Macrothink Institute™

International Journal of Learning & Development
ISSN 2164-4063
2013, Vol. 3, No. 4

A suitable Model for Formulating Technology Strategy (Case study: A Car Parts Manufacturer in Iran Khodro Company)

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Accepted: August 14, 2013 Published: Sep 06, 2013
Doi:10.5296/ijld.v3i4.4246 URL: http://dx.doi.org/10.5296/ijld.v3i4.4246

Abstract
Nowadays, technology has a great importance. Usage of technology has a significant impact on development and advancement of industry; hence, technology can be used for utilizing suitable opportunities. The purpose of formulating technology strategy is to optimized employment of technologies in order to achieve better position in the market and to save the costs of complicated structures in industrial businesses. Since formulating technology strategy and employing technology strategy models in industrial organizations face with ambiguous, current study attempts to evaluate technology strategy models and to compare them with industry circumstances and as a result, propose a suitable model. We therefore can guarantee the future of car parts manufacturers and help them to achieve competitive advantage.

Keywords: Technology strategy, Strategy formulating approaches, Little model, Hax-Majluf's model

Introduction

The majority of companies perform activities that are based on innovation which in turn, the innovation is based on technology. Thus, technologies are the main factor in generating new products, processes and services in an innovative way. Firms need to formulate technology strategy in an attempt to establish a stable competitive position. In doing so, intelligence planning of firm offered technologies, goods and services; customers and future vision of organization are required. Formulation of suitable technology strategy contributes organization to achieve technological advantage. Nowadays, technology plays a critical role in firm competitiveness; it therefore should be viewed as a key source of organization with a strategic perspective. The first and the most important phase of technology strategic management is the codification of a long-term program that determines investment priorities of organization. This program is called "Technology Strategy". The basic questions in which technology strategy would answer are as following (Lindsay, 1999):

1. What technologies constitutes stable competetive advantage of the firm ?
2. Are these technologies available ?
3. Which ways are suitable to achieve these technologies ?

4. How can acquire more interests from technological assets and capabalities of the firm ?

Firms operating in different industries and of different sizes, have different features. These features make impossible the use of some models. Therefore, managers and experts of weighty piece industry may be difficult to choose the right model. The reason is unawareness of models and differences among them. Understanding the differences among the models is dependent on comparing the models and the awareness of their strengths and weaknesses, as well as the awareness of features, assumptions and applied constraints of them (Dewit and Meyer, 2004). Automobile industry and its parts manufacturers is one of the most important industries of the country and its development can help to the growth of the country. Development of the industry needs to utilize new technology effectively. The necessity of knowing and employing these technologies depend on technology strategy formulation and planning. According to the status of the industry, there is no effective model in line with today circumstances of the industry. Hence, the main issue of this study is to propose a suitable model in line with status and opportunities and as a result, formulating technology strategy matching with firm position based on Hax's model and Little's model integration.

Theoretical background

Technology strategy

The most basic definition of technology strategy is an operational strategy. Therefore, the strategy is a translation and interpretation of the overall strategy of organization in the area of technology. So that the method of superior competitive position achievement and meeting long-term goals of the organization are determined by the development of organization technologies (Danila, 1989). According to Vrnt and Rasty's perspective (1999), technology strategy refers to the priorities of organization for technology development, which in turn, it implies on future activities of the company in the area of its technology (Arabi and Menati, 2010).

Approaches to technology strategy formulation

Different approaches to strategy formulation require to have and to select a specific model. Therefore, the most appropriate model is a model that is consistent with the characteristics of the industry and is flexible in facing with changes.

Two different approaches for developing technology strategy have been proposed (Hax and Majluf, 1996):

1) Identification of the company or organization position approach: The most important of these models based on this approach are Porter's model, Hax's-Majluf's model, Little's model.

2) Resource-oriented and key capabilities approach: The most important of these models based on this approach are Kieza, Prahalad and Hamel's core competency model, the model of super competition of D' Oney and etc.

