Presenting a Model for Evaluating Technological Innovation Capability for Attaining Turbocharge Technology

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Abstract

Recent evolutions in World Trade Organization (WTO) and other international trading agreements have made industries all around the world face a new era of intense global competition. Simultaneously with increased competitive pressure, permanent development and innovation comprise building blocks of firm excellence. In a dynamic environment, failure to innovate ends up with business stagnation and getting out of the competition ring.

Technological innovation capability is a complex, elusive and uncertain concept, which have made it difficult to characterize. Measuring technological innovation capability requires considering numerous qualitative and quantitative criteria at the same time. One of the main factors hindering the success of adopting technological innovation to attain competitive advantage by firms in developing countries is lack of awareness about and recognition of the level of firm technological capabilities and how to use them to acquire relative advantages. Evaluation of technological capability serves as a tool for identifying the required capabilities to implement the firm technological priorities.

Based on a wide spectrum of available literature, the present paper attempts to extract criteria related to technological innovation capabilities in the field of turbocharging technology. These criteria were then provided to a group of experts in automotive industry, so as to identify the desired level of technology for turbocharging technology in automotive industry. On the other hand, by restricting items of the questionnaire based on the experts' opinions, the current state of turbocharging technology capabilities was identified, based on which technological gap in each criterion under study was determined. On the other hand, once the technological gap was identified, improvement projects were defined to either suppress or eliminate the gap.

Keywords: *technology, technology evaluation, technological innovation capability, turbocharger*

1. Introduction

By definition, technological innovation is a process involving interactions among different resources. This concept is complex, multi-dimensional, and directly immeasurable. It is highly correlated to internal experiences and empirical education. In general, various types of assets, resources, and capabilities are required to achieve success in innovation, particularly technological innovation. Technological innovation can be considered as a learning process. Learning ends up enhancing the deal of required knowledge and skills for selection, setting up, maintenance, matching, improvement and development, all of which are known as technological innovation capability (TICs). Therefore, in order to coordinate with organizational strategies, special conditions, and competitive environment, TIC shall be defined in all fields and at different levels (Cohen and Levinthal, 1989).

Today, the growth of technology in automotive industry follows an increasing trend considering the main drivers established by regulations toward reducing fuel consumption and contamination. Among these technologies, one may refer to turbocharging technology which have contributed to smaller engine capacities in vehicles that tend to reduce fuel consumption and air pollution while maintaining performance of the vehicles at desired levels. The purpose of adopting turbocharging in internal combustion engines has been to increase output power per constant engine size, as compared to naturally-aspirated engines. This purpose is achieved by pressurizing the input air into the engine. Indeed, turbocharging contributes to higher ratios of engine power to engine weight. Different variants of turbocharging technology have been used in engine development industry: turbochargers and superchargers, which are selected and used depending on the engine design and expected performance.

Therefore, it is of paramount importance to pay attention to this level of technology in domestic

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automotive industry considering future perspective. In such an increasingly competitive environment and considering technological changes and evolutions, innovation generation and distribution not only depend on the technological knowledge produced through domestic research and development activities, but also have large contributions from interactions with international resources of innovation. Whether achieved via domestic and indigenous development works or transmitted from external resources, attainment of turbocharging technology requires adequate infrastructure and planning description. In this respect, TIC represents one of the most important indices or criteria which can help us with making decision on the type and process of attaining the technology. Observations indicate that, as of current, those who are in charge of attaining the knowledge of designing and developing the technology (e.g. Irankhodro Powertrain Company, Mega Motor Company, domestic automotive manufacturers, auto parts manufacturers, etc.) suffer from gaps to the desired levels of technological innovation in different aspects. Some examples include lack of personnel of adequate expertise in research and development departments, lack of adequate knowledge for designing turbochargers, lack of required equipment to inspect performance accuracy of imported parts, lack of needed technology and equipment for manufacturing turbocharger systems by domestic manufacturers, etc. Finally, the present research can help us identify the set of indices and criteria introduced to us by the level of technological innovation capability and evaluate the gap to the desired point where turbocharging technology can be attained based on the technological innovation capability. Therefore, the present research aims at presenting a model for evaluating technological innovation capability, so as to help research and development policy-makers determine planning preferences to facilitate the process of technology attainment.

2. Definitions

Capability and resources

As elementary units in analyzing capability of organizations, resources can be defined as assets tied to the firm semi-permanently (Maijoor and Witteloostuijn, 1996; Wernerflet, 1984); these include financial, physical, human, commercial, technological, and organizational assets used by the company to develop, manufacture, and present products and services to its customers (Barny, 1991). In contrast, capabilities refer to the capacity of an organization to implement and coordinate different resources, usually in combination with one another, using organizational processes to achieve a desired result (Amit and Showmaker, 1993; Grant, 1996; Prahalad and Hamel, 1990). Capabilities are based on inherently sensible information and processes which are specific to the firm and developed over time via complicated interactions among the firm resources (Amit and Showmaker, 1993; Conner and Prahalad, 1996; Itami and Rohel, 1987; Kogut and Zander; Leodard-Bartone, 1992; Winter, 1987).

