QUID 2017, pp. 509-519, Special Issue N°1- ISSN: 1692-343X, Medellín-Colombia

A MODEL FOR TECHNOLOGICAL LEARNING INTERACTION ON THE DEVELOPMENT OF NEW PRODUCT, IN STUDENT'S TABLET PRODUCTION BY FUZZY DEMATEL METHOD

(Recibido el 15-06-2017. Aprobado el 04-09-2017)

***Sorur* Sefidgar[1]**
[1]PhD student, Iran University of Science and Technology

***hamed* Firoozeh[2]**
[2]IT management graduate student at Azad University

***saeed* Shavalpor[3]**
[3]Assistant Professor, Department of Economic Advancement, Faculty of Engineering of Advancement, University of Science and Technology

RESUMEN: El aprendizaje es un factor clave para que las empresas alcancen velocidad y flexibilidad en términos de proceso de desarrollo de nuevos productos. Este estudio tiene como objetivo presentar un modelo para examinar la interacción entre el desarrollo tecnológico de nuevos productos, en la industria de producción de la tableta del estudiante por el método difuso DEMATEL. En primer lugar, mediante el estudio de la literatura y la encuesta de expertos, se han identificado indicadores de aprendizaje tecnológico. Y luego en una fase cuantitativa, utilizando técnicas difusas para clasificar e identificar los factores causales que se están investigando. Para ello, el punto de vista de expertos en educación se recopiló mediante cuestionarios y análisis a través de Excel y MATLAB. De acuerdo con los indicadores, incluidos en el modelo, 6 criterios que afectan más la interacción con otros factores y son prominentes, Respectivamente, son: conocimiento disponible, convertirse en productos de ideas inmaduras (básicos) y servicios al consumidor, redes de negocios y compartir experiencias, interacción multilateral Tecnologías en clusters industriales, mejora de procesos, innovación, aprendizaje de desbordamiento acumulado otras tecnologías.

PALABRAS CLAVE: Aprendizaje tecnológico, curva de aprendizaje, desarrollo de nuevos productos y tableta estudiantil DEMIZ

ABSTRACT: Learning is key enabler for companies to achieve speed and flexibility in terms of new product development process. This study aims to present a model for examining the interaction between technological development on new products, in production industry of student's tablet by fuzzy DEMATEL method. First, through the study of literature and experts survey, technological learning indicators have been identified. And then in a quantitative phase, using fuzzy techniques to rank and identify the causal factors being investigated. For this purpose, the education expert viewpoint collected by using questionnaires and analyzing via Excel and MATLAB. According to the indicators, included in the model ,6 criteria that affects more interaction with other factors, and are prominent, Respectively, are: available knowledge, becoming immature idea (basic) products and consumer services, business networking and sharing experiences, multilateral interaction technologies in industrial clusters, process improvement, innovation, learning overflow accumulated other technologies.
KEYWORDS: Technological learning, learning curve, new product development, and student tablet fuzzy DEMATEL

1. INTRODUCTION

Grabler (1998) states that the process of technical change is not independent of the social system, but it is connected to innovation opportunities, incentives for taking advantage of these opportunities, and organizational and institutional mechanisms that make possible this process. This process has a systemic, unreliable, dynamic, and cumulative nature that is considered of characteristics of social processes.

Thus, technical change can be considered as a continuous process of replacing and improving resulting from the interaction and competition between new and existing technologies in the market. If we consider society as a learning system, technical change happens as a social learning process in parallel with the accumulation of knowledge and experience and leads to higher productivity, more production, more variety, more specialized and increased dependence and correlation between the technologies. Constant interaction provides learning facilities to improve the transfer of tacit knowledge.

Ongoing relationships of customers and suppliers help them have formal and informal exchange of information and ease the creation of innovation or innovative emulation. Since learning helps identify seen or latent needs of customers for the design and development of new products and services and ultimately helps customers' satisfaction, it is one of the important aspects in the product development process [1]

2. THEORETICAL FOUNDATIONS

2.1. Learning model and development of technological capabilities of firms

Technological, organizational, and managerial efforts lead to the accumulation of technological knowledge. In the units where management looks for the quality of the products and in long-term decline in the cost of production, by staff training and monitoring other environmental factors, it tries to reduce production costs.