The characteristics of the first approach are the approximate constancy environment, predictability, a fixed market and the technology assessment of low-tech. The second type of approach is characterized by an unpredictable environment, the effective company's own technology, and the technology assessment of high-tech. To select one of the approaches and related model, the characteristics of technology used by car parts manufacturing industry should be addressed in order to formulate technology strategy path. Technologies used in the production of auto parts have the following characteristics:

- In general, they are not advanced (Hi-Tech) and are nearly Low-Tech.
- Speed of technological change associated with this product is generally low.
- Market dominant paradigms of the product are approximately constant.
- The trend of technology changes almost is predictable.

According to these characteristics, we found that the positioning approach is suitable for developing technology strategies for the company studied in this paper. Therefore, in this paper, the models that have this kind of approach are briefly mentioned.

Little's model

This approach is based on the market and its influential factors and the emphasis on competition and success in the market. Technology strategy has five steps as follows (Floyd, 1998):

1) Identification of the product with the full knowledge of the market
2) Basic knowledge of competing principles
3) Assessment of the critical success factors
4) Knowledge of relevant technologies
5) Selecting the important strategic technologies

Key factors for success are considered as key strategic factors in which provide an operational environment to obtain high efficiency. These factors rise inside and outside of the industry. After identifying key factors, we address internal success factors. The factors would be used in goal setting. Key success factors are one of these internal factors.

Determining the factors has a significant impact in maintaining the competitive position. In this model, technologies related to the key factors should be determined to formulate technology strategies in order to identify future investment by recognizing firm priorities regarding technology.

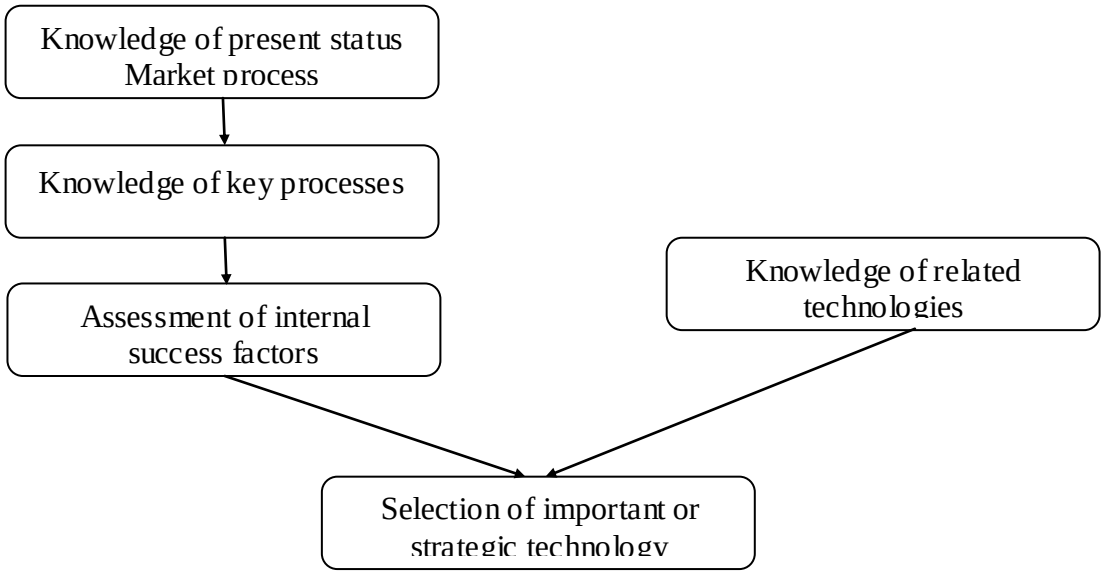

Figure 1. Formulating technology strategy

Porter's model

According to Porter's technology strategy, firm attitude towards development and usage of technology is considered as an important factor in improvement of competition strategy. Porter proposed six steps to formulate technology strategy as following (Khalil, 2000):

