Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

ASSESSMENT AND ANALYSIS OF EFFECTIVE ELEMENTS ON TECHNOLOGICAL CAPABILITY OF IRANIAN AUTOMOTIVE INDUSTRY AND PRIORITIZE ALL DIMENSION OF CAPABILIITY BY AHP

Abbas Khamseh [1]*, Hamid Hanifi [2]
Department of Industrial Management, College of Management and Accounting, Karaj Branch, Islamic Azad University, Alborz, Iran. * (Corresponding author)
E-Mail: khamseh1349@gmail.com
Department of Technology Management, College of Management, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran.
E-Mail: hanifi123@yahoo.com

ABSTRACT
This study aims to assess factors affecting technological capability of the automotive industry in Iran using Panda & Ramanathen's Assessment Model. Accordingly, three Iranian large automakers including Iran Khodro, Saipa and Pars Khodro companies were selected and then the capability of each company was identified in nine major dimensions through a separate investigation of each of the three companies. Additionally, the gap in each level in three companies was separately determined and using the numbers calculated on various capabilities; a comparison was separately and averagely made between the different dimensions for three companies of Iran Khodro, Saipa and Pars Khodro. The results finally showed that among from 9 capability dimensions, Pars Khodro had a lower capability in 8 items compared to the other two companies. In all dimensions of strategic and technological and complementary capacities, Iran Khodro Company had a higher capacity than the other two companies. It was also found that Saipa was stronger than the other two companies in all dimensions of tactical capacities. Also, in this study, capabilities of each of the three companies were compared to the industrial average of the automotive industry. To conduct the study, a number of experts in three companies were identified as the study population. The study instrument was a questionnaire and after the completion of the study, comparison was made in terms of various capabilities of the three companies and warning level.

KEYWORDS: Analytical Hierarchy Process (AHP), Panda and Ramanathen Model, Technology, Technology Assessment.

INTRODUCTION

Not only have countries pioneer in modern science and technology never neglected the continuous assessment of their companies, institutes and scientific centers, but also they have gained effective strategies for utilization of researching human resources, improvement of the quality of research and their obtained results and preparation for national and international collaborations based on the logical assessment. According to Chen Lo and Mei (2010), the more the knowledge of companies on the processes of work, market, customers and their technology is, the better the determination of the value of project opportunities will be. In addition, the possibility of the management of the assessment process will highly influence the results of assessment. Therefore, the process of assessment should be structured, regular and measurable (Khalil, 2002). In this regard, given the high significance of technology development, the senior managers of economic enterprises should continuously take a step for upgrading the technological capabilities of their organization through properly understanding the technological capabilities of their organization, identifying technological developments in the world and considering efforts of competitors to achieve new technologies (Unido, 2002) In this study, three companies in the automotive industry have been examined and after auditing and evaluating the technological capabilities of these companies, their technological gaps have been identified and proper solutions have been presented to eliminate them. The overall process of the study is that the related product and technology has first been described and then, a ruler has been designed for measuring technological gap and using it, the technological gap between the current and desired situations has been measured. Furthermore, causes of technological gap between the desired and current situations in all three companies were investigated and at the end, in order to reduce the technology gaps, effective solutions have been presented.

REVIEW OF THE RELATED LITERATURE

Technology is much beyond machines and in addition to hardware specification, other technical cases including software and human skills are applied too. Technology includes all knowledge, products, tools, methods and systems

served to provide a product or service. Technology is the process of transition and conversion of resources through knowledge, experience, information and tools (Khalil, 2002). Technology refers to the systematic knowledge in producing a product, presenting a service in industry, agriculture or commerce or installing and maintaining an industrial company or equipment for the management of an industrial company (WIPO, 2010). Technological capabilities in an industry include technical, managerial and institutional skills (Lo and Mei, 2006). Innovation is the conversion of knowledge and ideas into new or improved products, processes, services or to obtain competitive advantage (Microsoft Corporation, 2007).