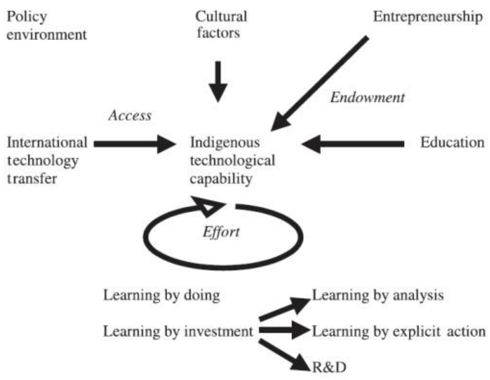

Figure1. Learning model and development of technological capabilities of firms

2.2. Technical learning and its mechanisms

Increasing production scale provides the opportunity for producers to reduce production costs. All the financial benefits that accrue to producers from mass-production are due to decline in product unit cost. This means that fixed costs are divided over a larger number of products produced. There are different methods to determine the importance of economies of scale. One of these methods is calculation and estimation of optimal size or efficient scale. As the optimal scale is larger, smaller firms will be unable to compete with larger firms and for firms wishing to enter the industry it will be more difficult.

Technological change is primarily learning and learning in its turn is a concept of network. Learning extends through network feedback between the various actors in the market as partners and even competitors. Networks strengthen mutual learning, and increase compatible and mutual solidarity among market participants and through sharing experiences, reduces risk and concerns arising from the usage of new technologies.

Learning is the main factor is technological change and diffusion of innovations. Learning through experience shows the quality of improvement in performance in a specific activity due to experience [1]

2.2.1. Learning by doing

refers to acquiring knowledge, skills, and new insights or developing human capabilities by doing work and specific activities within the organization related to product development, learning from activities and tasks within the organization [2]

2.2.2. Learning through research (research and development activities as a technical learning)

Research and development allows the firm to identify the knowledge spread in the enterprise environment and change it to knowledge capital. Improving innovation process depends on the ability of firms to absorb knowledge dispersed in the environment.

2.2.3. Learning through use

One part of learning associated with a technology is achieved through use of technology in the market and feedback received from the customer that will open the way for future development and reduce future costs. IT application in the market makes efficiency, limits, and the actual needs of the users to be identified. In this learning, technology profile is improved through a two-way interaction between inside and outside the firm.

2.2.4. Learning through interaction

Interactions among various stakeholders in the market such as research laboratories, industry, end users, and policy makers in the public sector strengthen knowledge about the technology and thus learning. Thus, learning through interaction allows firms benefit from learning external sources and this type of learning is closely associated with the development of technology in the market.

2.3. Technology spillover

Technology spillover refers to benefiting of host countries from knowledge and technology spillovers transferred from multinational corporations to subsidiaries because of foreign direct investment. Technology spillover is essentially due to the presence of foreign investors and multinational companies that have high technological, financial, and research power. If besides the presence of foreign investors and multinationals firms three things happen, technology spillovers from multinational companies to industries and institutions in the host nation will happen. These factors include:

1) Presenting the latest manifestations of technology
2) Learning (through circulation) of labor
3) The relationship between technology owners (foreign investors) with domestic enterprises

The role of skilled and efficient work force in transfer and technology absorption is undeniable. This is true both for the leading institutions in new technologies that have significant investments in research and development and in the following countries that are users of technology. In this respect, and with regard to the competitive environment in the global business environment, training, being update, and deepening of the knowledge of workforce are of utmost importance. Technical learning as a factor of technical change was primarily introduced by scientists White 1936, Hirsch 1952. However, a study by orrow 1962, could be the basis for the concept of the learning curve in the economy. According to Chun, to illustrate learning, instead of the variable “accumulated production” we should use accumulated gross investment (accumulated production of capital goods). Thus, in his view, technical change at any time is reflected in new capital goods [2]

Learning of workforce is achieved in two ways:

A) Learning through planned training by holding seminars, specialized courses and in-service training for labor by multinational corporations in the host country

B) The workflow of labor force, participation of foreign investors and multinationals companies in the economies of host countries (developing) provides the opportunity, due to the relatively low level of internal staff wages relative to labor in industrialized countries, for enough motivation to attract internal forces and skills training they need.

This can lead the host country's labor force to knowledge hidden in subsidiaries to foreign investors, and because of the return of this trained labor to enterprises and domestic industries and the use of acquired skills technology spillover occurs. Of course, in this case, conditions such as government incentive policies, motivation of work force to attract the necessary skills, and return to domestic enterprises, technology and content exchanged between multinationals and host country agreements are effective [3].