1) identifying all key technologies in a chain value
2) Investigating key technology tranformations among other recognized technologies
3) Assessing attractiveness of technology strategy and choosing important technologies

4) Evaluating organization capabalities in technology and estimating required investment to develop them
5) Formulating strategy

Technology strategy formulation for reinforcement of organization competitive position after identifying technologies in firms and related technologies in other industries and identifying probable technological changes, the next step is to indentify critical technologies for competitiveness and adaptability with industry structure. In fact, identifying current technologies and/or future technological options is important because of their effect on current competition in current industry. Next, firm resources would be evaluated to determine what combination of investment in key technologies is possible and reinforce firm competitive position. Hence, based on Porter's theory, technology strategy is formulated to support overall strategy (Positioning School); further, this model propose a step-by-step process to formulate technology strategy in which each step input constitutes previous step output.

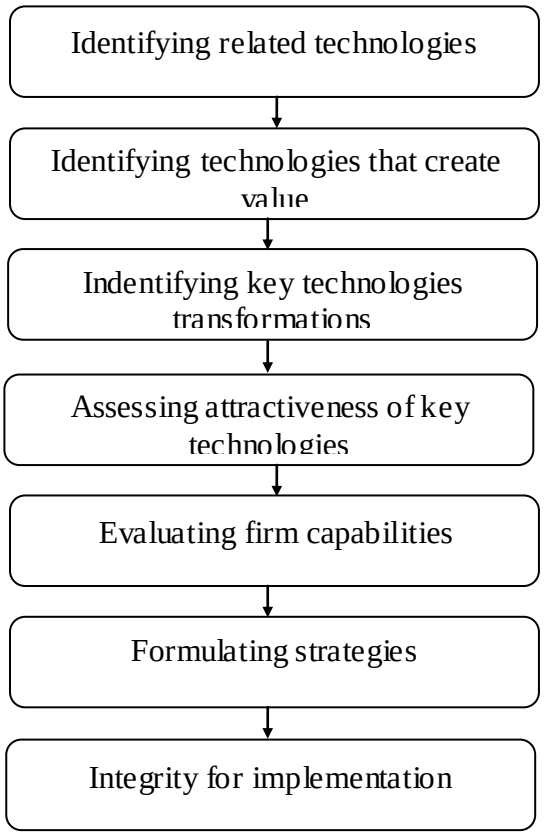

Figure 2. Porter's framework for technology strategy formulation

Hax-Majluf's model

Hax and Majluf (1984; 1991) proposed their model based on Porter's conceptual model to formulate technology strategy. The phases of their model are as following:

1. Determining macro strategies of organization

2. Identifying technology strategic units
3. Evaluating technology transformations particularly n relation to strategic technologies
4. Determining technological capabilities in relation to each strategic technology
5. Formulating technology strategy including three decisions: selection of technologies for development, timing of new technologies introduction, and selection of acquiring methods (4).

According to Hax and Majluf's model, macro strategies of the firm constitute the main inputs of the process of technology strategy formulation. Figure 3 determines the macro strategies of technological needs and then, technological strategic units are identified on the basis of technologic needs (positioning approach). Internal analysis considers technological weaknesses and strengths of the firm and evaluates attractiveness of technology to provide required information for technology strategy formulation (Arasti and Pakniat, 2010).

