Identification and Ranking of Innovation Management Factors in Petrochemical Companies Producing Polyethylene Products

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Abstract

Since a major part of Iran's petrochemical base products has been taken into account for export, it is essential and inevitable to consider international markets to examine the economic conditions of petrochemical development projects. The aim of this research in Iran's petrochemical industry is access to appropriate solutions to solve the facing challenges as well as development of innovation management model in petrochemical companies producing polyethylene products with the approach of the new polyethylene goods. Data collection was conducted using the library and field studies. After taking these steps, 58 main indicators were considered by experts' screening among 130 extracted indices. Based on these indicators, final questionnaire was designed by Likert scale and it was also distributed. Finally, after asking comments of 105 managers and experts in 5 Petrochemical Companies producing polyethylene products on these indicators, Data were collected and the research model was fitted using structural equation and Smart PLS software. After fitting, 29 indices, 2 factors and 6 dimensions were accepted for designing model. General dimension was composed of economic, organizational, regulatory and supervision factors while specific dimension was formed of technological, technical, marketing and systemic factors. According to research conducted for successful innovation management, considering all the above mentioned points is necessary in Petrochemical companies which are producers of polyethylene products.

Keywords

Innovation, Innovation management, Innovation management model, Petrochemical Industries, Polyethylene Products

1. Introduction

Today, companies and organizations are made to innovate in the process with the approach of producing the new products in order to maintain a competitive advantage (Salajegheh, 2008). Falling in world oil prices and the subsequent drop in prices of petrochemical products in global markets has had the large aftershocks so far in which

metamorphosis of petrochemical industry based on producing more advanced products and the use of new technologies are some of its effects.

One of the most widely used products in petrochemical industry is polyethylene. As the major part of basic petrochemical products in Iran is taken into account for export, considering international markets for investigating economic conditions of petrochemical development projects is essential and inevitable. As a result, the need for new technologies as one of the factors for achieving innovation and its objectives is essential.

So Iran's petrochemical industry must enter the field of petrochemicals and chemicals with high added value to leave the challenges and it must act as Entrepreneur and must lead to creation of sustainable jobs by systematic development of downstream petrochemical industries in form of industrial, petrochemical and chemical parks and by creation of knowledge-based small and medium enterprises Petrochemicals with the approach of innovation and manufacture of new products. On the other hand, it should cause reduction in costs of production and eventually achievement of the Maximum added value from petrochemical raw materials. In this regard, according to the above-mentioned problems in Iran's petrochemical industry, it is searched for appropriate solutions in this study to solve encountered challenges and to develop innovation management model Petrochemical companies producing Polyethylene Products

With the approach of the new polyethylene goods.

Therefore, this study was carried out based on the main question that is "What are effective indicators and factors on the innovation management in Polyethylene products with the approach of the new products are there?"

Innovations of this research are as the following:

Innovation management model in Petrochemical companies producing polyethylene products is proposed for the first time in this research

It is specifically concentrated on innovation management in petrochemical companies producing polyethylene products in this study.

Extracted model for managing innovation is obtained locally based on collaboration of companies producing polyethylene products with the approach of the new polyethylene goods and it enjoys integrity and high reputation in the mentioned companies.

2. Literature review

Successful innovation is a key to business growth. In the realm of technological development, innovation processes have been transformed into various forms, like open innovation, crowd sourcing innovation, or collaborative innovation. Innovation, in general sense may be seen as a process of designing, developing and implementing a novel product or service to improve economic, physical and logical parameters in the process(Khamseh et al. ,2012). Innovation is a process in which person allows their imagination at first to ascend to the heavens and then brings it back to Earth and Engineers the idea is to become an idea. Then ideas are converted to scientific useful and convenient thoughts through management. Innovation is described by Schumpeter (1943) as an irreversible and historical change in the way of doing things and creative destruction. Here, innovations are defined as new Creativities in terms of economic importance. In fact, innovation is a process through which, existing problems are Identified and defined by organization. Then, new knowledge is applied to actively solve it (Fathian, 2005).

