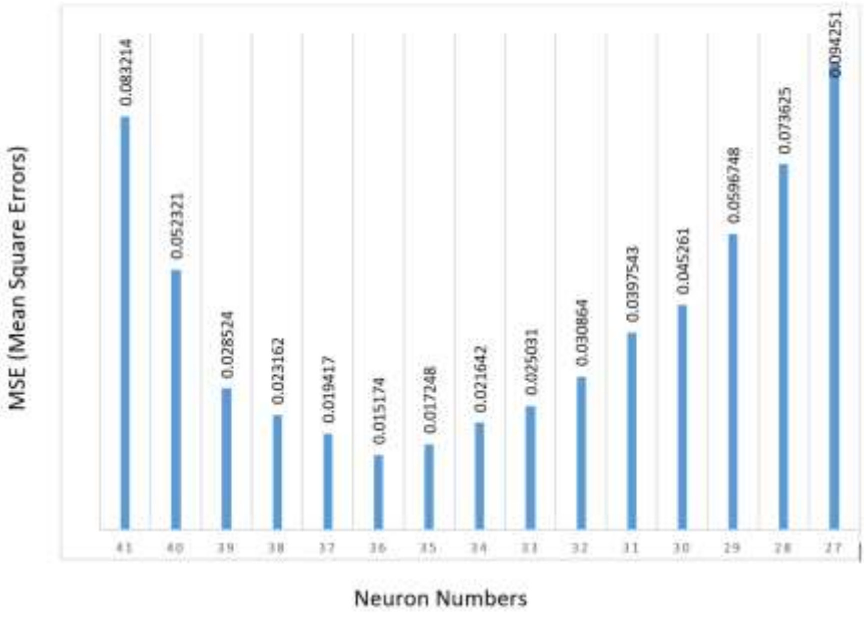

Figure 4. Determining the number of middle layer neurons

The findings indicated that a network with two hidden layers has a high performance in predicting CKM. Moreover, we tried to select the least number of neurons that provide the most function and the least amount of error for the network to find the best number of neurons in the hidden layer of the neural network.

According to Figure (4), if there are 36 neurons in the middle layer, the average squares of the network error is minimized, so the number of neurons in the middle layer 36 is considered. The network is feedforward and the Levenberg-Marquardt backpropagation algorithm is used to train it. Additionally, the sigmoid stimulus function is used for the neurons of this network, expressed as follows:

$$a = \frac{1}{1 + e^{-n}} \quad (1)$$

At the end of the learning phase, another set of experimental data with no involvement in network modeling and training was used as test data separately as network input and the predicted values for CKM were received from the network output. Then the predicted values for CKM were compared by the neural network with its experimental values and the corresponding graphs were plotted.

