Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at http:// http://www.cibtech.org/sp.ed/jls/2014/01/jls.htm
2014 Vol. 4 (S1) April-June, pp. 216-227/Ghaydari et al.
Research Article

ANALYSIS OF TECHNOLOGICAL INNOVATIVE CAPABILITIES IN MILITARY INDUSTRIES: CASE STUDY OF AEROSPACE INDUSTRIES

Kiumars Ghaydari[1], Saeed Ghaydari[2] and Hamid Ghaydari[3]
[1] *Department of Industrial Management, Faculty of Management and Accounting, Islamic Azad University, Iran*
[2] *Department of Industrial Management, Faculty of Management and Accounting, Islamic Azad University, Iran*
[3]*Department of Industrial Management, Faculty of Management and Accounting, Islamic Azad University, Iran*
**Author for Correspondence*

ABSTRACT
Economic development of all countries, industries and companies depends now on the effective technology management, and appropriate efficiency of technologies will be not only the reason of survival of organization but the cause of wealth creation through competitive capability. Unfortunately, almost all corporates in developing countries have not been successful in applying technologies as a competitive advantage due to unawareness of their technological capabilities and potentials, as solution of this problem is a purpose and challenging target of current managers. Technological capabilities evaluation models may help us in acquiring this knowledge and identifying the relative advantages of corporates. This research was carried out in a company of aerospace industries after selecting Panda & Ramanathen model among the available models, supposing that the criteria of the mentioned model can be different in importance and this was studied as minor question of research. For this purpose, the model criteria were compared to each other two by two (couple comparisons) by using AHP technique, and finally the importance of each criterion was extracted. Then, a number of senior managers, middle-rank managers, senior experts and experienced experts in the field of technology were selected as statistical society of research and answered to the 36-question questionnaire, and after reliability of the compatibility rate of answers and statistical analyses, capability level of industry on study was identified.

Keywords*: Technology, Technological Capability Assessment, Panda & Ramanathen Model, Innovation*

INTRODUCTION
Science deals with understanding the nature law, which results the discovery of fundamental knowledge on world, ontology and all living objects. Scientific knowledge concentrated on the natural phenomena keeps silence on this question: "how to use knowledge". The scientific knowledge is served in connection to the works we do in life only when the knowledge enters technology.

When we talk about the science, we point to the scientific discoveries but when we address the technology, it means technological innovation. Both are interrelated as they influence on each other. Scientific discoveries may result the innovations and inventions. New technology makes possible the new scientific discoveries. Science and technology may effect on the human life when they come to trade. Market may purchase or even ignore an innovation. Figure 1 shows the interrelation of scientific discoveries, innovation, invention, market and their interrelations.

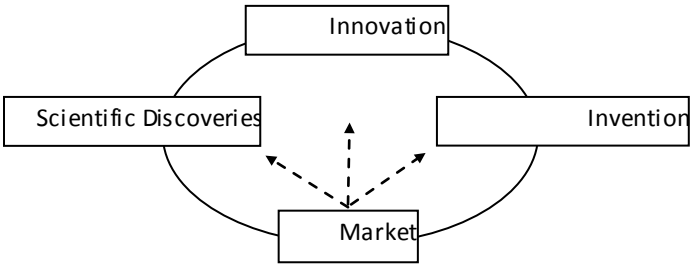

Figure 1: Components of a Technology Cycle (Khalil , 2000)

The most important and obvious difference between today and past worlds is the fast speed of technological changes caused by the rapid changes of innovation so that the technology has changed to a critical factor in economic growth and success. In addition, the market behavior has changed and current products are manufactured for supplying special needs and demands of customers, and the customers have right of selection. Accordingly, producers have to ignore the method of using fixed production lines. Flexibility and capability of immediate response to modification is a principle of this new method.
Countries, industries and individuals shall develop their capabilities and potentials in order to prevent backwardness from technological changes and control of technology. In world level, national competition requires an appropriate economic system, strong technological capabilities and potential of trade with other countries. Generally, the integration of economic system, technological capabilities and business will reinforce the sustainable economic development. Figure 2 indicates these three conceptions.