1. Technological innovation

Knowledge generation is a key output of technology and science-based industries, which resembles boiling bubbles coming out of the knowledge deeply situated into the organization. Some of the bubbles are of higher energy than the others, some others may be vanished easily, and some may interact to one another to form a greater opportunity. Meanwhile, even the best scholars and researchers cannot predict ultimate fate of each bubble. Generation of new knowledge serves as a source of innovation. Not surprisingly, innovation has many things in common with knowledge – the things which have made it difficult to manage.

2. Technological innovation capabilities

Technological innovation is a process which involves interactions among different resources. This concept is complex, multi-dimensional, and directly immeasurable. It is highly correlated to internal experiences and empirical education. In general, various types of assets, resources, and capabilities are required to achieve success in innovation, particularly technological innovation. Technological innovation can be considered as a learning process. Learning ends up enhancing the deal of required knowledge and skills for selection, setting up, maintenance, matching, improvement and development, all of which are known as TICs. Therefore, in order to coordinate with organizational strategies, special conditions, and competitive environment, TIC shall be defined in different fields and at different levels.

Technological innovation capability is a special asset and feature of an organization and encompasses different key fields including technology, product, process, knowledge, experience, and organization. Furthermore, it is an implicit feature and cannot be planned. Burgelman (2004) defined TICs as a comprehensive set of features for an organization which tend to facilitate and back technological innovation strategies of the organization.

3. Turbocharging technology

Turbocharger is a simply a blowing system which injects highly pressurized air into engine cylinder. As you know, when piston is in reverse state, air and fuel mixture is sucked into the cylinder. The higher the air

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pressure, the higher will be the count of air molecules, and hence the more amount of air and fuel mixture will be accommodated in the cylinder. The higher the amount of fuel, the higher will be the power generated by the resultant combustion. In this way, a turbocharged engine tend to provide higher deal of power than that of a conventional engine. Turbocharger can enhance the ratio of output power to engine weight; that is, at given output power, a turbocharged engine enjoys lighter weight and smaller size than those of a naturally-aspirated engine, which ends up with smaller size and lighter weight of the vehicle. This means faster acceleration for the turbocharged vehicle. Turbocharging increases the amount of air injected into the engine, and this can increase engine power or efficiency or even both. This system is usually used in auto cycle and diesel cycle for internal combustion engines, though its application in external combustion engines have been also proved to be useful.

3. Literature review

Technological innovation can be considered as a learning process. Learning ends up enhancing the deal of required knowledge and skills for selection, setting up, maintenance, matching, improvement and development, all of which are known as TICs. Therefore, in order to coordinate with organizational strategies, special conditions, and competitive environment, TIC shall be defined in different fields and at different levels. Successful technological innovation depends not only on technological capabilities, but also on other important capabilities including organizational, marketing, capital funds, production, strategic planning, and resource allocation capabilities (Yam *et al.*, 2004). In a research aimed at finding a systematic quantitative method for evaluating technological innovation capabilities of 182 Chinese innovative industrial firms, Guan *et al.* (2006) employed data envelopment analysis (DEA) method to account for learning, research and development, manufacturing and production, marketing, organization, and resource allocation indices. In their study, they used seven indices including learning capability, research and development capability, marketing capability, etc. and presented metrics of three of the indices in the paper. Qualitatively, the empirical work by Perdomo-Ortiz *et al.* (2006) showed a positive relationship between comprehensive quality management and technological innovation capability. Results of their research indicated that, organizations shall be more focused on qualitative activities such as promotion of team work, empowering employees, training employees on the subject matter of quality, and designing a system of incentives to have different tasks performed at higher quality tend to give better capabilities. Burgelman (2004) defined TICs as a comprehensive set of features for an organization which tend to facilitate and back technological innovation strategies of the organization. In his study, Sumrit *et al.* (2013) followed a systematic approach using analytical hierarchical process (AHP) to the evaluation of technological innovation capabilities of Thai car manufacturing companies. Used in this research were the following indices: leadership management capability: proper strategic leadership, resource allocation; investment capability: enhancement of product processes, exclusive technology development, attained external technology; organization capability: innovation culture, network connection, response to a change; learning capability: internal foreign knowledge, knowledge exploitation, knowledge of incorporation; technology development capability: exclusive technology development, project-related research and development; technology transfer capability: structural design products, process design, strategic development; commercial technology capability: manufacturing capability, marketing capability. In an investigation by Lahovnik *et al.*, an attempt was made to provide a model of technological capabilities, where different potential effects of the model on sustainable competitive advantages among the considered industries were studied. They also tried to have the attained theoretical knowledge in the form of dynamic capabilities as some competitive advantages. Indeed, the use of technological capabilities as competitive advantages was investigated in Slovenian industries as a case study.