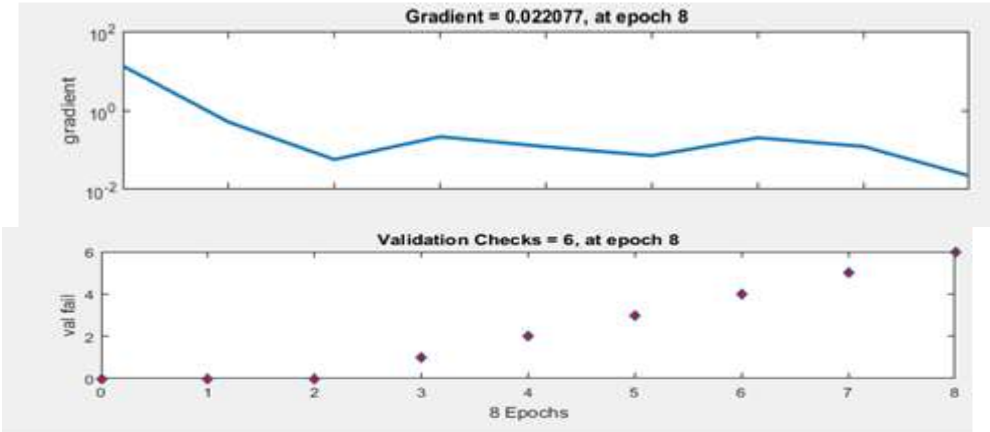

Figure 5. Network training status during the learning process

As can be seen from the graphs in Figure 5, CKM is predicted by the neural network in eight iterations. Moreover, the predicted values for CKM have a mean of MSE = 0.015 error squares compared to the experimental values and in the test phase, the degree of conformity of the model results with their actual value had a high correlation (R = 0.90512). This shows the high validity of the model. Eight iterations were considered to reduce errors and increase the accuracy in estimating the weight of the network and the predicted values for each stage of training, validation, and testing of the network. Statistical indices like correlation coefficient (R), mean square error (MSE), and the sum of squared error (SSE) were used to compare the performance of the proposed models.

Table 4. Predictive results of CKM by perceptron neural network

MSE	0.015
SSE	0.185
Regression (R)	0.90512

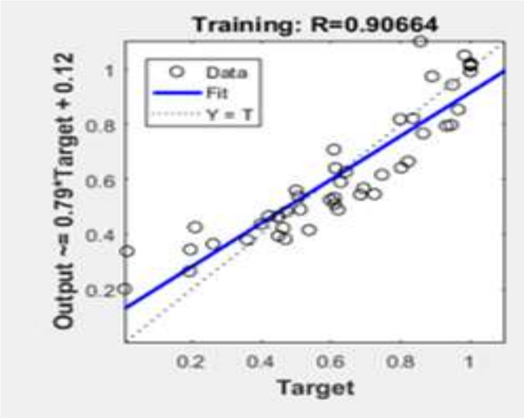

Figure 6. Regression of experimental data relative to data obtained from the neural network model in the training phase

Plotting the scattering curve of the predicted values of the models against the observed values and considering that the lower the scattering of the predicted data around the regression line indicates the high accuracy of the model in estimating the data, the data scattering predictions around the regression line are given in Figure (6). This figure greatly shows the efficiency of the selected neural network model. According to Figure (6) and the expectation from the selected network with regression of 0.90664 as the training outcome, the observed CKM has a very good similarity with the values predicted by the network.

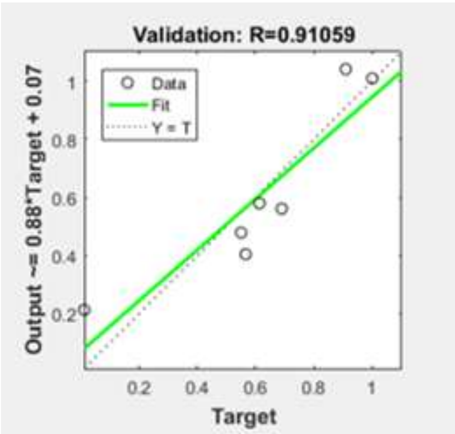

Figure 7. Regression of experimental data relative to data obtained from the neural network model in the validation stage

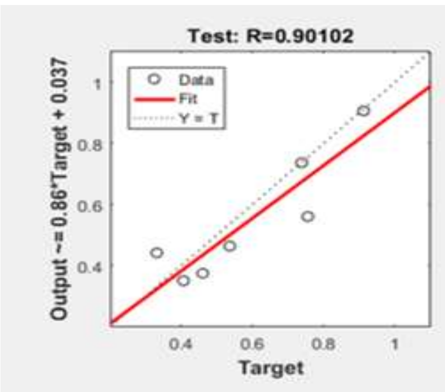

Figure 8. Regression of experimental data relative to the data obtained from the neural network model in the test phase

After determining the training data, the transfer function, the number of hidden layers, and the number of appropriate neurons, it is essential to assess the constructed network in terms of performance. Thus, 15% of the total data that were not previously randomly selected and used for network testing were used to evaluate the network. Based on Figure (9), the proposed network in the study has a strong correlation (R = 0.90512).