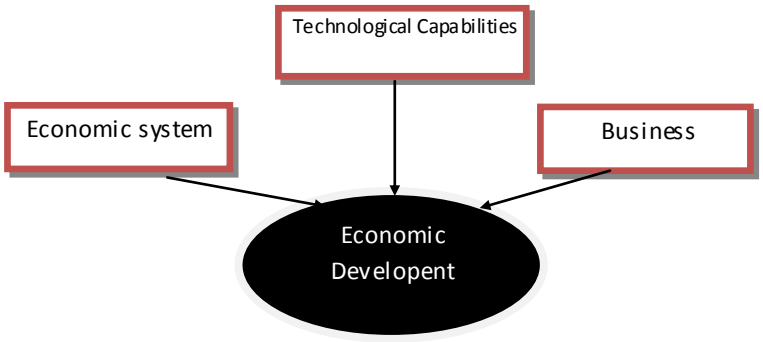

Figure 2: Technology and Sustainable Development (Khalil , 2000)

Developed economies are recognized by the countries which use technology for wealth creation in an appropriate manner, and the underdeveloped economies by the countries not having the necessary technological knowledge for wealth creation. An obvious item in this regard is that "wealth is not created by the technology but the effective and appropriate method of using technology". When technology is used for increasing resources and providing goods and competitive services, wealth is created; therefore, this is technology management that creates wealth (Khalil, 2000).
The status of governments, different industries, private and public companies and all members of a society are dependent on the use of technology. Development of different sciences provides the fields of pressure on technological development so that prototypes change to technological innovation, and such ideas change new products and services. Hence, policy makers pay attention to the technology management in higher levels as a strategic factor. In industry, authorities and planners of different industries consider the technology management in this respect that the promotion of technology may increase the efficiency and affectivity of related industry. Technology, however, is infrastructure of

business and main factor of production and services in economic corporates. Therefore, higher managers of economic corporates try the best for correct guidance of this principal factor. Disregarding technology either is or shall be used in a level, competition and fast technological developments play critical role in formation and completion of its management (Dorri, 2012).

One of the main factors in unsuccessful use of technology for acquiring the competitive advantage in defensive industries is unawareness of technological capabilities and its use in reaching competitive advantages.

Review of Literature

Assessment of technological needs is a framework and mean designed for recognizing and determining capabilities required for execution of technological priorities in developing countries (UNIDO, 2002).

Technological capability assessment is a mean for determining required capabilities and executing technological priorities, which not only analyzes and assesses the technological problems and deficiencies in corporates but tries to identify the relative technological advantages of corporates (Esbati, 2007).

Nowadays, organizations have to develop advanced technology for survival in the competition but this question comes to the mind that "what is the best solution for reducing gap of technology in the way of reaching technology?" (Jafarnejad, 2006).

It seems that a suitable mean for confirming mental estimations is technology capability models. It is approved in experience that the models and methods used in company should enjoy two principal characteristics: (1) being simple and understandable, and (2) offering result in an acceptable short time (Tabatabaeian, 2005).

There are different models concerning the technological capability assessment, classified in three general parts, and shown in table 1:

Table 1- Classification of Technological Capability Evaluation Models (Khamseh , 2010)

Technology Gap Determining Models	Technology Gap Reason Evaluation Models	Solution Presentation Models for Compensation of Technology Gap
Atlas Fanavari Model Porter Model Panda & Ramanathen Model Fluid Model Technological Needs Management Model Technological Content Evaluation Model Technological Status Evaluation Model Economic Value Added Model	Ford Model Lindsey Model Atlas Fanavari Model Fluid Model Technological Needs Mngt. Model Technology Capability Level Model	Ford Model Lindsey Model Fall Model Garcia- Arola Model Leen Model Tec. Needs Evaluation Model Science & Tech. Mngt. Information Systems Model Technological Needs Mngt. Model

Research Goals and Questions

The purpose of execution of this research is to determine technological capabilities levels of one of the aerospace companies and analyze the gap in all levels. This research is applied in terms of purpose, and survey in terms of methodology.