2.4. Development of new products

In the current world full of change and developments and taking into account the competitive conditions prevail in business environment, companies and organizations will have to synchronize with the dynamics to provide grounds for survival. The pace of these changes is so high that many existing products have recently been introduced into the market are about to change. The companies that have understood these conditions pay more attention to the activities of research and development and put the need to develop new products in agenda.

Given the complexity and importance of new product development process, various definitions have been offered here we refer to some of them. Handbook of Product Development and Management Association defines new product development as a set of regulated tasks, steps and measures that explain the natural goal of the firm to transform premature (early) into products and services. In other words, new product development process is considered as a series of activities that transfer instructions and orders of customers, market demand and technology advances into production and design processes [1].

2.5. Economies of scale

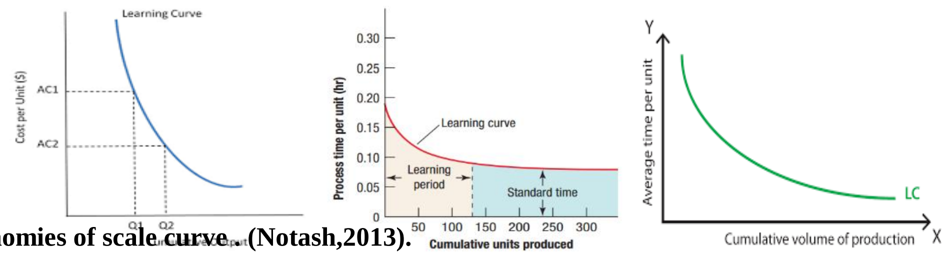

Figure 2. economies of scale curve . (Notash,2013).

Economies of scale in micro-economic concept that refers to advantage of cost reduction due to increased production volumes. Economies of scale mean that with increase in production volumes, the average cost of production per unit decreases. There are several reasons for this, including things such as business discount on purchases due to the high volume of purchases, enhance in the experience and learning of employees, gaining more financial resources, prorated latest marketing expenses and improving production technology in wider markets. When the amount of production increases (Q1to2), the average cost of production is reduced (AC1toAC2) (figure 2).

2.6. Learning curve

Phrases like, experience curve, improvement curve, improvement curve cost, the curve of progress, progress function, establishment curve, and yield curve are often synonymous with learning curve. A learning curve is a graphical representation of the learning rate (in the person as average) for an activity or a tool. Learning curve theory is based on the principle that the time required to run an activity reduces by repeating that activity. [4]

Learning curve shows the relationship between the costs of production an item or performing a task or tasks performed and the number of manufacturing units over time. Its inclination reflects how quickly a person or an organization is to develop experiences. The more steep the curve is, learning will be easier. The most common definition of the learning curve, the average cost of production of technology is considered as an indicator of performance and defines it as a function of cumulative capacity technology.

Cumulative capacity is considered, in fact, as an alternative to the accumulation of knowledge, i.e., accumulated knowledge. Learning curve reflects the fact that some technologies could be due to the widespread acceptance of the community because of the accumulation of knowledge through processes of "learning through experience(figure 2)," "learning through use," and "learning through interaction" that are gradually associated with decreasing costs associated with them. Learning curve indicates the effect of gradual and sustainable changes in technology that are the principal component of technical progress.

Technical change is as and evolution and done with considerable experimental effort and develops with storage growth and learning experience. [2]

The learning curve theory is based on the following conclusions:

time (cost) required for a specific purpose or a completed unit, when the goal is achieved or by increased cumulative production will reduce.

time (cost) of distribution will reduce.

Reduction of this time is predictable through a series of calculations. One important concept related to the learning curve is the cost of learning. Learning cost is the total investment required for a technology to reach an emerging break-even point. This cost is an estimate of the resources required to achieve the level of competitiveness for a technology [3].

With increase in learning, it advances along the learning curve and increases production. Ascending curve reflects negative learning and usually does not happen except for cases when increasing the number of employees in a company grows.

2.6.1. Computing learning curve

Various models have been proposed for learning curve used by various industries or technology. Wright Model is the easiest and most common equation and is valid for a large number of processes.