If an organization seeks survival in a dynamic and changing environment, it is necessary to invest in different types of innovation as they affect organization in different ways and lead to diverse results. Some studies related to innovations have focused on its different types such as product / process, administrative / technical and fundamental / gradual innovations. Some other types of innovation include administrative and technical innovations. Technical innovation is defined in relation with new products, processes or services while administrative innovation is referred to changes in the social structure of the organization such as

Attracting policies, allocation of resources, structure of duties, powers and rewards (Rowley, 2011).There are also two categories of innovation in the field of economy and business including gradual innovation and radical innovation. Gradual innovation is the result of a process of continuous improvement. This means that innovation can develop and refine the existing knowledge and process. Fundamental Innovation (radical) is entirely new and discrete phenomenon which is often obtained from the research and development activities in industrial laboratories, academia or studies. (Chiesa, 2001, North and Smallbone 2000). Present society is associated with movement and dynamism. The axis of the dynamics is disappearing traditions and past rules. Today, most of the techniques, concepts, approaches and practices that were useful for effective managements of organizations which provide them to grow and succeed over the years, do not come to work at present. In fact, it should be noted that Today 'world is the realm of innovation (Fadaee, Mosayyebi, 2011). Innovation Management is the process of combining different

knowledge sets together and creation of a successful innovation in situations with high uncertainty and also resource mobilization (Tidd,J. Bessant, 2002).Key changes such as acceleration and global distribution of knowledge production, globalization and virtual markets, emergence of active users, technological and social infrastructure development which work in the turbulent context of innovation , cause creation of a variety of models, innovation concepts and processes in the management . This has had a significant impact on transforming innovation to a key component of economic policy. Innovation management has increasingly become as one of the main causes of long-term success in companies in competitive markets because companies with high innovation capacity will be able to respond to environmental challenges more quickly and better. (Liao, S. et al., 2008). It was pointed out that in a study conducted by Ismail pur et al. (2016) that access to financial resources has a significant role in managing innovation. Innovation strategy and studying the variables including appropriate strategies and state control in innovation management was also investigated by Jonathan (2011).moreover, its mentioned effects were achieved on innovation management in their study.

In this regard Leadership style as an influential factor in innovation management has been expressed by Nasermeli et al. (2015).The role of knowledge management and knowledge processes in innovation management was studied by Researchers such as Jing Wen et al (2008) and Bang et al. (2016). Moreover, the effect of these characteristics on innovation was also confirmed by them.

It is indicated in the research conducted by Joe Tidd (2009) that clear goals and strategies, teamwork reflection , strategic cooperation, collaboration and interaction with centers of knowledge, research and development budget, organizational structure of strengthening innovation, technological capability of suppliers and Competitive environment of product are considered as factors affecting innovation management. Flexibility of structure and operational processes, presence of clear procedures and mechanisms, Increased use of product by current customers and screening systems of ideas are taken into account as important factors in a research conducted by scholars such as Tidd,J. and Hull (2003) in the management of innovation. It was achieved in research by Samadi (2012) that organizational Culture is considered as effective characteristics of innovation management. Cost efficiency, international standards and Commercialization mechanism of novel ideas were cited as important and effective markers in the management of innovation by Kimitaka, N. Munehiko (2016). Index of innovation costs was investigated in innovation management was studied by researchers such as Zhiqiang et al. (2016) and it was concluded that innovation costs are effective on management innovation. In this regard, the strategic cooperation is known as one of the important factors in management of innovation by Popiolek and Thys (2016) as well as Hejazi and Divsalar (2012). In the same direction, the impact of organizational maturity and wages were pointed out on the innovation management by Hedayati and Khamse (2016). Intellectual property laws and antitrust rules were considered as important and effective characteristics on innovation management by Kexin et al. (2016) as well as Rahimi and Abdolvand (2016). In a subject discussed by Foose et al. (2010), Government incentives and motivational systems were taken into account as effective features on management of innovation. Environmental concerns were noted as an influential factor on innovation management by Mostajabi (2012).

Concepts of scientific changes and adaptation of technology was examined by Rasa (2016) in which impact of technology compatibility and development of technology was studied on management innovation and effectiveness of compatibility as well as technology development was confirmed based on their studies. Market research, identification of customers and higher profit margin are taken into account as factors affecting innovation management by Gruber and Ogut (2014) as well as Ismailpur et al (2016). In this regard, variable of training and development of human resources is considered important in the management of innovation by Soltani and Hussain (2010). On the other hand, the market needs were considered as an effective variable on innovation by Ebrow et al. (2014) and Chen et al. (2016). The development of new markets is also taken into account as an important issue by Jahangard (2003) in this respect. Sales support and network marketing on product innovation were considered significant by Motevasseli and Meygoon (2013). Another variable, which was emphasized by Zhiqiang et al. (2016), is position of participating in the value chain and considering the upstream and downstream chain of products. Variables of controlling records and measures as well as access to information and scientific systems were addressed by Khamse and Sheikhi (2016) as important issues in assessing the need for management innovation.