A. Main questions of this research are as follows:
- **1-** What level is the technological capabilities of company in 9 minor aspects?
- **2-** How much is the technological gap of company in 3 main aspects?

B. Minor questions of research are as follows:
- **1-** How much is the weight importance of criteria of Panda & Ramanathen evaluation model on the subject of research?
- **2-** What level is strategic capabilities of company in?
- **3-** What level is tactic technological capabilities of company in?
- **4-** What level is complementary technological capabilities of company in?

Introduction To Used Model

Ramanathen and Panda technological levels evaluation model is a mean for specifying and determining necessary capabilities for execution of technological priorities in corporates in order to analyze levels of technological capabilities in 3 major and 9 minor aspects with 36 indices . Figure 3 shows the classification of aspects of technological capabilities according to Panda & Ramanathen Model.

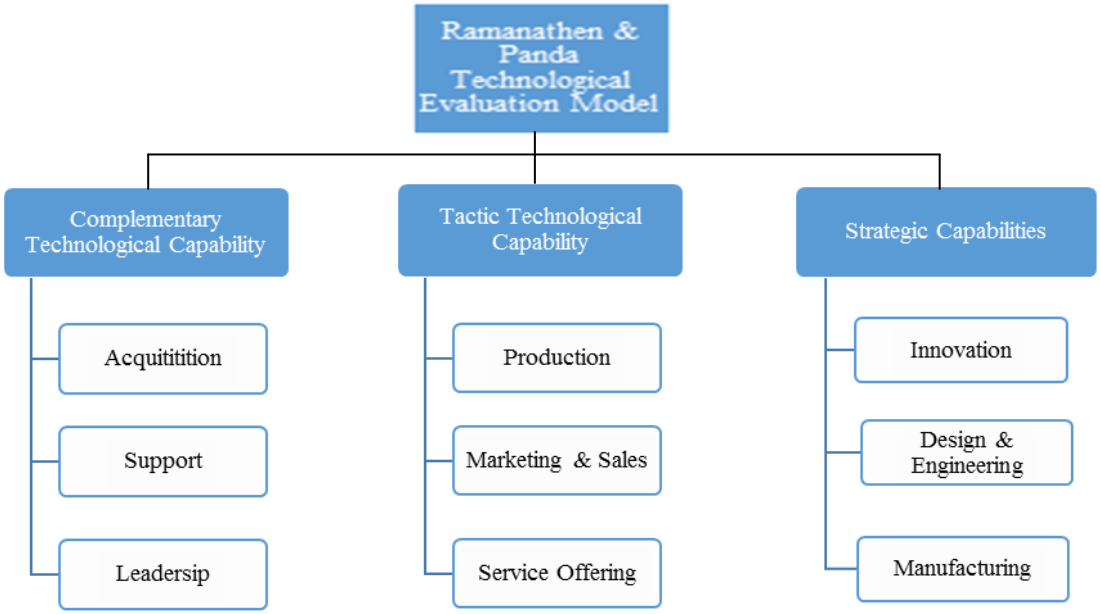

Figure3- Criteria of Panda & Ramanathen Evaluation Model (Radfar, 2011)

Weighing Criteria

Before we use Panda & Ramanathen model and try the evaluation process, this question is discussed: "do the weights of major and minor criteria in this model have the equal importance?", and "what change will the obtained results have if any difference?".