Log-Linear (wright) : $y(x)= a.x^n$ (1)

a= number of hours required to produce the first unit

x= total number of production units

2.6.2. one-factor learning curve

$$C_i = a x_i^{-b} \tag{2}$$

A= first unit production costs

Ci= the costs of n-th production unit

Xi= the cumulative volume of production

B= cost elasticity with respect to output

2.6.3. Two or multi-factor learning curve

$$C_i = a_i (x_i^{-b_{LBD}})(RD_i^{-b_{LBR}}) \quad (3)$$

a i=expense of accumulated capacity and assets knowledge i, Ci cost of technology

Xi= cumulative volume of technology i

b LBD= learning by doing

b LBR= learn by research

RDi= research accumulated capital and assets or development knowledge i

This model suggests that research and development costs play an important role in reducing production costs [7]

2.6.4. Applications of learning curve

The most important question about the learning curve is how a company uses learning curve in business. A practical application of learning curve in the budget forecast and estimates of the cost. Determining the needs of human resources is another application where learning curve can be used, so companies will be more efficient. The learning curve is regularly used for strategic planning at all levels of the firm. To determine the high-tech project budget, the correlation between labor costs to the project is critical for companies. As such projects are done with high payments to professionals, using learning curves helps set realistic and better time for job that improves pricing decisions and the competitiveness of the company. [5]

2.6.5. Components affecting reduction of learning-based cost

Learning takes place at a different level such as research, development, design, materials and system elements, subsystems, systems, product, application, maintenance and end of life cycle.

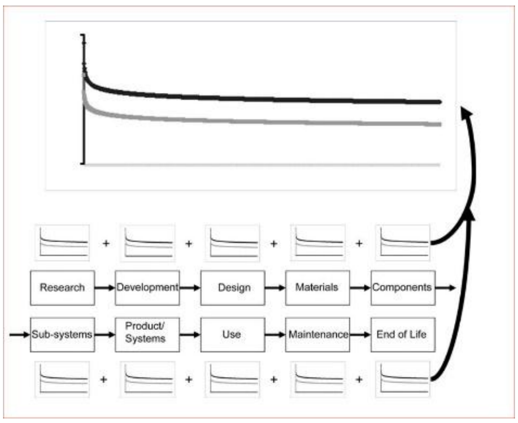

Figure 3. Learning the different levels [6]

3. A REVIEW OF SIMILAR RESEARCH

Suvan Napurn et al (2010) In his study entitled evaluating the success of new product development in the food industry in Thailand, the importance of using marketing research in the industry was pointed out. Kandmer and others (2006) Factors such as the use of multi-functional and focused teams dedicated team, using comprehensive market research that have presence in international markets are seen effective in the success of new product development projects.

Sharma (2006),In a study titled components of the success or failure of new product development in Nepal, it was stated that 87% of the companies surveyed stated system failure and guidelines for new product development, and 90% insufficient attention to product specifications according to customer needs as the most important barriers and challenges in improving innovation in the product development. Cooper (1999),In a study entitled experience, invisible success factors in product innovation, challenges such as shortage of ideas, segregated markets, government and social restrictions, cost, lack of capacity (financial, human), the need for rapid production, short life cycle of product, providing product timely on the market, lack of appropriate organizational structure were expressed.

Haldi,Withcomb Using engineering methods, They determined optimal production levels for the industry in America. They found that in basic industries such as petroleum refining and electricity production, economies of scale hold in large scale of production. These economies of scale have been realized affected only by the initial cost of investment and learning over time [7].

4. RESEARCH METHODOLOGY

The study population included managers, experts, and professors active in the field of staff and education. Through a questionnaire with high reliability(Table 1), and a defined range, expert opinions were collected as paired and after concluding comments in MATLAB and with DEMATEL technique about the impact between criteria on each other were developed.

Table 1. Determining the reliability of questionnaire with an emphasis on internal solidarity

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.778	.780	20

Factor analysis was used to assess construct validity. Using factor analysis, one can identify whether the questions measure in the form of indices or not. In factor analysis, questions that have proposed to evaluate a characteristic or a specific trait should have a common factor loading and these factors should be significant.

KMO index has been used has been to determine the adequacy of the sample. It is an index of sampling adequacy assessing the insignificant partial correlation between variables, and thereby determines whether the variance of the variables is under the influence of shared variance of some hidden factor or not. The index is in a range from zero to one. If the index value is close to one, the given data (sample size) are suitable for factor analysis. Otherwise, the results of factor analysis for data of interest (usually less than 0.6) are not suitable.