3. Research method

This study is considered as a descriptive research since current situation is described by its results. Due to the direct connection of researcher with studied phenomena, it is also considered as a field study. It is also an applied research since effective factors on innovation management in petrochemical companies producing polyethylene products which are used in industry are identified in current study. Data collection method was conducted using

questionnaires and interviews with experts. The reliability of the questionnaire was evaluated by implementing Cronbach's alpha. Its validity was also approved by judgment of experts.

Based on studying the literature and summarizing conducted research as well as experts' perspectives, 130 effective Indices on management of innovation in the petrochemical industry producing polyethylene products were extracted by designing a questionnaire with Likert scale in this study. Then experts were surveyed for the effectiveness of these measures and decisions were taken over these indicators. After the screening, 58 indices were accepted which were categorized in form of 2 factors and 6 dimensions. The main identified dimensions include: general dimension which consists of (economic, organizational, regulatory and supervisory) factors and specific dimension, which contains (technical and technological, marketing and systemic) factors. The final questionnaire was designed and distributed among managers and experts in 5 petrochemical companies producing polyethylene products and then the questionnaires were collected. A total of 25 managers and experts in each of the companies were selected as statistical population. Finally, among 125 distributed questionnaires, 105 ones were completed and returned .then the research model was fitted using structural equation and Smart PLS software.

Based on the purpose, title and conceptual model of study, the research questions are as follows:

1. What are effective indicators and factors on the innovation management in Polyethylene products with the approach of the new products are there?

2. How is the ranking of factors affecting the innovation management in petrochemical companies which are producers of polyethylene products?

4. The findings of the first research question

58 main filtered indicators were obtained to answer this research question. Finally, research model was analyzed with SMART PLS software for validation so that research model was shown as figure 1 which was indicator of initial measurement model in case of estimating standard coefficients and also as figure 2 which was representative of corrective Measurement model(approved model) in case of estimating of non-standard coefficients(significance of Z). All questions with loading factors less than 0.7 are removed from research model. Indicators, in which their loading factors are close to 0.7 and the indices of the variable are compensated by another loading factor, can be retained in the model. (Hair, 2006). According to Figure 2, 29 indicators were excluded from the model for homogeneity of the model.
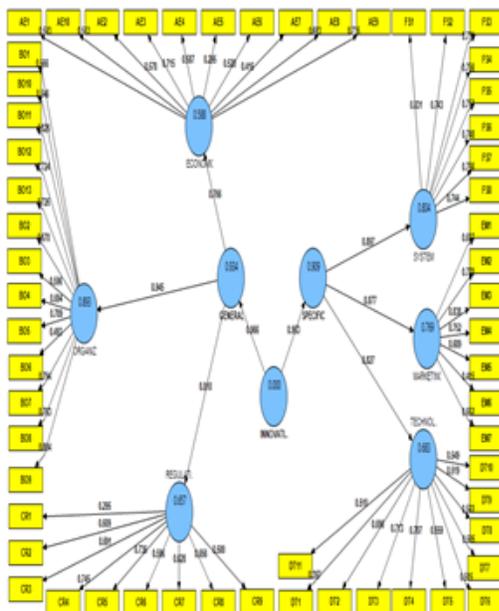

Figure 1. Initial Structural Equation Modeling of research along with coefficients of loading factors
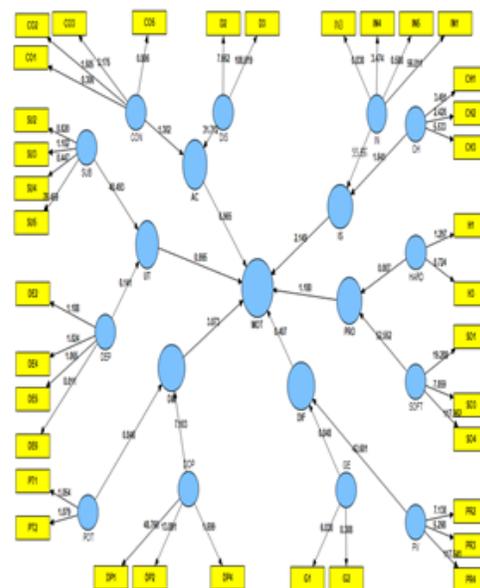

Figure 2. Measurement model of research after fitting with significant coefficients of Z