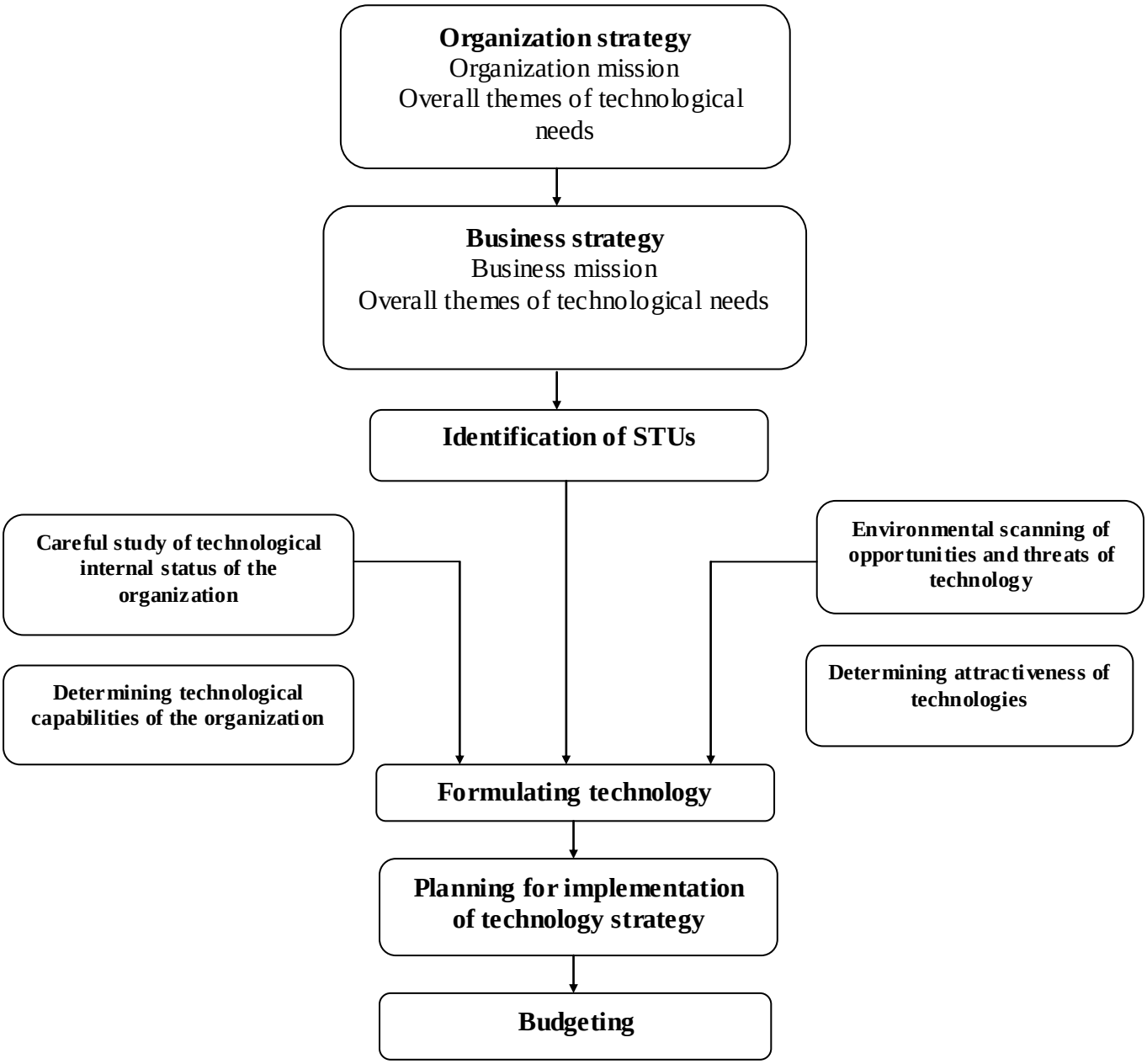

Figure 3. The process of technology strategy based on the macro strategy of business

Organization strategy determines the policies of firm in which primarily mission, vision, values and goals are identified in order to formulate macro strategy. Business strategy relates to independent units. In this strategy, the decisions on three areas including product, customer and geographical region for operation are made. Knowing strategic technical units after identification of key processes are key activities of the processes and consequently, STUs are determined. When the attractiveness of influential selected technologies on formulating technology strategy were determined and organization capabilities regarding mentioned technologies were evaluated, the strategies of selected technologies are formulated (Hax and Majluf, 1996).