Principally, it is difficult to find the weight of each criterion, compared to other criteria, and as the number of criteria increases, the mental imagination and presentation of answer will be harder. To solve this problem, comparisons were performed two by two (couple comparisons). The technique used in this research is AHP, by which the importance coefficients for 3 major criteria are compared in the first step, and the minor criteria through the next three steps. In addition, the compatibility of comparisons was controlled by using the compatibility rate at the end of each step.

1st Step: Couple Comparisons

Two by two comparison is performed by using the scale designed from equal to indefinite priority of reference. The experience shows that the use of numerical rate of 1/9 to 9 enables decision maker to perform the comparisons in a good manner. (Azar , 1994).

In this step, four senior experts compare three major aspects two by two in the form of four 3×3 matrices. The common method for combining four comparative tables (comparative matrices completed by 4 senior experts) is to gather 4 members together and reach to a unit decision (consensus) concerning each component of comparative table Researchers don't advise such method for integration of decisions of group members because the use of this method will make in practice the comparative table of each member meaningless. The best method of combining comparative tables of group members is to use

geometrical average. Since couple comparisons will average is mathematically the best average for combining judgments in AHP. The result of combining decisions of four senior experts by using geometrical average is shown in table 3 (Azar, 1994).

Table 3- Criteria Comparisons Matrix to Each Other in Terms of Experts Group

Complementary Capabilities	Tactic Capabilities	Strategic Capabilities	Major Criteria
4.161791	3.662842	1	Strategic Capabilities
1.565.85	1	0.272998	Tactic Capabilities
1	0.638927	0.265915	Complementary Capabilities

2nd Step: Extraction of Importances

We consider only the group comparison table (table 3) for extraction of importance. The concept of normalization and calculus average is used to determine the importance. After normalization, calculus average of rates of each line (normalized) shows the importance grade of each criterion. Results of the 2nd step are shown in table 4.

Table 4- Normalized and Prioritized Rates of Criteria of Table 3

Priority	Complementary Capabilities	Tactic Capabilities	Strategic Capabilities	Major Criteria
0.65	0.618681	0.690872	0.649809	Strategic Capabilities
0.2	0.232661	0.188616	0.177397	Tactic Capabilities
0.15	0.148657	0.120512	0.172794	Complementary Capabilities

3rd Step: Determining Compatibility Rate

The importance of AHP is the combination of different levels of decision hierarchy, consideration of various factors and the calculation of compatibility rate (C.R). This mechanism indicates the extent we can rely on the priorities (importance coefficient) obtained from group members or combinational tables. Experience may confirm that we can accept comparisons compatibility if C.R is less than 0.1, otherwise, new comparisons are needed. To compare the compatibility rate, the best method is use of special vectors. We don't point the mathematical logic of this method here but use its process for make the data in the form of relation, geometrical measuring C.R in table 4. (Azar, 1994). since n is equal to 3, the rate of R.I was obtained at 0.58 through the Random Compatibility Index table, and after insertion of this rate in the related equation , compatibility of

major criteria is estimated at 0.029 which is less than the experimental rate of compatibility factor

showing the results compatibility and confirmation of importance weights. A similar operation carried out on the main criteria was performed on 3-member groups of minor criteria and their compatibility test was accepted, and the results obtained for determining importance coefficients were estimated equal to the rates mentioned in table 5:

Table 5: Method of Calculating and Determining Importance Coefficient of Minor Criteria to Each other

Measuring Integrated Importance Coefficient of Minor Criteria	Importance of Minor Criterion	Minor Criteria	Importance of Major Criterion	Major Criterion
0.33	0.51	Innovation	0.65	Strategic Capabilities
0.2	0.3	Design & Engineering		
0.12	0.19	Production		
0.11	0.58	Manufacturing	0.2	Tactic Capabilities
0.06	0.28	Marketing & Sale		
0.03	0.14	Service Offering		
0.07	0.48	Acquisition	0.15	Complementary Capabilities
0.03	0.2	Support		
0.05	0.32	Leading		

Statistical Society

General counting method was used for selecting the statistical society due to limited experts. Statistical society includes 37 senior managers, middle-rank managers and experts of production, design and development, quality control, planning and safety sections holding Bachelor's and Master's Degrees with average work experiences more than 10 years. Descriptive parameters of statistical society are mentioned in tables 6 and diagram 1.