There have been some research on technological innovation capability in Iran, some of which are cited in the following. Tabatabaian *et al.* (2010) made an effort to introduce a novel hybrid index for technological capability evaluation by considering the indices defined in international models for evaluating technological innovation capability, so as to better measure technological capabilities of different countries, particularly the developing ones. In addition, it was attempted to present the index based on a given process by presenting rational weights determined using factor analysis method. Karimi *et al.* (2010) studied proper technology transfer methods in the scope of automotive industry. In fact, They aimed at evaluating the effect of the technologies used to manufacture Dacia Logan on competitive performance of Iranian auto part manufacturers using structural equation modeling. Based on the results of this research, technology transfer tends to impose

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direct impacts on competitive performance of the companies involved in the project, and results in enhanced quality and reduced production cost. In his paper, Ansari (2011) tried to present a review on key concepts of technological partnership including others' attitudes toward technological partnership, theoretical paradigms of establishing technological partnerships, goals of and motivations behind technological partnership, partnership risks, types of the partnerships, models and criteria for choosing the type of partnership, and factors affecting the success of technological partnerships. Khamse *et al.* (2011) used the model of technological needs assessment model to analyze the level of technological capabilities of Yasan Metal Structures Company. This model evaluates the firm capability in 9 dimensions, specifying the firm position in each dimension while formulating strategies for reducing existing gap. Based on the results of this research, the company could establish partnerships and interactions in the scope of technological progress and communication by using parts of the strategies in the scope of using external links. Shojaei *et al.* (2011) tried to work on the internationally presented models and domestically practiced actions to develop an indigenous model for evaluating Iran's innovation capability. On this basis, they began with investigating a number of previously presented models with an emphasis on the models proposed for developing countries. This research further introduced a systematic conceptual framework for evaluation innovation capability by reviewing different approaches and summing up their weaknesses and strengths while taking into account domestic considerations in Iran. Haj Hosseini *et al.* (2013) described different technology transfer methods and then headed to the introduction of the models presented to select proper method of technology transfer, with the indices defined in each model compared to those of other models. Finally, they ended up setting up 28 indices as the most important factors and criteria for selecting proper method of technology transfer and categorizing them into four main categories: capabilities and policies of the receiver of technology, capabilities and policies of the owner of technology, policies of the technology receiver and owner companies, and technology features. Investigating the influence of different aspects of TIC on innovation performance, Yousefi *et al.* (2013) proposed a framework to describe the dimensions using Pearson correlation method and regression analysis to investigate the relationship between TIC and innovation performance. The data used in the paper was collected from IKCO managers. Suzanchi *et al.* (2014) studied knowledge-based companies in an attempt to investigate the growth and development of science and technology. In this research, the organizational capabilities affecting the success of knowledge-based companies were researched and compared to those mentioned in international references. Finally, common capabilities among the companies, capabilities whose absence tended to raise challenges for the companies, capabilities mentioned in literature while the companies lack them despite the challenges raised to the companies by the capabilities, and the difference between companies in possession of different capabilities were investigated. In a paper focused on the performance of technological innovation, Zand Hesami *et al.* (2014) prioritized different dimensions of technological innovation capabilities. They used DEMATEL method for this purpose and modeling. Based on their results, they found three capabilities as the most influential ones: strategic planning capability, resource allocation capability, and organization capability.

In total, improvement points can be established in the field of turbocharging form three perspectives:

1. Most of the cited research has followed some non-comprehensive attitude toward the subject.
2. Iranian automotive industry lacks a comprehensive activity for evaluating different levels of technology.
3. No research has been performed on turbocharging technology and how to attain the required knowledge for designing and manufacturing this technology.

4. An introduction on capability indices

A review on the research performed so far indicates that, according to the presented approaches, the following list of capabilities can be studied as the main indices and criteria for organizational capability assessment to evaluate levels of capabilities of manufacturing and research organizations in terms of various technologies:

- Learning capability
- Research and development capability
- Resource allocation capability
- Marketing and market analysis capability
- Organization capability
- Strategic planning capability
- Manufacturing and production capability

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Table 1. Capabilities and their references – literature review/foreign research.

Criteria	References
Learning capability	Guan *et al.* (2006) Chiwa and Algreh (2007), Tis (2007), Algeh and Chiwa (2008), Yam *et al.* (2004), Yam *et al.* (2011), Kamisson and VIllar-Lopez (2012), Samrit and Anontavranic (2013)
Research and development capability	Guan *et al.* (2006), Wang *et al.* (2008), Yam *et al.* (2011), Zahra and George (2002), Levitas and McFiden (2009), Kim *et al.* (2011), Forceman (2011), Mu and Bandto (2011), Lin *et al.* (2012), Samrit and Anontavranic (2013)
Marketing and market analysis capability	Guan *et al.* (2006), Yam *et al.* (2004), Yam *et al.* (2011), Lin (2004), Young (2013), Kim *et al.* (2011), Lin *et al.* (2012), Samrit and Anontavranic (2013)
Resource allocation capability	Guan *et al.* (2006), Yam *et al.* (2004), Yam *et al.* (2011), Chisaw *et al.* (1996), Barney and Clarck (2007), Dobni (2008), Silan and Cock (2007), Spiropolo and Kirejido (2012), Vedoris *et al.* (2012), Wang *et al.* (2008), Burgelman *et al.* (2004), Samrit and Anontavranic (2013)
Organization capability	Guan *et al.* (2006), Yam *et al.* (2004), Yam *et al.* (2011), Urgan *et al.* (2006), Talker (2012), Dobni (2008), Silan and Cock (2007), Spiropolo and Kirejido (2012), Burgelman *et al.* (2004), Samrit and Anontavranic (2013)
Strategic planning capability	Yam *et al.* (2004), Yam *et al.* (2011), Urgan *et al.* (2006), Talker (2012), Dobni (2008), Silan and Cock (2007), Burgelman *et al.* (2004), Samrit and Anontavranic (2013)

Level of academic education		
	Quantity	Percent
Higher diploma	3	4%
Bachelor	32	38%
Master	38	45%
PhD	12	14%

Figure 1.1. Frequency of the statistical population in terms of academic education.