Results of all tests of reflective measurement models, structural and general models are shown in table 1. Finally, structural model in case of estimating path coefficients is shown in fig. 3 while structural model in case of the significance of path coefficients is represented in fig. 4.
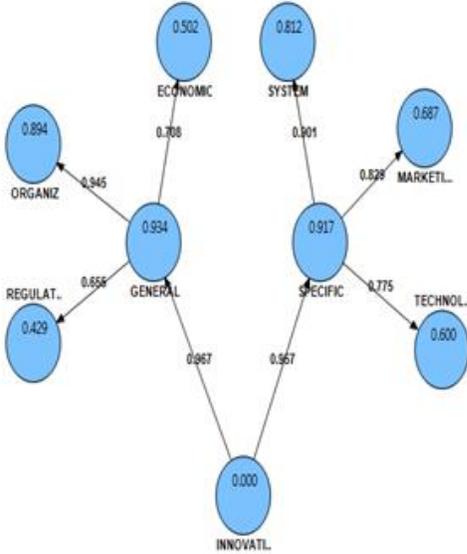

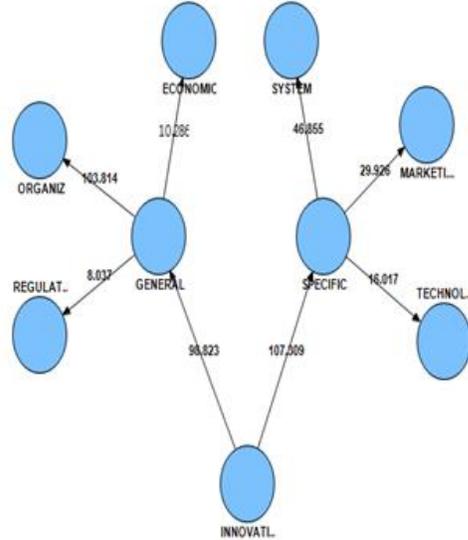Figure 3. structural model in the case of path coefficients (standard)

Figure 4. The structural model In the case of significance (non-standard)

Table 1. Results of fit tests of research model

Model	Test type			Acceptance criteria	Test result
Analysis of reflective measurement model	Homogeneity test			Load factors of all indicators are greater than 0.7	Removing 28 indicators with load factor under 0.7
	Reliability Test	Cronbach's alpha		Greater than 0.7	Approval for all the factors
		Composite reliability		Greater than 0.7	Approval for all the factors
		Shared reliability		Greater than 0.5	Approval for all the factors
	Convergent validity		Significance	Tvalue is greater than the absolute value of 1.96	Approval for all the factors and indices
			Homogeneity	All the loading factors after fitting are greater than 0.7	Approval for all the indices
			AVE	Greater than 0.5	Approval for all the factors

	Validity test		CR>AVE	The amount of composite reliability is greater than AVE For all the factors	Approval for all the factors
		Divergent validity	Transverse load test	Load factor of all observable variables on the corresponding latent variable is at least 0.1 higher	Approval for all the indices
			Fornell-larcker test	Square root of the AVE for each factor is more than a correlation of the factor with other reflective factors are in the model	Approval for all the factors
			Quality Test of measurement model	Coefficient of variation of shared indicators with three values including: 0.35(strong), 0.15 (average),0.02(weak)	Quality measurement of model For all the factors and variables is strong
Analysis of structural model	Factor of significance			T.value for all relationships between the independent and dependent Variables is Greater than the absolute value of 1.96	It is confirmed for all of research relations
	The coefficient of determination R2			Value of determination coefficient: 0.67 (strong), 0.33 (average), 0.19 (weak)	Coefficient of determination is moderate to high for economic, regulatory, supervisory and technological factors and it is strong for other factors
	Relationship of predictor Q2			The amount of Q2 with the predictive power: 0.35 (strong), 0.15 (average), 0.02 (weak)	Moderate to high predictive power is confirmed for general , proprietary, Regulatory and supervisory and economic factors and strong predictive power are confirmed for all other variables
Analysis of the overall model	GOF			The index with three values: 0.35 (strong), 0.15 (average), 0.02 (weak)	GOF=0.68 Very good fit. The general model is confirmed

According to the table above, indicators and factors affecting innovation management in petrochemical companies producing polyethylene products are obtained as Table 2.