Bartlett test examines the hypothesis that the observed correlation matrix belongs to a population with independent variables. For a factor model to be useful and meaningful, it is necessary that the variables be correlated. If Bartlett's test significance is smaller than 5%, factor analysis to identify the structure is appropriate(Table 2).

Table 2. Factor analysis to identify the structure of factor model

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.720
Bartlett's Test of Sphericity	Approx. Chi-Square	602.437
	df	276
	Sig.	.000

ANOVA with Cochran's Test						
		sum of squares	df	average of squares	Cochran's Q	Sig
Within groups		613.381	112	5.477		
	Between groups	100.485	19	5.289	80.392	.000
total		3296.981	2259	1.459		
Grand Mean = 2.58						

4.1. Fuzzy DEAMTEL method to identify and assess the relationship between measures [8]

Fuzzy Logic encompasses a wide range of theories and techniques, which are based essentially on four concepts: fuzzy sets, verbal variables, probability distributions (membership function), and IF-THEN fuzzy rules. Fuzzy set is a set whose elements belong to it with membership degree of (μ). In a situation where information required is quantitative, it is expressed numerically. However, when the study is conducted in a qualitative atmosphere and its knowledge is ambiguous and close-ended, information cannot be expressed in exact figures. Most managers cannot have an exact number to express their own opinion. This is why they use verbal evaluation instead of numerical value.

DEMATEL technique was proposed by Fonetla & Gabus This technique, which is of decisions based on paired comparisons, enjoys the judgment of experts in extracting factors of a structuring of a systematic them applying the principles of graph theory, the hierarchical structure of relationships with agents in the system provides mutual interaction, so that the impact of these relations will be determined by a numerical rating.

DEMATEL method is used to identify and assess reciprocity between the criteria used and the mapping of network relations. Since directed graphs can show relationships of a system better, the techniques is based on charts that can be divided into two groups: the cause and effect, and the relationship between them was made as a structural model to understand [9].

This technique features include:

1. considering interoperability; the advantage of this method over a network analysis technique is clarity reflected in communication between a wide range of components, so that professionals are able to express their views on the effects predominate (direction and severity of impacts) among the factors. It

should be noted that the resulting matrix from DEMATEL technique (grid of interconnection) in fact makes a part of the super matrixes. In other words, DEMATEL technique does not operate independently but as a subsystem of a larger system such as ANP.

2. Structuring complex factors in groups of cause and effect

This is one of the most frequent uses functions and one of the most important reasons for its use in the process of problem solving. Thus, by division of a wide range of complex factors in the form of cause-effect, it places decision-maker in a better relationships condition. This leads to a greater understanding of the factors and their role in the process of mutual influence [11].

Five steps have been identified to perform DEMATEL technique:

Direct communication matrix (M): When the vision of many people are used the simple average of views are used and form M.

$$N = K*M \tag{4}$$

3. Normalizing direct correlation matrix: In this formula, k is calculated as follows. First, the sum of all rows and columns is calculated. Reverse of the largest number of rows and columns constitutes k.

$$k = \frac{1}{\max \sum_{j=1}^{n} a_{ij}} \tag{5}$$

Calculating all correlation matrixes of other factors of system

$$T = N \times (1-N)^{-1} \tag{6}$$

4. Create chart : the elements of each row (D) for each indicator of the effectiveness of those operating on other operating systems. (The influence of variables) - Total of columns (R) for each factor represents the

(The impact of variables) The impact of factors - In other words, as the amount of D + R factor is higher, that factor has more interaction with other factors of the system. Perpendicular vector (D - R) shows the influence of each factor. Generally, if D-R is positive, the variable is a causal variable, and if it is negative, it is considered disabled. Finally, a Cartesian coordinate system is drawn.

In this device, longitudinal axis and D+R-value and transverse axis are based on the values of D-R. Position of each operating point is determined at the coordinates of (D + R, D - R) in a given system. Thus, a graphic diagram can be obtained.

5. Calculating the threshold of relationships: to determine the mapping network relationships, threshold value should be calculated. By this method, we can ignore minor relationships and draw reliable connections network. Only the relationships whose values is larger than the threshold value will be displayed in the map in the matrix T. After the intensity of threshold is determined, all the values of T matrix are smaller than the threshold zero, i.e., they are not considered in causal relationship.