Table 6- Descriptive Parameters of Statistical Society

No	Education	Quantity	Percentage out of Total	Average Work Experience (Year)
1	Bachelor's Degree	16	43	14.5
2	Master's Degree	21	57	13.91

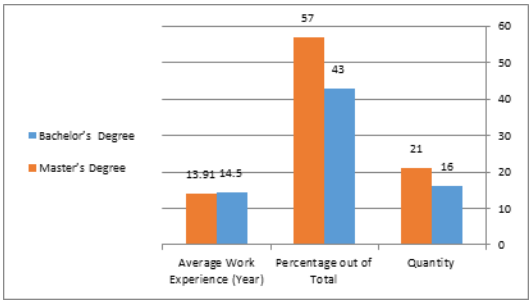

Diagram 1- Descriptive Parameters of Statistical Society

Conclusion of Research Findings

The results of the questions in Strategic Technological Capabilities are shown in the table 7.
The results of the questions in Tactic Technological Capability are shown in the table 8.
The results of the questions in Complementary Technological Capability are shown in the table 9.

Table 7- Average Indices, Components and Aspects in Strategic Technological Capabilities

Aspects	Components	No.	Index	Average Components (a)	Weighing Importance (w%)	Final Average Components a×(1-w%)	Total Average (%)
Strategic Technological Capabilities	Innovation	1	Improving previous products and processes	62.4	0.33	41.81	50.67
		2	Innovating new products and processes				
		3	Establishing new organizational structures				
		4	Planning, supervising and controlling R&D projects				
	Design & Engineering	5	Evaluating projects based on technical, economic, financial and environmental criteria and social outcomes	69.3	0.20	55.4	
		6	Partial ordinary & engineering designs in processes and products				
		7	Reconstructing or constructing again purchased technology				
		8	Compatibility with technology purchased or established				
		9	Planning, supervising and controlling designing and engineering activities of contracts				
	Production	10	Protecting feasibility studies and performing value engineering	62.3	0.12	54.82	
		11	Performing activities of structural construction				
		12	Performing contract working activities				
		13	Planning, supervising and controlling construction, production and startup				

Table 8- Average Indices, Components and Aspects in Tactic Technological Capability

Aspects	Components	No.	Index	Average Components (a)	Weighing Importance (w%)	Final Average Components a×(1-w%)	Total Average (%)
Tactic Technological Capability	Manufacturing	14	Using and controlling efficiency of technology in main and protection processes	67.5	0.11	60.10	61.03
		15	Quality assurance, inspection and control of inventory				
		16	Troubleshooting, preventive repairs and maintenance and removing damages				
		17	Planning production and scheduling equipment repairs and maintenance				
	Marketing & Sale	18	Recognizing customers, informing price of tenders and negotiation with sale conditions	61.6	0.06	57.90	
		19	Supplying product or services to the customers				
		20	Planning, supervising and coordinating marketing and sale activities				
	Service Offering	21	Identifying problems, performing amendments and removing products	67.1	0.03	65.08	
		22	Offering technical recommendations to the customers				
		23	Performing researches related to recognizing needs of customers and determining their satisfaction level				
		24	Planning, supervising and coordinating services, scheduling service equipment and personnel				

Table 9- Average Indices, Components and Aspects in Complementary Technological Capability