Technology assessment is an analysis to identify strengths and weaknesses of organization's technology assets and that it aims to assess organization's technology status in comparison with competitors and the most advanced technologies (Porter, 1998). Technology assessment is a tool or intellectual framework which helps better understand the technology and decision making on it. Nowadays, technology assessment is, at the macro level, introduced as an information source that injects information to the process of policy making. Technology assessment should analyze and assess wanted or unwanted outcomes, opportunities and risks of technologies including new or stabilized technologies. The maxim of technology assessment is that a new technology must be better than the previous one, otherwise it is not needed. The word better considers both scientific aspect of a technology and its social, economic and environmental dimensions. In general, technology assessment refers to the process within which the effects of introduction, development, and modification of a given technology are systematically examined and measured in an economic enterprise or in a society. Today, to survive in a competitive arena, organizations must inevitably turn to develop technology and create advanced technologies (Jafar Nejad, 2006). Technology is the process leading to the commercial production of goods or services in an explicit or implicit research and development stage by applying the scientific knowledge. Technology assessment means a systematic effort for predicting consequences of a particular technology in all areas which probably interact with that technology. One of the necessities for the selection of appropriate technology is its use in supplying benefits of society and institution and its proper assessment. Technology is in a human environment; therefore, technologies interact with physical environment and various systems of human environment including economic, social, cultural and political systems and other systems constituting it. In other words, different technologies affect diverse systems of surrounding human environment and in turn, these systems have reactions, therefore, technology assessment should be done with an overall attitude. In examining advantages and limitations of technology, the criterion should not be just technical effectiveness and economic efficiency but in relation to its surrounding human environment. The concept of technology assessment is to minimize positive effects and develop technologies compatible with the surrounding environment (Jafar Nejad and others, 2006). The assessment of technological capabilities is considered as a process through which the size and position of technological capabilities is measured and its strengths and weaknesses are identified. Thus, the related organization can compare its capabilities with that of competitors and through this, can define some activities to compensate its technology gaps (Tabatabaeian, 2006). Technology assessment involves all continuous efforts to identify, analyze, and assess results from the application of existing or emerging technologies on various sectors of the community. Results of these efforts are given to decision makers as guidelines and to select the most appropriate technology. According to this definition, it can be found that technology assessment is a continuous and permanent activity. In order to develop technology, nothing is more important than technology assessment and it should be noted that any type of assessment and action in this field requires a series of initial operations as the identification of the main indexes. In this assessment, all components of technology including brain-ware, hardware, software, organization-ware and management should be evaluated (Ghazi Nori, 2004).

In our country, the assessment of technological capability has not been fully considered and in this regard, not much culturalization has been done and even if organizations want to move toward this, very few sources is available to them. Today, to remain in the competitive arena, organizations must inevitably turn to develop technology and create advanced technologies while the question arise what is the best way to reduce technology gap in the route of obtaining technology (Jafar Nejad, 2006). It seems that in order to acknowledge these subjective estimates, models of technological capabilities are as appropriate tools. Experience shows that models and methods applied in a company should have two basic properties: first, it should be simple and understandable and second, it should present results at a short and acceptable period of time (Tabatabaeian, 2009). The main factor of failure in the implementation of technology to gain competitive advantage in developing countries is lack of knowledge and information in the level of technological capabilities as well as its application in comparative advantages. The significance of the improvement of

technology led the senior management of companies to take action for identifying and assessing their organizations' capabilities along with identifying technological improvement in the world, observing competitors' efforts to acquire new technology and moving toward the improvement of organization's technological capabilities. On the other hand, technology assessment is one of the key tools in environments of technological management for identifying strengths and weaknesses with the aim of measuring technological gaps (Radfar.*et al.*, 2014). As the factor of knowledge and practical experience, technology is suitable for producing or supplying products. Technology is the process to transfer resources and the process to transform knowledge, experience information and tool (Khalil, 2000). Through studying the development of technology assessment in six countries of the United States, Sweden, Germany, England, Holland and France, eight effects which technology assessment should have, were determined (Ende, 1998):

1. Developing the information resources of policy-makers
2. Assisting short-term and medium-term policy-making in executive and legislative organizations
3. Assisting to create and develop long-term policies through providing information about progresses and potential options
4. Early warning with an aim to provide information about the possible negative consequences of technology development at the earliest possible stage
5. Strengthening decision-making on technology by assisting various social groups for adopting a proper strategy in relation to technology development
6. Identifying, formulating and developing useful and desirable technological applications for the society
7. Encouraging the public to the acceptance of technology
8. Increasing the awareness of the scientists about their social responsibilities

The technology gap demonstrates the rate of gap between the current level of technological capability of a given company and its required level (Tsukamoto, 2008).