Work experience of participants		
	Quantity	Percent
< 5 years	6	7%
5-10 years	15	18%
10-15 years	40	47%
15-02 years	19	22%
> 20 years	5	6%

Figure 1.2. Frequency of the statistical population in terms of work experience of participants.

4. Research methodology and results

In the present research, we are to investigate and present a model for evaluating technological innovation capabilities in terms of turbocharging technology, and proposing strategies to fill in the gap between capabilities of domestic manufacturers and the acceptable level in the turbocharging technology. As such, this is a descriptive-survey research which measures relationships between variables.

2. Statistical population

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Statistical population of the present research was composed of the employees, experts, and managers of IKCO and its suppliers, particularly regarding turbocharging technology. An initial questionnaire was distributed among 85 experts and managers, with 10 experts then selected to perform interviews. Frequency distribution of the sampled individuals based on fundamental variables is presented in the following.

3. Introducing the model used in the research

Considering the performed research and objectives of the present research, the following model was selected to present a realistic measurable model of capabilities whose effect on economic performance of a firm can be evaluated as an ultimate evaluation index. Capability indices were considered at two levels, namely base level and production level, and their influences on the index of learning capability was presented.

4. Results analysis method

The questionnaires were composed of multi-choice questions evaluated by the respondents as either of very low, low, moderate, high or very high. For the sake of quantitative analyses, the items were scored to convert the qualitative responses to quantities. On this basis we had:

Very low = 1, low = 2, moderate = 3, high = 4, very high = 5.

Later on, the question sheet was summarized for each of the capability indices and then SPSS Software was used to calculate mean and variance of each sub-indices. Accordingly, input file for Smart-PLS software was generated as the output file from SPSS Software. In order to obtain the level of technological innovation capability for turbocharging technology and the effect of each of the factors on one another and finally determine economic performance of the form, capability evaluation model was designed. The designed model was implemented in PLS software and effect of each sub-index (items) on different levels of capability and their interactive influences on one another were further investigated.

5. Determining technological capability gap

Considering the results obtained from the questionnaires and the quantitized scores given by the experts to each question regarding technological capabilities, mean score in the initial questionnaire was considered as a criterion to measure desired state among the 85 samples taken from the experts and elites of automotive industry. Aiming at evaluating the current state of technological innovation capability for turbocharging technology in automotive industry, the second questionnaire was filled in by surveying 10 experts of automotive industry who were interviewed in person. According to the first method, average score for items of each capability was extracted.

Taking the values obtained from the first questionnaire as 100% utility and comparing them with the results obtained from the second questionnaire, technological gap was obtained for each of the technological variables in the corresponding scope (considered item). The results are presented in te following.

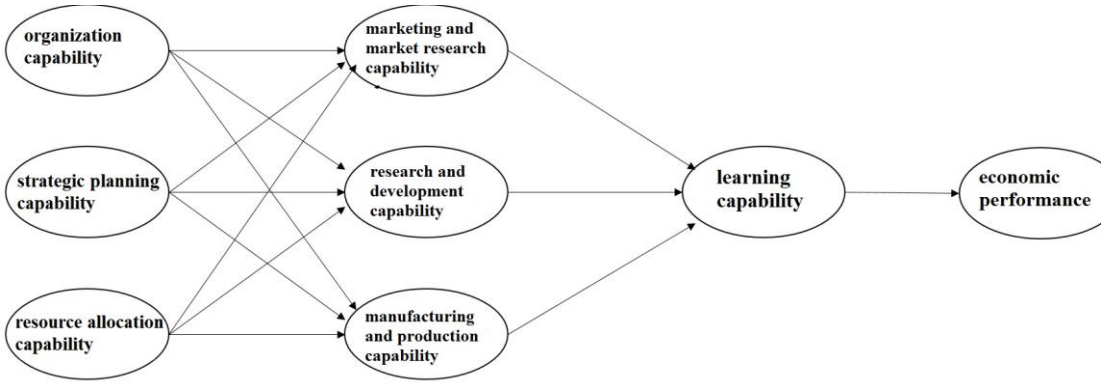

Figure 1.3. Proposed capability model for turbocharging technology.

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Table 2.