Methodology

Current study is applicable in terms of objective and is descriptive-exploratory in terms of data gathering because it seeks to identify present status and to analyze it. Population was 27 people including senior, middle and operational managers, and experts in the target company. As the population was limited, we used no sampling method and 27 respondents were selected as the sample size. To collect data, library method (referring to books, papers, etc), interview and open and close questionnaires were employed. Little's model and Hax's model were used to formulate technology strategy in car parts manufacturing company. The proposed model has eight phases that formed on the basis of literature review and adapting previous models. Hence, conceptual model regarding technology strategy is as follow:

In review of the most important models that use positioning approach to formulate strategy, it was found that no model is able to react and satisfy needs related to technology strategy formulation in car parts manufacturers. It is important to say that Porter has not attended to consumer market and value added was his focus point. On the other hand, he was belief in primary evaluation and then auditing. When some of technologies were removed, auditing of other technologies would be done in which is one of his proposition problems because of removing some of technologies. In relation to Hax's model it should be noted that the model is perfect; hence, this model do not consider the product, and market status and key success factors have not role in it while the target product is an influential factor to formulate strategy and has a critical role in it. Little/s model will remove the weakness of inattention to the market and product because this model focuses on market knowledge and determination of key success factors and consequently, identification of related technologies and success factors help to formulate technology strategy. Key success factors (internal factors) were considered in Little's model as key success factors have not attended to the internal environment. In order to removing this shortage, key factors were employed. Further, key factors help us to link market and inside of organization to get the areas of organization capabilities. As CSFs can improve the operational creativity in the organization and enhance the strategic program and or business program, it can be noted that usage of CSFs provides a technique to succeed the organization. When the opportunities and weaknesses of these models were investigated for final decision-making about final model, the circumstances of market of this product and its nature would be addressed. The circumstances of this product are as following:

- Technology of producing automotive interior parts is the process type, means that this technology is related to the ways of doing processes and production method.
- Market conditions of this product have critical role in developing technology strategy.
- The trend of technology change in the industry for producing automotive interior parts is approximately monotone and used technology in this industry is a part of the technologies that have long life and programmable.

- Forecasting future changes in the industry is important in the process of technology strategy formulation and can determine the technological attractiveness.

The most fit pattern and model in which 1) can meet needs 2) is influential in choosing related technologies and 3) has the least ambiguous in the process of project implementation is a combination of Little's model and Hax's model.