CLASSIFICATION OF THE TECHNOLOGICAL CAPABILITY ASSESSMENT MODELS

There are several models for technological capabilities that are categorized in three overall classifications in Table 1 as follows:

Table 1: Classification of technological capability assessment models (Radfar. *et al*., 2014)

Models of determining technology gap	Models of assessing the incidence causes of technology gap	Models of providing the guide lines to compensate the technology gap
Atlas of technology model Porter's model Panda and Ramanathen model Floyd model Management technology needs model Technology assessment content model Technology status assessment model Economic value added model	Ford models Lindsay model Atlas of technology model Floyd model Management technology needs model Model of technology capability levels model	Ford model Lindsay model Phaal model Garcia-Arreola model Lin model Management technology needs model Technology and Science management information model Technology needs assessment model

The objectives and research questions

This study aims to determine technological capabilities at automotive industry in Iran and the case study of the biggest automotive companies of Iran Khodro, Saipa and Pars Khodro. Also, the study aims to compare these three companies with each other in various aspects in terms of technological capabilities and the industrial average as well as to determine the technological gap in each dimension. In terms of aim and methodology, the current study is an applied and survey study. The research questions include:

ISSN: 2319–4731 (p); 2319–5037 (e)

1. How is the level of technological capabilities of the three companies in terms of strategic capabilities in comparison with each other?
2. How is the level of technological capabilities of the three companies in terms of tactical capabilities in comparison with each other?
3. How is the level of technological capabilities of the three companies in terms of complementary capabilities in comparison with each other?
4. How is the total of technological capabilities of the three companies in comparison with each other?
5. How is the technological gap of the three companies in each dimension of technological capabilities compared to the desired level and the industrial average?
6. How is the prioritization of the dimensions of technological capabilities in Automotive Industry in Iran?

An introduction into the model applied in this study:

Technological levels assessment model: Panda & Ramanathen Model is one of the instruments to specify capabilities required for the implementation of technological priorities in enterprises. This method examines technological levels of enterprises in 3 main dimensions and 9 sub-dimensions along with 36 indices according as given in Table 2.

Table 2: Classification of dimensions of capability based on Panda & Ramanathen Model

Panda & Ramanathen Model for level assessment	
Strategic capabilities	Creativity capability
	Engineering Design capability
	Construction capability
Tactical technological capabilities	production capability
	Marketing and Selling capability
	Serving capability
Complementary technological capabilities	Acquisition capability
	Support capability
	Strategic capability

The study population

Bachelor's degree and above, and associate's degree and above with the work experience more than 1 year (Table 3) were selected as the population of experts in the present study and the study population was determined according to the the company's conditions at the study time. In addition, it should also be noted that members of experts were selected from various units with diverse technical and engineering experiences.

Some of the work environment for experts are engineering and design unit, quality engineering, investigation and development of new products, product engineering, process engineering, production quality etc. in each of the three companies.

Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

Table 3: Descriptive parameters of respondents in Iran Khodro, SAIPA and Pars Khodro Companies

Row	Level of education	Number	The average work experience
Iran Khodro (Hanifi,2014)	Bachelor's degree	17	13
	Master's degree	13	12
Saipa (Khamseh and Pashmchi,2014)	Bachelor's degree	23	11.5
	Master's degree	17	11
Pars Khodro (Khamseh and Pashmchi,2014)	Associate's degree	2	4.5
	Bachelor's degree	22	9
	Master's degree	20	11

The answer for the research questions

The answer for the first research question:

How is the level of technological capabilities of three companies in terms of strategic capabilities in comparison with each other?