Availability of an initial knowledge in specialized fields of noise, vibrations, and calibration of turbocharging system Bringing about external experts via communications with universities and defining academic projects The presence of an efficient in-house (in-service) training system Promoting working groups to continuous learning and organizational investment to enhance the knowledge	Learn6 Learn 7 Learn 9 Learn 10 Learn 13	**Learning capability**

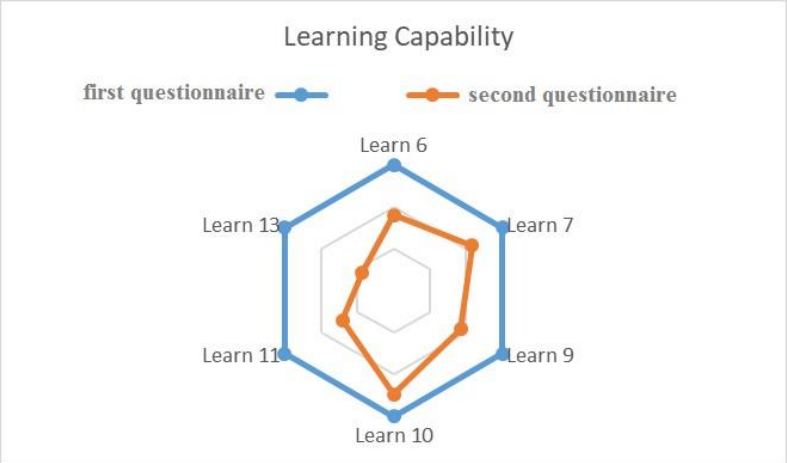

Figure 1.4. State of technological gap in learning capability.

Table 3.

Preparing an appropriate structure for the rise of innovation and creativity and collecting novel ideas Mastery in product development process in turbocharging development Mastery in designing methods and applying designer's restrictions from the viewpoint of the complex performance Comprehensive understanding of the performance of turbocharger components and different designs, e.g. variable geometry, upper header valve, etc. The presence of designing, simulation, manufacturing, combustion, and other departments in the organization in line with turbocharging technology	R&D 1 R&D 7 R&D 8 R&D 10 R&D 14	**Research and development capability**

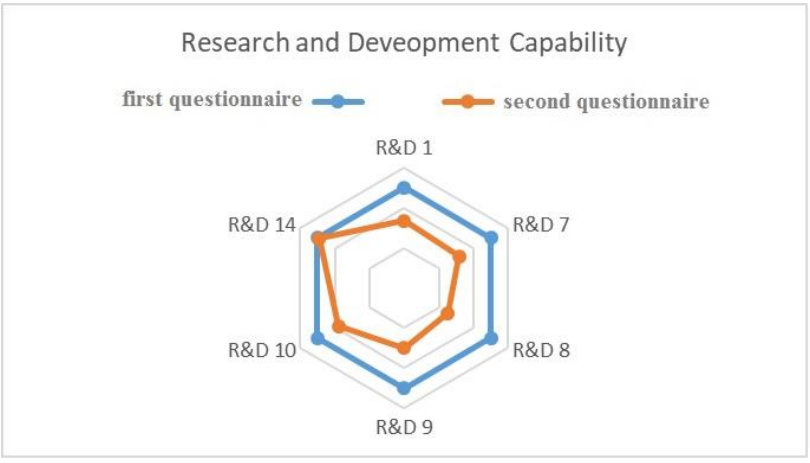

Fig1.. State of technological gap in research and development capability.

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Table 4.

The presence of expert and effective human force in combustion and calibration departments	Resource 2	**Resource allocation capability**
Human resource management capability in line with the firm's project portfolio	Resource 4	
Availability of the following specialized laboratories: - Turbine and compressor performance curves (Turbo Map) - Safety of turbine and compressor chambers - Part durability	Resource 5	
Capability of adopting technological requirements timely based on global development and growth of technology	Resource 7	

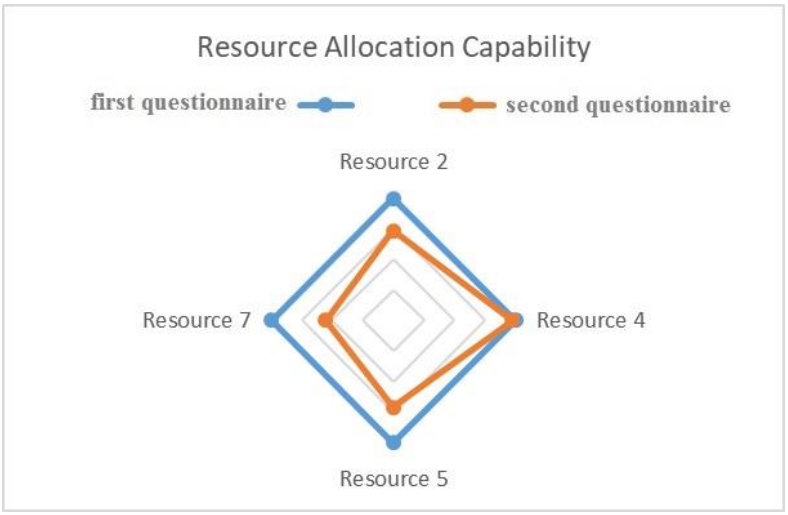

Figure 1.6. State of technological gap in resource allocation capability.

Table 5.