6. Conceptual model (Figure 4)

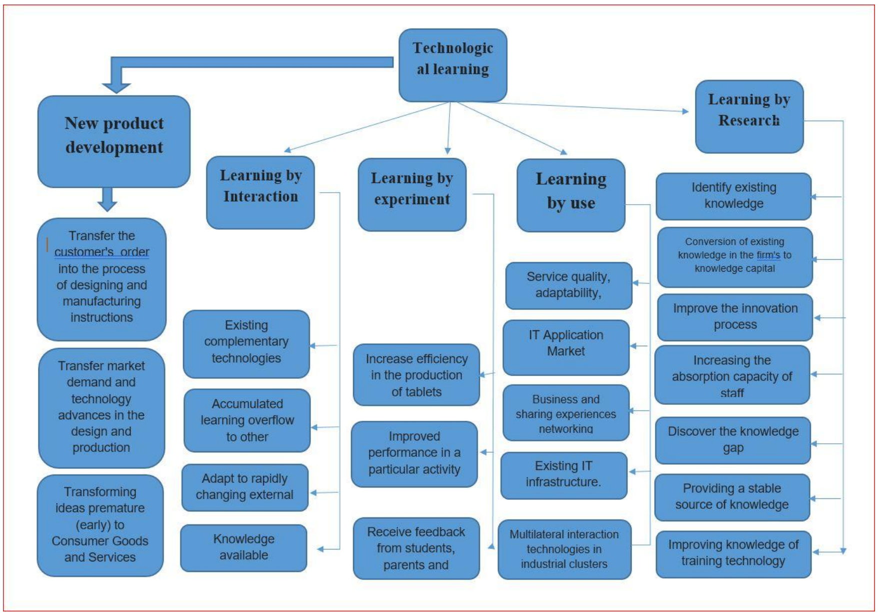

Figure 4. The conceptual model of technological learning indicators and new product development (Source: researcher's findings)

5. FINDINGS

In this study, in order to study the effect of interaction of technological learning on the development of new products in student-tablet production industry, 21 criteria have been used whose names are listed in Table 3.

Table 3 .Names of technological learning criteria and new product development, (Source: research findings)

Technological learning									
Learning through Research		Learning through use		Learning through experience		Learning through interaction		New product development	
Criterion 1	Identifying existing knowledge in the enterprise	Criterion 7	Service quality, adaptabilit, productivity and innovation	Criterion 12	Increase in efficiency of the production of tablets	Criterion 15	The existence complementary technologies	Criterion 19	Transfer of the customer's order into the process of designing and manufacturing instructions
Criterion 2	Conversion of existing knowledge in the firm's knowledge capital	Criterion 8	IT Application in Market	Criterion 13	Improving performance in a particular activity	Criterion 16	Accumulated learning spillover to other technologies	Criterion 20	Transfer of market demand and technology advances in the design and production process
Criterion 3	Improving the innovation process	Criterion 9	Business networking and sharing experiences	Criterion 14	Receiving feedback from students, parents and teachers	Criterion 17	Adapting to rapidly changing external environment	Criterion 21	Transforming premature (early) ideas to Consumer Goods and Services
Criterion 4	Increasing the absorption capacity of staff	Criterion 10	Existing IT infrastructure			Criterion 18	The existing knowledge and awareness		
Criterion 5	Discover the knowledge gap	Criterion 11	Multilateral interaction technologies in industrial clusters						
Criterion 6	Providing a stable source of knowledge								
Criterion 8	Improving knowledge of technology training aid								

Moreover, to compare the criteria, f a number of verbal expressions are used (Table 4)

Table 4. Verbal phrases used in research and their equivalents

Verbal phrases	Fuzzy value
No effect	(0.3000, 0.1000, 0.0000)
Very low effect	(0.5000, 0.3000, 0.1000)
Low effect	(0.7000, 0.5000, 0.3000)
High effect	(0.9000, 0.7000, 0.5000)
Great effect	(1.0000, 0.9000, 0.7000)

For the evaluation of criteria, opinions of 15 experts are used shown in pair-wise comparison of

Table 5. In these matrices, x_ij = (l_ij, m_ij, u_ij) are triangular fuzzy numbers and x _ii = (i = 1,2,3,..., n) are as fuzzy number (0,0,0).