Levels of strategic capabilities in the three companies and the industrial average are given in Table 4. Also, the items are determined in diagram 1 for each of the three as well as the industrial average.

Table 4: Comparison of the strategic capabilities in three companies in various dimensions

Dimensions	Pars Khodro (Khamseh and Pashmchi,2014) (%)	SAIPA (Khamseh and Pashmchi,2014) (%)	Iran Khodro (Hanifi,2014) (%)	industrial average (warning level) (%)
Creativity capability	63.64	64.06	72.08	66.59
Design and engineering capability	65.93	72.90	75.73	71.52
Construction capability	67.61	71.47	73.63	70.90
The total average of all strategic capabilities	65.72	69.74	73.81	69.67

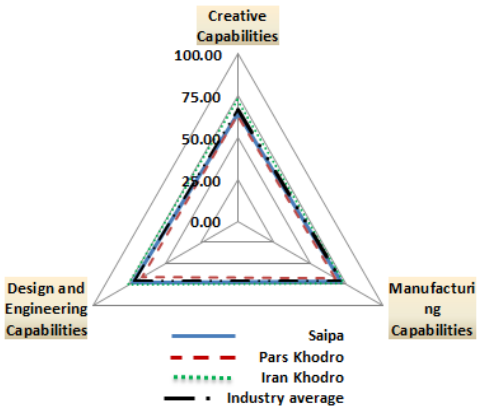

Diagram 1: Comparative diagram of strategic capabilities for three companies

The answer for the second research question:

How is the level of technological capabilities of the three companies is in terms of tactical capabilities in comparison with each other?

Levels of tactical capabilities in the three companies and industrial average are given in Table 5. Also, these items are determined in diagram 2 for all the three companies and industrial average.

Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

Table 5: Comparison of tactical capabilities in three companies in various dimensions

Dimensions	Pars Khodro (Khamseh and Pashmchi,2014) (%)	SAIPA (Khamseh and Pashmchi,2014) (%)	Iran Khodro (Hanifi,2014) (%)	industrial average (warning level) (%)
Production capability	71.31	74.25	72.92	72.83
Maketing and selling capability	66.06	78.21	69.89	71.39
serving capability	66.06	66.31	65.04	65.80
The total average of all tactical capabilities	68.19	72.44	69.28	70.00

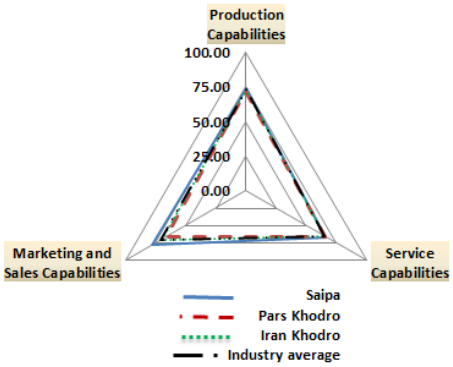

Diagram 2: Comparative diagram of tactical capabilities for three companies

The answer for the third research question:
How is the level of technological capabilities of the three companies in terms of technological capabilities in comparison with each other?
Levels of complementary technological capabilities in three companies and industrial average are given in Table 6 and these items determined in diagram 3 for every three companies and industrial average.

Table 6: Comparison of complementary capabilities in three companies in various dimensions

Dimensions	Pars Khodro (Khamseh and Pashmchi,2014) (%)	SAIPA (Khamseh and Pashmchi,2014) (%)	Iran Khodro (Hanifi,2014) (%)	industrial average (warning level) (%)
Acquisition capability	66.9	72.53	74.88	71.44
support capability	63	66.10	68.70	65.93
strategic capability	55	63.04	68.06	62.03
The average of all complementary capabilities	62.32	67.48	70.54	66.46

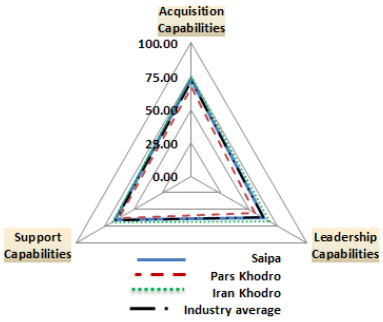

Diagram 3: Comparative diagram of complementary capabilities for three companies

Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

The answer for the fourth research question:
How is the total technological capabilities of three companies in comparison with each other?
According to the obtained results, all diamensions of the study are in accordance with Table 7 and Diagram 4 which show average and the percentage of capability scores and indicates that the technological capabilities of SAIPA, Pars Khodro and Iran Khodro Companies are 69.89%, 65.41% and 71.21% compared to the desired level (100%).