Aspects	Components	No.	Index	Average Components (a)	Weighing Importance (w%)	Final Average Components a×(1-w%)	Total Average (%)
Complementary Technological Capability	Acquisition	25	Identifying, evaluating, negotiating and finalizing conditions of acquiring protective technology and facilities	62.7	0.01	62.01	59.66
		26	Identifying, evaluating, negotiating and finalizing financing conditions				
		27	Identifying, evaluating, negotiating and finalizing conditions of supplying manpower				
		28	Planning, supervising and coordinating resource supply processes				
	Support	29	Offering educational programs	58.3	0.03	56.55	
		30	Strategic planning				
		31	Networking and information supporting				
		32	Keeping high level of safety and security				
		33	Selling technology				
	Leading	34	Routing	63.6	0.05	60.42	
		35	Decision making and execution				
		36	Integrating organizational activities				

Answers of research questions

1. What level is the strategic technological capabilities of the company in?

Table 10- Strategic Capabilities

Components	Success of Each Minor Aspect (%)
Innovation	41.8
Design & Engineering	55.4
Production	54.8

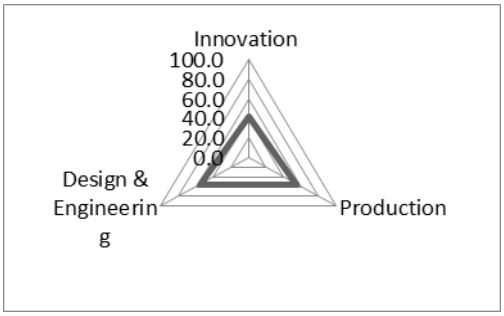

Diagram 2- Strategic Capabilities

2. What level is the tactic technological capabilities of the company in?

Table 11- Tactic Capabilities

Components	Success of Each Minor Aspect (%)
Production	60.1
Marketing & Sale	57.9
Service Offering	65.1

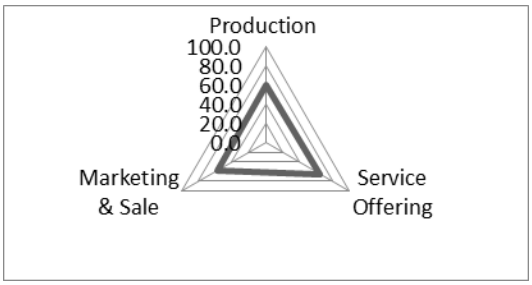

Diagram 3- Tactic Capabilities

3. What level is the complementary technological capabilities of the company in?

Table 12- Complementary Capabilities

Components	Success of Each Minor Aspect (%)
Acquisition	62.0
Support	56.6
Leading	60.4

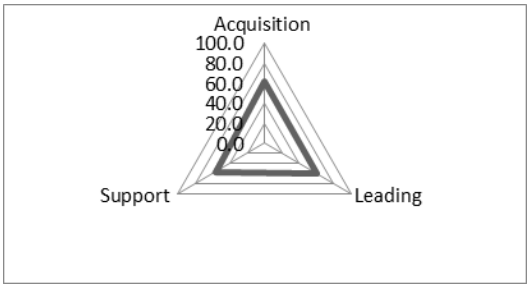

Diagram 4- Complementary Capabilities

4. What level is the technological capabilities of company in 9 minor aspects?

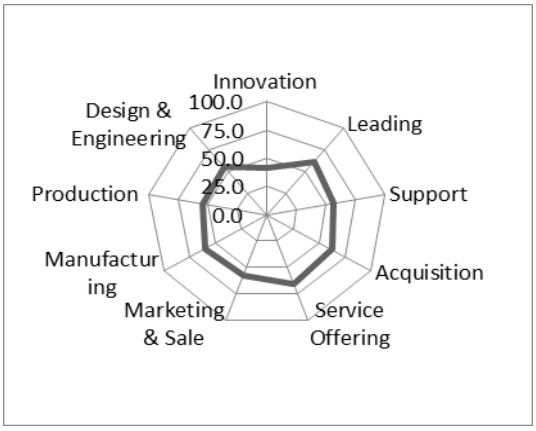

Diagram 5- Technological Capabilities of Company in 9 Minor Aspects

4. How much is the technology gap of company in 3 major aspects of technological capabilities? To confirm the gap, the good level of technological capabilities was considered at 100%.