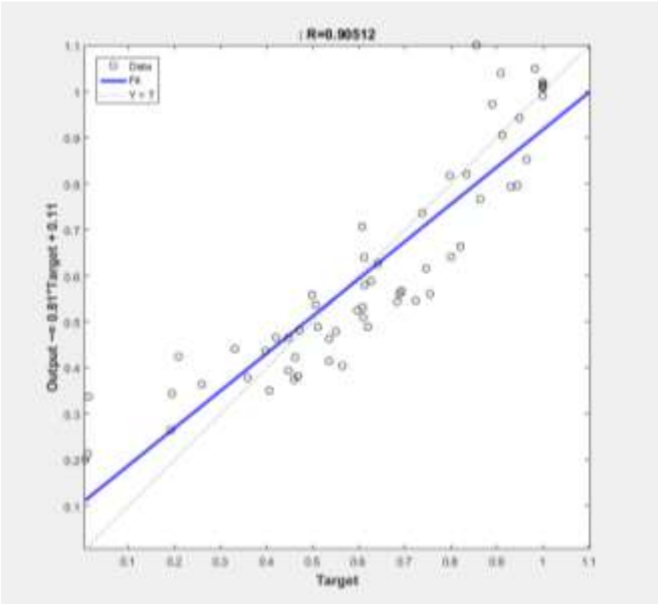

Figure 9. Comparison of all the experimental data with the data obtained from the neural network model

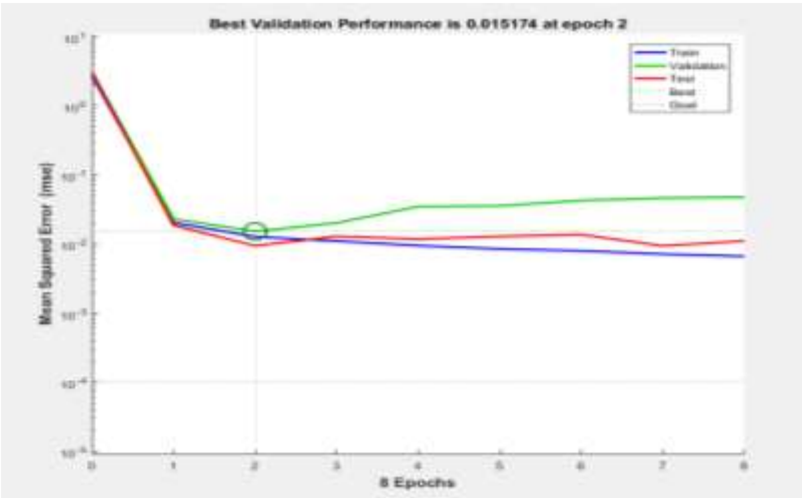

Figure 11. Performance of experimental data used in research including MSE in terms of number of iterations of the algorithm

As the figures indicate, the output of the neural network model in all stages of training, validation, and testing has a high correlation with real data and one can strongly state that the model produced based on the neural network algorithm can show the result of implementing CKM in the organization with acceptable accuracy.

Conclusion

Knowledge is seen as a critical competitive factor in the global economy, yet another key component called the customer has to be considered for a successful presence in today's dynamic market. CKM makes the organizations able to be more likely to identify market opportunities and increase their competitive advantage. CKM has to do with acquiring, sharing, and expanding customer knowledge and mutual benefit between customers and the organization.

Accurate expression of CKM model and parameters affecting it such as organizational structure and process, human resources, communication and interaction, knowledge, customer, management, IT technology and infrastructure, and the organization's strategy is an important step in modeling customer management and determining an appropriate strategy for analyzing the great information acquired from customers via the CRM system.

The study used a three-layer perceptron neural network for modeling CKM with 8 neurons in the input layer for organizational structure and process parameters, human resources, communication and interaction, Knowledge, Customer, Management, IT technology and infrastructure, and the organization strategy of one neuron in the output layer to manage customer knowledge and 36 neurons in the middle layer (hidden) as feedforward algorithm. The output of the neural network showed that the neural network has accurately predicted CKM. The values predicted for CKM have an MSE = 0.015 compared to the experimental values and in the test phase, the degree of conformity of the results obtained from the model with their actual value had a high correlation (R = 0.90512) showing the validity of the model.