Table 5 .An example of pair-wise comparison matrix

pair-wise comparison matrix 1	C1	C2	C3
C1	(0.0000,0.0000,0.0000)	(0.1000,0.3000,0.5000)	(0.1000,0.3000,0.5000)
C2	(0.5000,0.7000,0.9000)	(0.0000,0.0000,0.0000)	(0.7000,0.9000,1.0000)
C3	(0.7000,0.9000,1.0000)	(0.3000,0.5000,0.7000)	(0.0000,0.0000,0.0000)

For considering the views of all experts, we obtain their means according to formula seven.

z ̃=(x ̃^1⨁x ̃^2⨁x ̃^3⨁…^ ⨁x^p)/p (7)

In this formula, P is the number of experts, and x^1, x^2, x^p are, respectively, comparison matrix paired Certified 1, Certified and Certified p is 2 and z is triangular fuzzy number.

For normalizing the matrix obtained, we use formulas 8 and 9.

$$\left(\frac{l'_{ij}}{r}.\frac{m'_{ij}}{r}.\frac{u'_{ij}}{r}\right) = \left(l''_{ij}.m''_{ij}.u''_{ij}\right)$$

=H ̃_ij=z ̃_ij/r (8)

Where r is obtained from the following equation:

$$r = max_{1\le i\le n}\left(\sum_{j=1}^{n} u_{ij}\right) \quad (9)$$

Table 6. An example of normalized matrix

Normalized matrix	C1	C2	C3
C1	(0.0000,0.0000,0.0000)	(0.0526,0.1579,0.2632)	(0.0526,0.1579,0.2632)
C2	(0.3158,0.4211,0.5000)	(0.0000,0.0000,0.0000)	(0.3158,0.4211,0.5000)
C3	(0.2632,0.3684,0.4474)	(0.1579,0.2632,0.3684)	(0.0000,0.0000,0.0000)

After calculating the above matrix, the matrix of fuzzy relations is obtained according to formulae 4 to 7.

$$T = \lim_{k\to+\infty}(\tilde{H}^1 \oplus \tilde{H}^2 \oplus ... \oplus \tilde{H}^k) \quad (10)$$

Each element of it is a fuzzy number $\tilde{t}_{ij} = (l^t_{ij}.m^t_{ij}.u^t_{ij})$ and is calculated as follows:

$$[l^t_{ij}] = H_l \times (I - H_l)^{-1} \quad (11)$$

$$[m^t_{ij}] = H_m \times (I - H_m)^{-1} \quad (12)$$

$$[u^t_{ij}] = H_u \times (I - H_u)^{-1} \quad (13)$$

In these formulae, I is the identity matrix, and each is matrix n* n whose items are as the lower number, the middle number, and high number of triangular fuzzy numbers of matrix H.

Table 7 shows the matrix t.

Table 7. An example matrix of relationships

Matrix of relations	C1	C2	C3
C1	(0.0411,0.2306,0.7768)	(0.0668,0.2760,0.7843)	(0.0759,0.3105,0.8597)
C2	(0.4371,0.7974,1.5762)	(0.0805,0.3035,0.9216)	(0.3642,0.6747,1.3756)
C3	(0.3430,0.6632,1.3756)	(0.1882,0.4447,1.0588)	(0.0775,0.2920,0.8914)

The next step is to obtain a total of rows and columns of the matrix. Total rows and columns are obtained according to formulas 14 and 15,

$$\tilde{D} = (\tilde{D}_i)_{n\times1} = [\textstyle\sum_{j=1}^{n} \tilde{T}_{ij}]_{n\times1} \quad (14)$$

$$\tilde{R} = (\tilde{R}_i)_{1\times n} = [\textstyle\sum_{i=1}^{n} \tilde{T}_{ij}]_{1\times n} \quad (15)$$

where $\tilde{R}$ and $\tilde{D}$ are matrixes of $n \times 1$ and $1 \times n$ .Next, the importance of indices $\widetilde{D}_i + \widetilde{R}_i(\ )$ and the relationship between the criteria $)\widetilde{D}_i - \widetilde{R}_i($ are determined. If $\widetilde{D}_i - \widetilde{R}_i > 0$ is the relevant effective criterion, and if it is $\widetilde{D}_i - \widetilde{R}_i < 0$ the relevant criterion is bonding. Table 7 shows ، $\widetilde{D}_i + \widetilde{R}_i$ And $\widetilde{D}_i - \widetilde{R}_i$.