Row	Factors	R2	Dimensions	R2	Indicators	ID Code	Loading factor	R2	Ranking
					Table 2. Indicators and factors affecting innovation management in petrochemical companies producing polyethylene products				
1	General factors	0.934257	Economic	0.501845	Access to financial resources	AE3	0.755	0.57	Third
2					Development of downstream / upstream industries and products	AE8	0.789	0.62	Second
3					Economic Development	AE9	0.838	0.68	First
4			Organizational	0.893683	Method of leadership	BO4	0.707	0.49	Eighth
5					Innovation strategy	BO5	0.789	0.60	Third
6					Organizational Culture	BO7	0.780	0.60	Fourth
7					Specified objectives and strategies	BO8	0.767	0.57	Fifth
8					Thinking about team work	BO9	0.841	0.70	Second
9					Organizational Structure Reinforcing Innovation	BO11	0.851	0.72	First
10					Organizational Maturity	BO12	0.741	0.54	Seventh
11					Motivational Systems	BO13	0.758	0.56	Sixth
12			Regulatory	0.429460	Antitrust laws	CR3	0.805	0.64	Third
13					Specified national industrial policies	CR4	0.855	0.72	First
14					Privatization policy	CR5	0.826	0.67	Second

15	Specific factors	0.916550	Technological and Technical	0.600180	The technological capabilities of providers	DT2	0.854	0.72	Second
16					Technology Compatibility	DT3	0.859	0.72	First
17					Development of technology	DT4	0.834	0.68	Third
18			Marketing	0.686799	Increased use of product by current customers	EM2	0.788	0.60	Third
19					Sales Support	EM3	0.839	0.68	First
20					Competitive environment of product	EM4	0.808	0.64	Second
21					Market needs	EM5	0.724	0.51	Fourth
22			System		Specialized systems for screening ideas	FS1	0.831	0.68	First
23					Access to information and knowledge systems in petrochemical field	FS2	0.743	0.54	Eighth
24					Commercialization mechanism of Innovative ideas in the market	FS3	0.770	0.59	Second
25					Existing clear procedures and mechanisms	FS4	0.755	0.56	Fifth
26					Controlling records of previous measures	FS5	0.756	0.56	Fourth
27					Company status in the value chain	FS6	0.747	0.54	Sixth
28					Knowledge management and knowledge processes	FS7	0.765	0.57	Third

29					The flexibility of structure and operational processes	FS8	0.744	0.54	Seventh

according to the indices extracted from a literature review and conducted research as well as experts in petrochemical industry and after confirmation of the model fitting based on figure 1 and table 1, innovation management model in petrochemical companies producing polyethylene products was obtained as shown in figure 5.
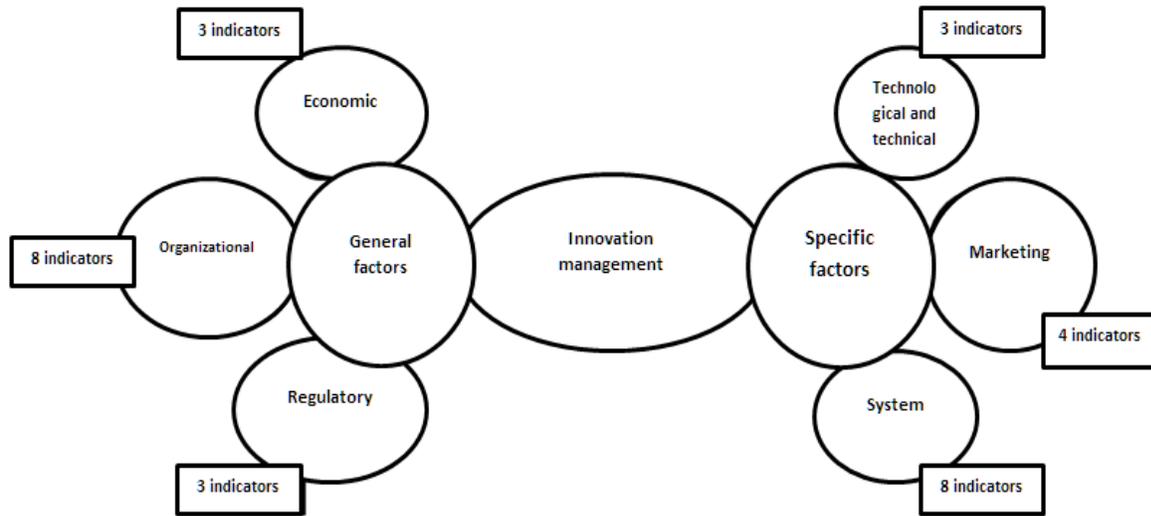

Figure 5. Model of innovation management in petrochemical companies producing polyethylene products

In this study, above-mentioned criteria as effective variables on necessity of innovation in petrochemical companies producing polyethylene products were extracted by taking advantage of previous studies related to the subject as well as using opinions of experts.