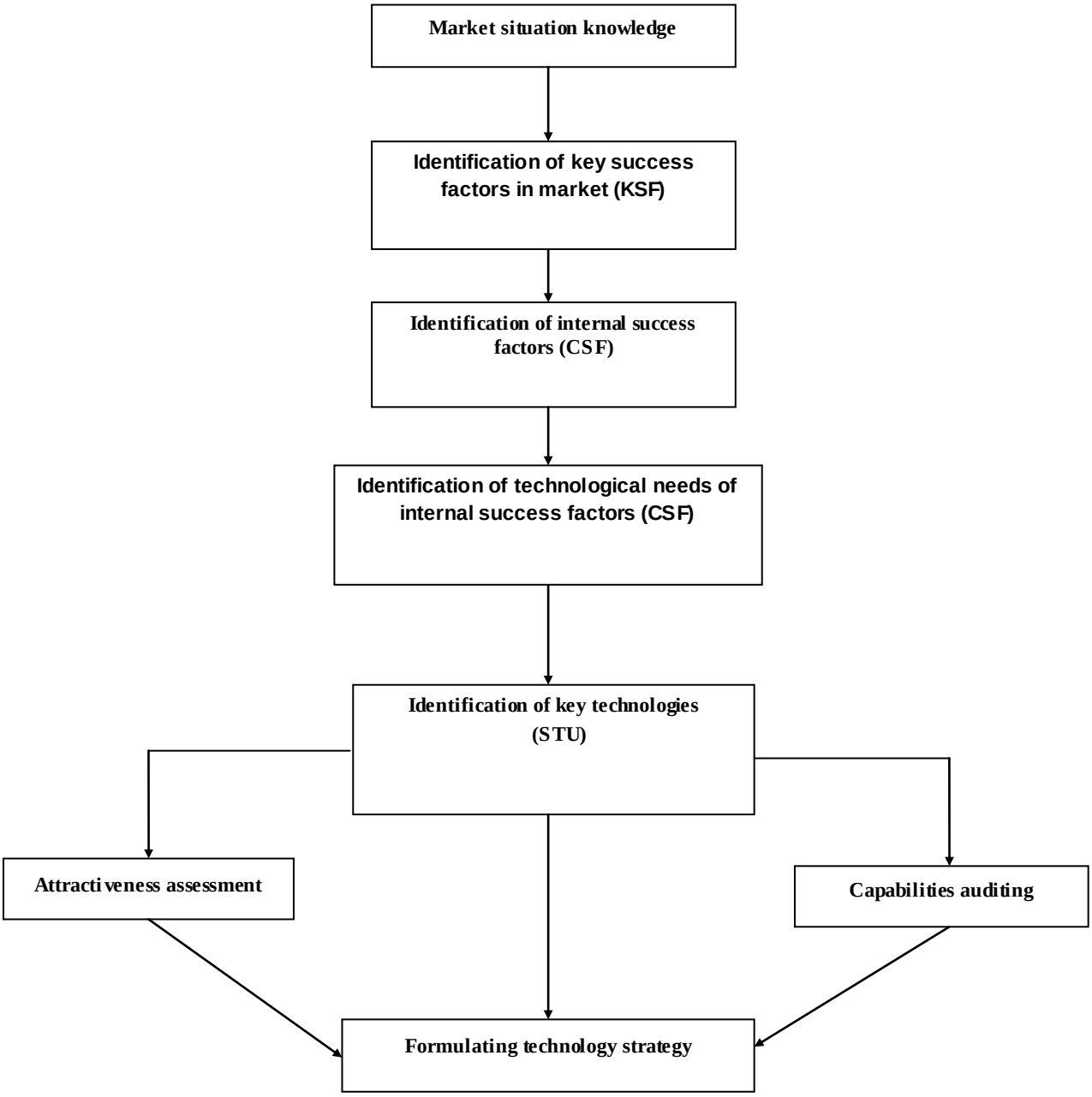

Figure 3. Model of strategy technology formulation in car parts manufacturing

Description of research, findings and results analysis

Step 1. Market situation knowledge

In this step, we studied the company status in terms of competitors, products, market volume, sale channels and customers to investigate company status in terms of competitive position and attractiveness of industry.

Step 2. Identification of key success factors in market

This step involves several steps. First step is to identify key factors in the target company. Using a literature review and an open-ended questionnaire, 10 key factors was adapted. In the second step, key success factors were recognized. These factors are a subset of key factors in which 16 key factors were adapted by an open-ended questionnaire (Delphi method).

Table 1. Key success factors in market

Number	Factors
1	Price
2	Size
3	Power
4	Reliability
5	Quality
6	Speed
7	Uniqueness
8	Matching with international standards
9	High accuracy
10	Flexibility

Table 2. Key success factors

Number	Factor
1	Advanced equipment armed by computers
2	Technology level compared to competitors
3	Intelligence and controlled equipment
4	Modern technologies related to cars and its parts
5	Technology in financial systems
6	Enhancement of technology through reverse engineering
7	Security systems in industrial environments
8	Technology information stream of manufacturing cars and its parts
9	Measurement equipment
10	Changing new technologies
11	Advanced equipment
12	Speed and acceleration of technology and innovation growth compared to other competitors
13	Industrial and technological activities
14	Advancement of designing science of car parts
15	Influential systematic modern technology on technology

Step 3. Ranking and determining the linkage between the two factors

In this step, key and critical factors are ranked in terms of their importance in which they were determined based on an 11-point spectrum.