Table 8. The sample of importance and impact of measures (fuzzy numbers)

Criterion	$\tilde{D}_i + \tilde{R}_i$	$\tilde{D}_i - \tilde{R}_i$
C1	(1.0048,2.5085,6.1493)	(-3.5448,-0.8741,1.5997)
C2	(1.2173,2.7998,6.6380)	(-1.8829,0.7514,3.5378)
C3	(1.1262,2.6772,6.4525)	(-2.5181,0.1227,2.8082)

The next step is fuzzy numbers obtained from the previous step, we make Defuzzification according to the formula

B is defuzzy $\widetilde{A} = (a_1 ، a_2 ، a_3)$number (16)

Table 9. The importance and impact of criteria (absolute numbers, defuzzy number)

Criterion	$(\widetilde{D}_i + \widetilde{R}_i)^{def}$	$(\widetilde{D}_i - \widetilde{R}_i)^{def}$
C1	6.0579	0.1636
C2	7.6531	-1.6133
C3	9.7442	-0.0819
C4	9.6817	0.0343
C5	6.6152	-1.9334
C6	9.5125	-0.0844
C7	9.5280	-0.3206
C8	9.7013	-0.4393
C9	9.8830	0.0869
C10	9.2230	0.3898
C11	9.7576	0.1690
C12	9.6652	0.0311
C13	9.6812	0.6494
C14	9.3525	0.2350
C15	8.6174	0.6055
C16	9.7371	0.0468
C17	9.4659	0.3418
C18	10.0068	-0.0030
C19	9.3553	0.7316
C20	9.1884	-0.1483
C21	9.6868	0.1653

6. CONCLUSION

About the results of DEMATEL, it can be argued that the factors that have more interaction with the system, (i.e. have larger R + D) or have great effects on other factors impact, they have great D or receive major impact from other factors are large R or both have positive R-D are important for us. Concerning the factors being influenced, the factors that have the greatest amount of interaction with the system (i.e. larger R+D) and smaller being influenced (i.e. small R-D) are more prominent.

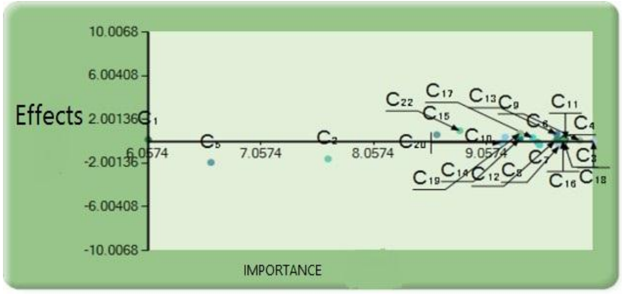

Figure 6. shows both the importance and influence and effectiveness of the measures.

The horizontal axis shows measures the importance of criteria and vertical axis shows influencing or being influenced graph of the criteria.The importance and influence and being influenced among the measures.

7. REFRENCES

[1] Notash, 2013.

[2] Arani, 2009.

[3] 2. Durshari, 2010.

[4] N. name, „(LEARNING CURVE ANALYSIS, 1990),“ 1990.

[5] P. J. ,. E. R. ,. a. S. Y. Ines Azevedoa, 2014.

[6] J. D. L. a. S. T. Walsh, „Extracting Value from Learning Curves: Integrating Theory and Practice“.

[7] kashi, „Economies of scale in the economy: Iran industry sector,“ 2007.

[8] Habibi, „Fuzzy Multi Criteria Decision Making,“ 2014.

[9] T. D. F. Gharakhani, „Fuzzy AHP and Fuzzy DEMATEL Methods for Supplier Selection Criteria,“ *International conference on Computer Science and Information Systems (ICSIS'2014) Oct 17-18, 2014 Dubai (UAE),* 2014.

[10] „Learning curve analysis,“ 1990.

[11] C. CHEN, „Comparative Study of CODP for PC Manufacturing Industry,“ *Management &*

Engineering, Izvo. %1 od %2 16 (2014) 1838-5745, 2014.

[12] B.-S. T. Jeffrey L. Cummings, „Transferring r&d knowledge: the key factors affecting knowledge transfer success," *Elsevier-Engeneering and technology management,* 2003.

[13] Y. n. Liu, „Manufacturers' Customization Decisions in Distribution Channels," *University of Illinois at Urbana-Champaign,* Octob er 8, 2013.

[14] 0. J. 2. (Chang, „(Chang, 08 Jun 2015.)," 2015.