Table 13- Gap between Current Level and Good Level

Technological Capabilities	Current Level (%)	Gap between Current Level and Good Level (%)
Strategic Capabilities	50.7	49.3
Tactic Capability	61.0	39
Complementary Capability	59.7	40.3

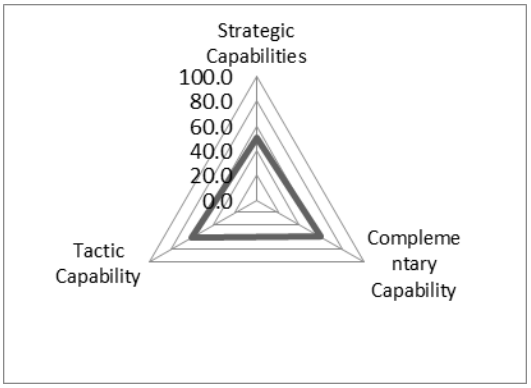

Diagram 6- Diagram of Radar of Technological Capability Levels in Major Aspects

ANALYSIS AND CONCLUSION

1- In strategic capabilities (table 10 and diagram 2) :

Element of innovation capability obtained the lowest score and design and engineering the highest.

Innovation depends on both person and his environment, and the company has to change the workplace to an innovative environment by supposing that the personnel are employed with appropriate specifications. According to Jean and Triyendris (1990), an innovative environment has the following specifications:

a. Allowing personnel work in their favorite fields;
b. Allowing personnel accept the weak risks;
c. Allowing personnel tolerate failures and inconsistencies;
d. Using bonus and acknowledgement for encouraging personnel;
e. Encouraging personnel for making relationship with innovative and motivating colleagues;(Thamhain ,2007)

2- In tactic capabilities (table 11 and diagram 3):
marketing and sale capability has the lowest score, and the service offering capability the highest.

Successful transfer of technologies from idea to market is a complicated and critical process. For success and increase of capability in this field, it is recommended to:

a. Recognize and classify well the customers and their needs;
b. Identify the last technologies in the field of business, and monitor their changes permanently;
c. Create new product by using the technologies based on the customer's favorite;
d. Reduce the time between creating new idea to marketing new product;

3- In complementary capabilities (table 12 and diagram 4):
support capability has the lowest score, and acquisition the highest score. Successful protection of technologies requires performance of the following activities in the company:

a. Planning for training the technological development to the personnel;
b. Trying to sell and support technology in market for acquiring wealth and increasing the knowledge;
c. Passing strategy for obtaining necessary technologies, recognizing suitable technologies, developing current technologies and even removing them, if necessary;

REFERENCES

Esbati H. et al, (2007). Compiling Technology Strategy,Defense Industries Organization;
Jafarnejad A. et al, (2006). Auditing Technology and Offering Suitable Approach for Reduction of Technology Gap;
Khamseh A. et al, (2010). Assessment of Technologic Capability Levels in Metal Industries in Technologic Need Model, Technology Management Conference;
Dorri A., (2012). EMBA Thesis, Tehran University of Science & Technology;
Tabatabaeian S.H. (2005), Assessment of Technology Capability in Corporates, Aryan Edition;
Radfar R. et al, (2011). Assessment of Technologic Engineering Level in Automotive Industry, a Case Study in Pars Khodro Company, Technology Management International Conference;
Azar A. (1994), AHP a Modern Technique for Group Decision Making, Management Knowledge Magazine, No. 27;
Khalil T. M. (2000), Management Of Technology ,The Key To Competitiveness And Wealth Creation , Mc Graw Hill.
Unido. (2002), Technology Need Assessment For Developing Countries , www.unido.org
Thamhain H. (2007), Management Of Technology, Managing Effectively In Technology-Intensive Organizations.