Table 3. Ranking of key success factors

7. price	**5. size**	**3. reliability**	**1. quality**
8. Matching with international standards	6. uniqueness	4. high speed and accuracy	2. power

Table 4. Ranking of critical success factors

13. Influential systematic modern technology on technology	**9.** Advancement of designing science of car parts	5. Enhancement of technology through reverse engineering	**1.** Advanced equipment armed by computers
14. Advanced equipment	10. Speed and acceleration of technology and innovation growth compared to other competitors	6.Measurement equipment	2. Intelligence and controlled equipment
	11. Technology level compared to competitors	7. Technology information stream of manufacturing cars and its parts	3. Modern technologies related to cars and its parts
	12. level of technology investment compared to competitors	8.Changing new technologies	4. Security systems in industrial environments

As these two factors are correlated, we recognized that critical factors are related with which key factor and to do this, correlation test was used. Based on the critical success factors (advanced equipment, new systematic technologies affecting technology, industrial and technological activities, the technology level compared to competitors, speed and acceleration of technology and innovation development relative to other competitors, and changing new technologies) are correlated with all key success factors in the market.

Step 4. Determining key technologies

According to the determined model, key technologies related to critical factors should be identified in this step. Using a closed questionnaire with an 11-point spectrum and correlation test, 18 key technologies were achieved.

Table 5. Key technologies

Analysis tests	Fire saw
salt spray	Lathe machine
Spot welding	Hydraulic Press
resistance test of water oil and lubricants	Grinding
Testing paint adhesion	Bending machine
Destructive testing of welds	Drilling
Welding Press	cutting sheet
Kick press	Air Compressor

Fixtures	Milling machine

Step 5: Assessment of the attractiveness of technology and auditing technological capabilities

At this stage, assessment is based on two perspectives: external environmental assessment (assessment appeal applications) and internal capabilities assessment (the rate of organization governance on technology). To determine which technology has high attractiveness and capability, a questionnaire with an 11 point spectrum was used. Correlation test was also conducted in order to investigate the relationship between technologies and sub factors of attractiveness and capabilities. Finally, it was possible to categorize technologies with similar attractiveness and capability.

Step 6: Analysis of matrix

In this step, when the attractiveness-capability matrix was formed, each of the key technologies was located in its related area in the matrix.