In its practice, the study revealed that using ANNs can provide a good approach in predicting the results of management processes, and the output of the process could be well predicted with this technique before it is practically examined. This can have significant effects on process management and reduce costs associated with it and can bring about an overview of the process examined and judgment of the researcher before implementation.

CKM system is proposed as the main research tool based on the results of designing a comprehensive program for recording, recording, and digesting data of organizations, and on the other hand managers and employees of organizations have to be mentally prepared to accept the new method of CKM and CRM.

References

1. Akhavan, Peyman and Heydari, Safanaz. (2007). CKM An Approach to Gaining Competitive Advantage. Journal of Tomorrow Management, Fifth Year, No. 18. pp. 24-40.
2. Akhavan, P., Zare Moghadam, Z., Barzinpour, F. (2010). Presenting a conceptual framework of factors and components of CKM in Bank Melli. Scientific and Research Journal of Tomorrow Management. Year 8, 24.
3. Amir Salehi, M. (2012). Identifying and evaluating the factors affecting the implementation of CKM. Master Thesis, Semnan University, Faculty of Economics and Administrative Sciences.
4. Tabanifar, B. (2012). The analysis of the relationship between KM and CRM Case study: Azaran Milk Gas Company. Master Thesis, Faculty of Management, University of Isfahan.
5. Haji Karimi, A.A., Mansourian, T. (2012). "Study and explanation of the role of CKM in improving organizational performance". Journal of Business Management Exploration, Volume 4, 8. pp. 75-92.
6. Heidari, M., Moghimi, S.M., Hanifar, H. (2013). "Examining the critical success factors in implementing KM ", Journal of Organizational Culture Management, Volume 11, 1, pp. 149-184.
7. Rezaei Nour, J., Lak, B. "Providing a model of social CKM in organizations providing electronic services". Journal of Resource Management in Law Enforcement, Volume 3, 3, pp. 17-47.
8. Zahedi, Sh.S., and Najjari, R. (2006) The benefits of human resources and management knowledge. Peike Nour, Year, 6, 1.

9. Mahmoudi, A., Henry, H., and Eslami, A. 2016. The role of CRM in the loyalty of the customers to recreational centers. Journal of Sports Management Studies, 36, pp. 189-208
10. Moradian, Z. (2016). "Studying the possibility of implementing KM in the Court of Audit using a neural network". Central Province Court of Accounts, http://zahramoradiyan.blog.ir.
11. Niknia, B. (2007). "CRM", Shoe Industry. Year 14, 118, pp. 52-54.
12. Homayouni, S.M., Mohtashami, E., Esfandiari, A.R. (2006). "CKM". International Marketing Management Conference.
13. Ansari, A., and Riasi, A. (2016) Modelling and Evaluating Customer Loyalty Using Neural Networks: Evidence from Startup Insurance Companies, *Future Business Journal*, (2); pp. 15-30.
14. Davenport, T.H., and Glaser, J. (2002) Just-In-Time delivery Comes to Knowledge Management. *Harvard Business Review*, 7 (80); pp. 107-111.
15. Fang, C., Lee, J., and Schilling, M. A. (2014) Agent-Based Modeling and Neural Network to Meet the Demand of Residential Customers, *Organization Science*, (21); pp. 625–642.
16. Gebbert, H., Geib M., Kolbe, L., and Brenner, W. (2003) Knowledge-Enabled Customer Relationship Management: Integrating Customer Relationship and Knowledge Management Concepts. *Journal of knowledge management*, 7(5); pp.107-123.
17. Li, Pin Tan., and Kuan, Yew Wang. (2017) A Neural Network Approach for Predicting Manufacturing Performance Using Knowledge Management Metrics, *Cybernetics and Systems Journal*, 48(4).
18. Salomann, H., Malte, D., Lutz, K., and Walter, B. (2005) Rejuvenating Customer Management: How to Make Knowledge for, From and About Customers Work, *European Management Journal*, 23 (4); pp. 392-403.
19. Zhang, W.J. (2002) An Artificial Neural Network Approach to Mechanism Kinematic Chain Isomorphism Identification, *Mechanism and Machine Theory* (37); pp. 549–551.