Capability of manufacturing turbocharger shell and chamber	Manuf 1	**Production and manufacturing capability**
Capability of producing parts and assemblies based on design requirements (production quality and tolerance)	Manuf 3	
Understanding all special characteristics and restrictions of producing turbocharging system	Manuf 4	
Capability of deploying continuous production improvement	Manuf 5	
Capability of controlling the production quality	Manuf 7	

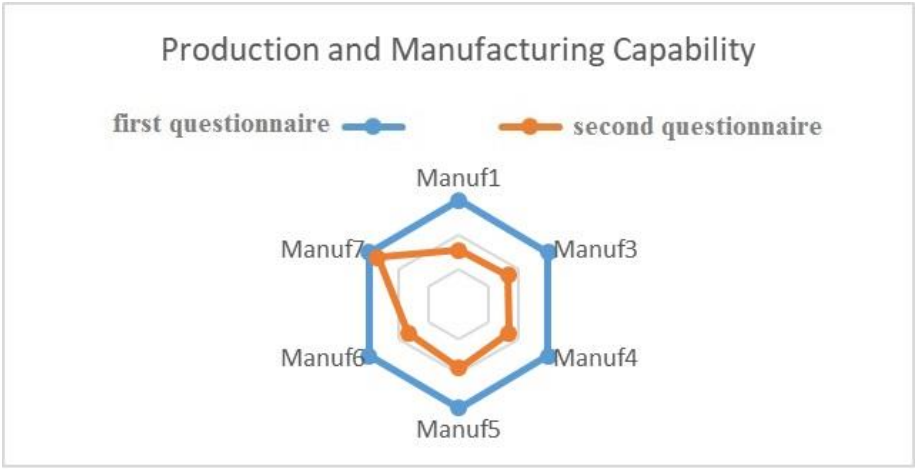

Figure 1.7. State of technological gap in production and manufacturing capability.

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Table 6.

Adequate knowledge of potential markets for powertrain	Market 1	**Marketing and market research capability**
Capability of motivating engine designers to adopt turbocharging technology to reduce duel consumption and enhance engine performance.	Market 3	
Capability of developing demand for engine designers	Market 4	
Capability of selling the product at competitive price	Market 5	

Figure 1.8. State of technological gap in marketing and market research capability.

Table 7.

Availability of specific procedures and organizational routines and their flexibility against changes	Organize 1	**Organization capability**
Consistency of the organizational growth with the progress and development of turbocharging technology	Organize 3	
Capability of the organization in managing development projects in the form of project portfolio management	Organize 4	
Flexibility of the organization to coordinate and collaborate research and development, production, and marketing departments with one another	Organize 5	
Establishing connection between suppliers of different assemblies in the turbocharging system and external customers	Organize 6	
Flexibility of the organization to rapidly adapt with evolutions in turbocharging technology	Organize 7	
Capability of managing supercharging parts supply chain	Organize 8	

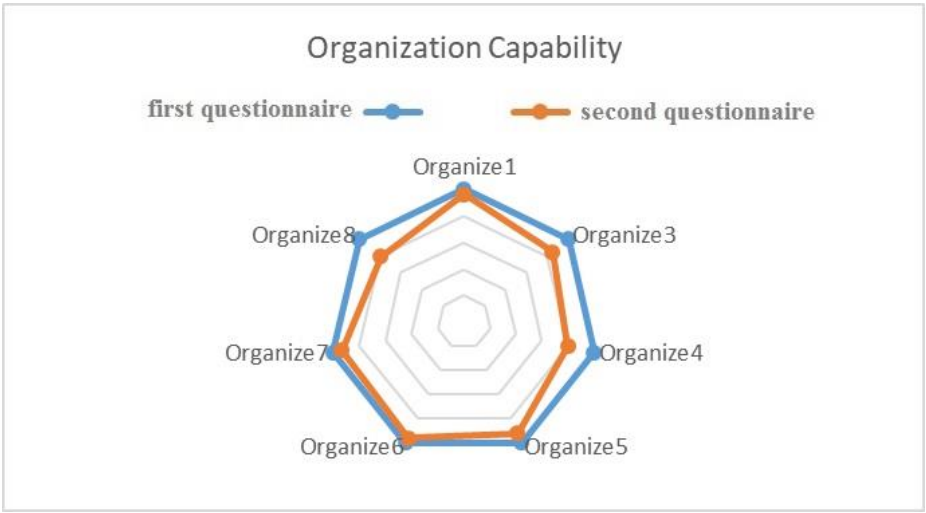

Figure 1.9. State of technological gap in organization capability.

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Table 8.

The presence of well-established mechanisms for recognizing SWOT matrix across the organization and regularly updating the matrix	Strategy 2	**Strategic planning capability**
The presence of a well-defined and vision and adopted missions for the organization	Strategy 3	
Commitment and belief of top managers and experts of the organization to realize the vision and implement the missions	Strategy 4	
Availability of a well-developed road path in the scope of turbocharging technology with specified and measurable critical points	Strategy 5	
The presence of an adapted strategy across the organization, to be directly related to SWOT	Strategy 6	
The presence of a legal position in decision-making authorities	Strategy 8	

Figure 1.10. State of technological gap in strategic planning capability.

Table 10.