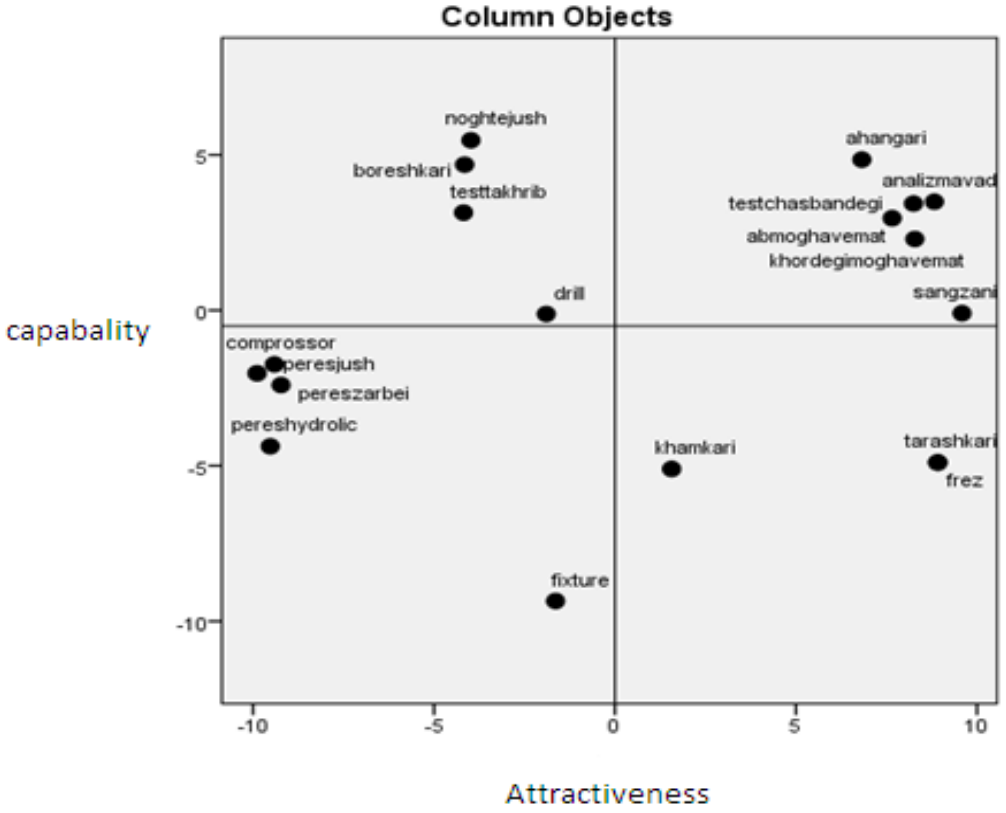

Figure 4. The position of technology attractiveness- Capabilities matrix

Step 7: Technology strategy formulation and approval

Using the matrix, the appropriate strategy is developed for each type of technology. These strategies are outlined in the following four areas.

District 3 Top attractions - low capacity	**District 1** Top attractions - high capacity
District 4 low attractions - low capacity	**District 2** low attractions - high capacity

Assessment of technologies based on the two criteria of attractiveness and capability allow determining the position of each technology potential technologies in a two-dimensional matrix by the charm of "capability-attractiveness". Each district is represented a state and requires its own strategy. District 1 (high attractiveness-high capability):

As shown in Figure 4, 6 technologies (from 18 technologies) have been located in the District 1 in which the majority of technologies resided in this area. Leveraging core technologies to achieve long-term goals should be considered. These technologies include forging, materials analysis, testing, adhesion, and resistance in face with corrosion, water and grinding). The overall strategy is to protect the investment associated with these technologies. Overall strategy regarding these technologies is investment to keep the position. However, due to technological developments, the organization may be forced to invest on new technologies or to improve existing technologies in order to maintain its ability. The focus of the company is foreign. Technology strategy in the area is to maintain status/development.

District 2 (low attractiveness-high capability):

Technologies lied in this area are in a position that the organization ability regarding them is well; however these technologies have no attractiveness for the organization. As shown in Figure 4, the three key technologies have been located in this area (The technologies include milling, turning and bending). The maximum capability of the organization should be employed to replace these technologies with technologies that have more attractiveness. Furthermore, utilization of existing technologies in other activities and/or selling them to other organizations is another suitable strategy. Technology strategy that would be employed in the area is replacing/selling.

District 3 (high attractiveness-low capability):

This district is related to the technologies that have high attractiveness but the organization has not high ability to govern the technologies. These technologies include drilling, testing, demolition, cutting and welding. The most important technologies should be selected and invested. According to acceleration of growth and innovation in some of these technologies, they should be improved and be considered as main activities of the company. The technology strategy employed in this area is an improved selectivity strategy.

District 4 (low attractiveness-low capability):

Attractive and capable technologies are laid in this area. (These technologies include air compressor, welding presses, impulsive presses, fixtures and hydraulic presses). It can be said that any new investment in these technologies is not suitable in terms of economic of scale. The strategy that is employed in this phase is ignorance strategy.

Conclusion

It seems that the lack of attention to the strategic management of technology, the lack of sufficient knowledge about the key and critical factors to achieve a sustainable competitive position as well as the unemployment of key technologies for the development/improvement are the most significant problems that companies operated in automotive parts manufacturing would be faced by arriving new technologies in the next years. Hence, this study sought to integrate existing models in technology management literature and to propose a pattern that has a more adaptability with present status of car parts manufacturing industry of the country. To do this, a 7-step model was proposed based on Hax's model and Little's model to formulate technology strategy for the target company. In this study, the market status should be identified because in models, which are based on positioning approach, market analysis is one of the most fundamental steps of the proposed model. Finally, it is recommended that if the proposed model is used, key and critical success factors in the various steps should be identified. In doing so, key technologies are identified, and the determination and implementation of strategies would be possible in a simple way.

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