Table 7: Comparison of technological capability in three companies in various dimensions

Main dimensions / main factors	Sub-dimensions	Pars Khodro (Khamseh and Pashmchi,2014) (%)		SAIPA (Khamseh and Pashmchi,2014) (%)		Iran Khodro (Hanifi,2014) (%)		industrial average (warning level) (%)	
		sub dimensions	Main dimensions	Sub-dimensions	Main dimensions	Sub-dimensions	Main dimensions	Sub-dimensions	Main dimensions
Strategic technological capabilities	Creativity capability	63.64	65.72	64.06	69.74	72.08	73.81	66.59	69.67
	Design and engineering capability	65.93		72.90		75.73		71.52	
	Construction capability	67.61		71.47		73.63		70.90	
tactical technological capabilities	Production capability	71.31	68.19	74.25	72.44	72.92	69.28	72.83	70.00
	Maketing and selling capability	66.06		78.21		69.86		71.39	
	serving capability	66.06		66.31		65.04		65.80	
complementary technological capabilities	Acquisition capability	66.90	62.32	72.53	67.48	74.88	70.54	71.44	66.46
	support capability	63		66.10		68.70		65.93	
	strategic capability	55		63.04		68.06		62.03	
Overall thecnological capabilities		65.41		69.89		71.21		68.71	

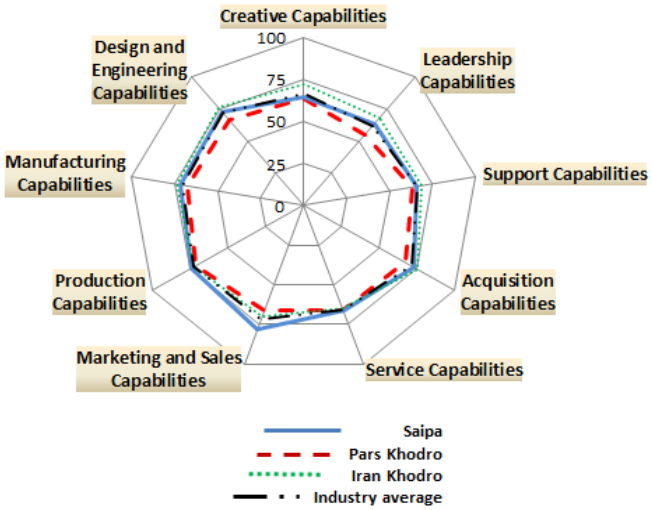

Diagram 4: Comparative diagram in various sub-diomensions of capabilities for three companies

Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

The answer for the fifth research question:
How is the technological gap of three companies in each dimension of technological capabilities compared to the desired level and the industrial average? According to the current and desired levels, it can be said that there is a difference between these two levels in three companies assessed for technological capabilities. Compared to the desired level (the top level of questionnaire) in each main diomension, the size and difference of gaps in the three companies have been shown in Table 8 and Diagram 5.

Table 8: Qantitative level of the gap between the existing and desired leves

Thecnological capabilities	Pars Khodro		SAIPA		Iran Khodro		Industrial average (warning level)	
	Existing level	Gap	Existing level	Gap	Existing level	Gap	Existing level	Gap
Strategic technological capabilities	65.72	34.28	69.74	30.26	73.81	26.19	69.67	30.33
tactical technological capabilities	68.19	31.81	72.44	27.56	69.28	30.72	70	30
complementary technological capabilities	62.32	37.68	67.48	32.52	70.54	29.46	69.46	30.54
Overall tecnological capabilities	65.33	34.67	69.81	30.19	71.21	28.79	69.71	30.29