The criteria are divided in two dimensions including general and specific factors. Economic, organizational and regulatory and supervisory indicators were considered in the general dimension while technological and technical, marketing and system indicators were taken into account in specific dimension.

5. The results of the third research question

According to the output of Smart PLS software, ranking of effective factors was done according to the coefficient of determination .therefore, the rating of each factor and the dimensions affecting innovation management in the petrochemical industry is presented in table 3.

Table 3. Ranking of effective factors and dimensions on innovation management in petrochemical companies producing polyethylene products

Factor	Path coefficient	R2	Rank	Dimensions	Path coefficient	R2	Rank
General	۰,۹٦۷	۰,۹۳٥	First	Economic	0.708	۰,٥۰۱	Fifth
				Organizational	0.945	۰,۸۹۳	First
				Regulatory	0.655	۰,٤۲۹	Sixth
Specific	۰,۹٥۷	۰,۹۱٥	Second	Technological and technical	0.775	۰,٦۰۰	Forth
				Marketing	0.829	۰,٦۸۷	Third
				System	0.901	۰,۸۱۱	Second

6. Discussion and conclusion

as the major part of basic petrochemical products in Iran are intended currently for export, considering international markets for investigating economy conditions and Petrochemical development projects is essential and inevitable. This research was conducted in order to achieve appropriate solutions in order to solve the challenges and development of innovation management model in petrochemical companies which are producers of polyethylene products. In this study, two factors, 6 dimensions and 58 indices were obtained in this study in which the results of research indicated that economic, organizational, regulatory and supervisory, technological and technical marketing and systemic dimensions which were constituent dimensions of the general and specific the factors, have a significant effect on innovation management in petrochemical companies producing polyethylene products. As a result, between the two factors involved in this aspect, general factor has the maximum influence on innovation management. On the basis of the outcomes obtained of SMART PLS software output, indicators with the maximum amount of R2, have a greater share in explaining variance, and also in strengthening and predicting behavior of the related factors, thus, more attention is required for them.

According to the results presented in Table 2, 3 and Fig. 1, following results and the recommendations are obtained:

Economic development (AE9) in economic factor of the indicator has the highest R2 among other indicators of this dimension. This means that economic factor has the greatest share in Explaining variance of economic factor. In this regard, it is suggested that government increases investment in petrochemical companies producing polyethylene products and also pays special attention to such companies.

The organizational structure of innovation reinforcement (BO11) in the organizational factor of indicator has the highest R2 In this context, it is recommended that structure of the petrochemical companies producing polyethylene products is revised and flexible structure with minimal bureaucracy is replaced.

Specified national industrial policies (CR4) in regulatory and supervisory factor have the greatest share in explaining this factor. It is recommended that government takes action on codification of the industrial policies which reinforces innovative products for petrochemical companies in the field of Polyethylene to strengthen this factor.

Compatibility of technology (DT3) in technological and technical factor has the highest r2 in which improvement to greater efficiency is suggested so that innovative technologies are used locally and considering the specific circumstances of the companies. Moreover, necessary Adaptability in this area is done in the field of technology transfer.

Index of sales support (EM3) in marketing factor has the highest R2. Therefore, it is recommended that process of selling support is revised and custodian unit is also strengthened by education and training in order to strengthen this indicator.

The highest amount of R2 in system factor is related to specialize screening system of ideas (FS1) .it is recommended that a system to collect and select ideas and eventually to implement selected ideas, that can lead to can lead to value takeover, is created in order to maintain and strengthen the proposed indicator.

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  Evaluating and analyzing the factors affecting innovation management in the extrusion industry, International conference on business and organizational intelligence. Tehran, Iran, 2016.

  Developing Innovation Management Model in Petrochemical Companies Producing Polyethylene Products and Prioritizing the Factors Using Fuzzy Analytical Network Process (ANP).

  The Development of Innovation Management Model in Petrochemical Companies Producing Polyethylene Products in Iran.

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   Assessment of innovation capability in Iranian power industry & provide solutions for improving

   Identification and evaluation of factors affecting the management of innovation in Iranian pharmaceutical industry

  Performance Evaluation of N.P.D Management in the Iranian Automotive Industry and Prioritize of the Components with TOPSIS

  Providing a Model for Assessment and Analysis of Technological Capabilities in Iran Petrochemical Industries Engineering Services

  Consideration and Evaluation of Knowledge Management Performance in Iranian Automotive Industry