Number of new products commercialized (domestic and foreign markets)	Economy 1	**Key indices of economic performance**
Value of quality enhancement and equipment performance projects	Economy 2	
Satisfaction of industry with firm's products and services		
Penetration rate of produced products (ratio of the volume of organization's products to total market size)	Economy 4	

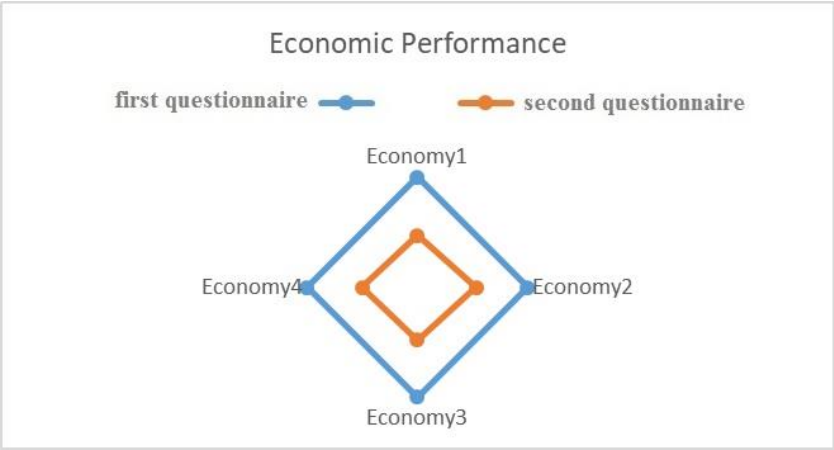

Figure 1.11. State of technological gap in economic performance of firm.

6. Analysis of the technological gap

Considering the results obtained from the statistical and quantitative analyses performed among the experts from automotive industry, for each of the

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technological innovation capabilities referred to herein, one can define improvement projects to enhance the level of that capability:

Learning capability

Establishment of internal expert associations to share knowledge and experience among different departments of the organization
Establishing an independent modeling department in the organization where up-to-date products in the world are being constantly modeled
Formulating industrial projects with universities to bring about expert human forces and exploit available theoretic base in the domestic and foreign universities

Research and development capability

Holding training courses on new product development and execution of new development projects based on product development literature
Attempting to adopt such concepts as DFM, DFC, and DFA in new product development projects
Establishing more connections to engine designers to identify performance restrictions of the whole team via designing shared projects.

Resource allocation capability

Identifying and employing expert human forces in the fields of combustion and calibration
Equipping specialized part testing laboratories
Establishing a coordinated connection to the modeling department to identify the trend of growth n technology
Production and manufacturing capability
Signing a contract with a well-known foreign supplier to equip and set up casting plant for producing the shell and chamber of the turbocharger
Identifying up-to-date world-class technologies in turbocharger manufacturing
Executing continuous improvement and QC projects along the production line

Marketing and market research capability

Executing cost reduction and control projects to present the product at competitive price
Establishing a specialized working group with engine designers to collect needs and technological pressure

Organization capability

Inducing the required flexibility across the organization to align with the development of turbocharging development
Managing turbocharger parts supply chain
Providing software and hardware infrastructures in project portfolio management

Strategic planning capability

Defining clear visions and missions across the organization
Preparing a road map for turbocharging technology
Establishing a legal position at decision-making authorities

Investigating the effect of enhancing technological innovation capability on organizational performance

In this section, in an attempt to analyze the technological gap in each of the capability factors, factorial load of each item was taken as the factor weight and average value of the item was considered as score to calculate a score for each of the main factors affecting the capabilities. This process was calculated for the first questionnaire as the acceptable level of technological innovation capability from the 85 samples taken in this research. On the other hand, the second questionnaire was adopted to evaluate the current state in automotive industry. The obtained difference (technological gap) for each of the main components of technological capability is presented in the following table.

As can be observed, in each of the technological innovation capabilities considered in the present research, there is a gap between the current state and the desired level defined for that capability. These gaps have ended up diverging economic performance of the firm (which is a measure of the number of new products commercialized, value of improvements in quality and performance of equipment, and level of industrial satisfaction with the products and services, and the company's share of market) from the desired state widely. Therefore, one should undertake improvement projects to enhance the level of these capabilities at firm and domestic automotive industry levels.

In order to evaluate the effect of improvement projects on the firm performance considering the factorial load of each of the paths related to the capability variables in the designed structural model, the percentage of influence of improving the organization capability, strategic planning capability, and resource allocation capability by 5, 10, and 15% (equivalent to percentage of reduced technological

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gap) on innovation performance (learning capability) and overall organization performance (economic capability) were calculated and reported in Table 12.

Table 11.

Technological capability	Mean desired score	Mean current score
Learning	3.61	3.16
Research and development	4.00	3.38
Resource allocation	3.93	3.38
Manufacturing and production	3.80	2.90
Marketing and market research	3.90	3.58
Organization	3.59	3.27
Strategy	3.80	2.92
Economic performance	4.32	2.13