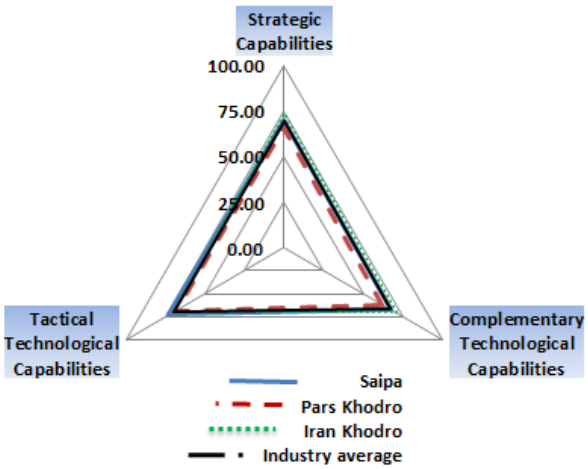

Diagram 5: Comparitive diagram of levels

The answer for the sixth research question
How is the prioritization of dimensions of technological capabilities in Automotive Industry in Iran? Given the opinion of the experts, using AHP paired comparisons and Expert Choice software, the sub-dimensions of technological capabilities were prioritized in 9 above-mentioned dimensions in each of the three companies according to Diagram 6:

Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

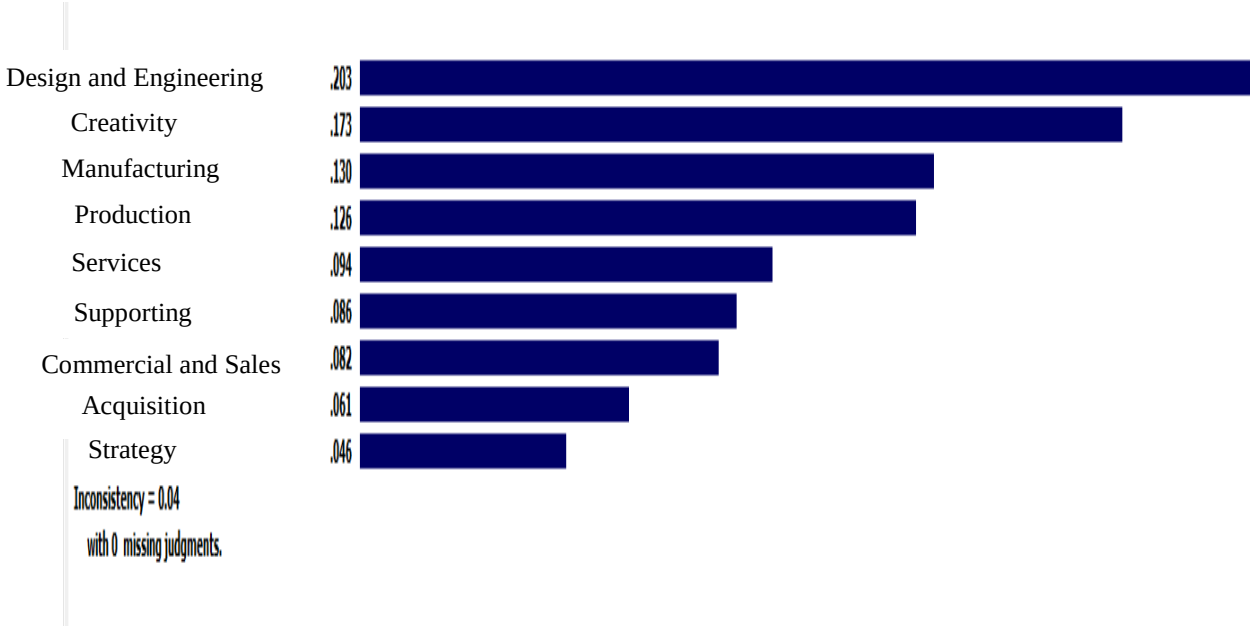

Diagram 6: Prioritization of dimensions of technological capabilities based on AHP paired comparisons in Automotive Industry in Iran

CONCLUSIONS AND RECOMMENDATIONS:

According to the conducted study, the obtained results are expressed in three parts:

A. Results of the tables of the comparison of capability dimensions in Iran Khodro, SAIPA and Pars Khodro Companies:

1. In the main dimension of strategic technological capabilities, Iran Khodro was more capable compared to Pars Khodro in every three sub-dimensions i.e. creativity, design and engineering and construction capabilities, while Pars Khodro had the least capability than the other two companies in the three mentioned sub-dimensions.
2. In the main dimension of tactical technological capabilities, SAIPA was higher capable compared to the other two companies in every three sub-dimensions i.e. production, marketing and selling and serving capabilities and Pars Khodro had less capability than the other two companies in both sub-dimensions of production, marketing and selling.
3. In the main dimension of the complementary technological capabilities, Iran Khodro was the most capable company compared to the other two companies in the three sub-dimensions i.e. acquisition, support and strategic capabilities and Pars Khodro had the least capability than the other two companies in this item.
4. According to the results obtained from the percentage of capabilities in all three companies in comparison with each other, Pars Khodro had the most improvable points in 8 sub-dimensions except for serving dimension compared to the other two companies.
5. In addition, according to the comparison of capabilities with industrial average (warning level), Pars Khodro had averagely the least capability than the industrial average and both Iran Khodro and SAIPA had higher capabilities compared to the industrial average (warning level).

B. Results of the technology gap tables:

According to the results of capabilities and compared to the desired level, it was determined that all the three companies had gap in various dimensions compared to the desired level. The obtained results indicated that based on the desired level, Pars Khodro Company had more gap in three dimensions of strategic technological capabilities, tactical technological capabilities and complementary technological capabilities compared to the other two companies and industrial average (warning level). On average, Iran Khodro Company had the minimum gap among three companies in three above-mentioned dimensions based on the desired level, while SAIPA had fewer gaps than Pars Khodro compared to the desired level.

C. Results of prioritization table using AHP paired comparisons

Given the opinions of the experts, all three companies were prioritized in 9 dimensions of capabilities using AHP paired comparisons and Expert Choice in terms of importance. In this prioritization, design and engineering, creativity and construction capabilities, have the highest importance, respectively and marketing, acquisitions and strategic capabilities, had the least importance than other capabilities, respectively.

REFERENCES

Ghazi Nori S.S. (2004). Assessment of the technology of tool to help policy-making, First edition, Tehran: Publishing by Center of New Industries.

Hanifi (2014). *Indian J. Fundamental and Applied Life Sci.*

Jafar Nejad A. and *et al*., (2006). Technology Auditing: A Methodological Presentation for Filling the Technology Gap.

Khalil T. (2000). Management of Technology: The Key to Competitiveness and Wealth Creation. McGraw-Hill.

Khamseh A., PashmchiA (2014). *Indian J. Fundamental and Applied Life Sci*. ISSN: 2231– 6345.

Lall S., "Technology Policies and Market-Stimulating", Office of Industrial Policy, Technology Studies of Sharif University of Technology, 2006.

Lo and Mei (2010). A Preference Relation Model for Technology Assessment in Business Management, *International J. Information Systems for Logistics and management*. 6:

Microsoft Corporation (2007). White Paper Innovation Process Management, download.microsoft.com.

Porter M. (1998). Competitive Advantage: Creating and Sustaining Superior Performance, Free Press, and New York.

Radfar R. *et al*. (2014). Assessment of technological capability level of Iranian Pharmaceutical Industry. *Indian J. Sci. Res.* 1(2) : 556-562.

Tsukamoto O. (2008). Overview of superconductivity in Japan –Strategy road map and R&D status, Physical.

Tabatabaeian S.H. (2005). Assessment of firm-level technological capabilities, Arian Printing
Site of Technology Exchange Center of the Country.

Unido, (2002). Technology Need Assessment for developing countries, www.unido.org.

Van Den Ende J. (1998). Traditional and Modem Technology Assessment: Toward a Toolkit Technological forecasting and social change. 5-21.

WIPO (2010). National office for Technology Acquisition and Promotion (NOTAP), Basic Issues in negotiating technology Transfer Agreements.