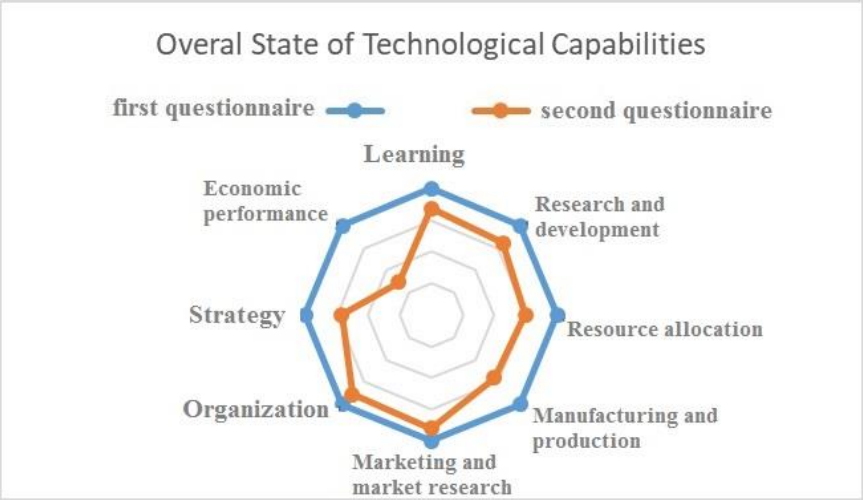

Figure 1.12. State of technological gap in each of the main technological capabilities.

Table 12. Influence of implementing technological gap reduction projects on increasing innovation performance and overall organization performance.

	Percentage of reduction in organization gap			Percentage of reduction in strategic planning gap			Percentage of reduction in resource allocation gap		
	5%	10%	15%	5%	10%	15%	5%	10%	15%
Increased percentage of innovation performance	2.6 %	4.9 %	7.5 %	0.9 %	1.6 %	2.6 %	1.9 %	3.5 %	5.1 %
Increased percentage of overall firm performance	2.2 %	5.2 %	7.5 %	0.7 %	1.5 %	2.2 %	1.5 %	3.7 %	5.2 %

5. Conclusion

The present research was performed with the aim of proposing a comprehensive model for evaluating technological innovation capability of Iranian powertrain industry and turbocharging technology. For this purpose, once finished with investigating the literature and previous research, indices of technological capability were identified and the

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considered model was presented. The model was developed based on infrastructural capabilities to enhance innovation performance level and overall performance of organization, so as to evaluate the effect of each of the capability factors on the mentioned variables, in one hand, while assessing the current state in each of the fields, on the other hand.

The following questions were addressed in the present research:

At which level is technological innovation in automotive industry?

An investigation on the results of this research indicates that, from automotive industry's experts' point of view, in a desired situation, in order to achieve high economic performance across the organization, the economic firm shall acknowledge research and development, production and manufacturing, marketing and sales, and resource allocation as top priorities, because these were found to impose the largest effects on learning capability which is a measure of innovation performance of the organization. On the other hand, focusing on the enhancement of learning capability via establishing specialized associations across the organization, executing continuous modeling process on up-to-date products in the world, increasing communications with specialized universities to bring about expert work force, and defining joint projects between industry and university to share knowledge and experience within the organization and between organizational departments are among the workarounds that can be adopted.

However, based on the results on the capability gaps, today's manufacturing and research firms working in Iranian automotive industry are witnessing the largest technological gap in the scopes of research and development, resource allocation, production and manufacturing, and strategic planning, all of which have contributed to larger gap between the firm's economic performance and the desired performance in terms of the number of commercialized products in the industry and acquisition of larger share of market.

What strategies can be proposed to eliminate the gap in technological innovation?

Recommendations were proposed to enhance the level of technological innovation capability, which once realized at firm level, one can expect considerable enhancement in economic and innovation performances of the frim, getting closer to the desired level at which the frim becomes a competitive economic firm.

6. References

[1]. Ansari, R. (2010) Innovative partnerships: key concepts and success factors, Expert Journal of Parks and Growth Centers, Vol. 8, No. 30.

[2]. Haji Hosseini, H.; Mohammadi, M.; Hamidi, M. (2013) Classification of the factors and criteria affecting the choice of proper method for technology transfer, Journal of Industry and University, Vol. 6, Nos. 21 and 22.

[3]. Khamse, A.; Saboktakin, Sh. (2011) Evaluation of technological innovation capability in metal industries using technological demand model, Expert Journal of Parks and Growth Centers, Vol. 7, No. 27.

[4]. Zandhesami, H.; Hosseini, SN.; Ozaei, K. (2014) Identification of criteria for evaluating technological demands and its effect on domestic development, 3rd International Conference on Information Technology.

[5]. Suzanchi Kashani, E.; Talebi, S.; Asgari, VA. (2014) An investigation on organizational capabilities of four knowledge-based companies at Sharif University Growth Center, Journal of Science and Technology Policies, No. 3.

[6]. Shohaei, S.; Bita'ab, A.; MOnajemzadeh, SS. (2011) Systematic description of innovative capability at national level, Journal of Industrial Technology Development, No. 17

[7]. Tabatabaeian, SH.; Naghizadeh, R.; Khaledi, A.; Naghizadeh, M. (2010) A index for monitoring innovation capability: an investigation on the state of innovation capability in Iran and 69 countries in the world, Journal of Science and Technology Policies, Vol. 2, No. 4.

[8]. Karimi-Dastjerdi, D.; Mokhtarzadeh, N.; Yazdani, HR. (2010) An investigation on the effect of technology transfer on competitive performance of firms: case study of Iranian manufacturing companies supplying Dacia Logan auto parts, Journal of Industrial Management, Vol.2, No. 4.

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