Analyzing the Barriers Encountered in Innovation Process Through Interpretive Structural Modelling: Evidence From Turkey*

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ABSTRACT

The aim of this study is to determine the barriers in the innovation process in Turkey's conditions, investigate the interrelations among them and develop a model that can measure the interacting effects of the barriers on the other barriers and in the innovation system. Since there has not been a research in the relevant literature, which has identified the innovation barriers in Turkey, a detailed review related with innovation barriers has been conducted. After identifying 32 internal and 29 external barriers from the literature review, the second step was to determine the valid barriers for Turkey. This validation was performed by means of a DELPHI study. After identification of 12 valid barriers for Turkey's conditions, interrelations between 12 barriers were established by using ISM (Interpretive Structural Modelling). The research was conducted based on the opinions of the experts about innovation barriers. It was found that "finance of innovation" barrier affected all of the barriers in Turkey. In order to increase innovation performance of Turkey, "finance of innovation" barrier should be settled. There have been a number of researches about innovation barriers in general. The researches are either on firm level, sector level, or country level. However, there has been no research in literature specifially looking for the interrelation among the innovation barriers. This paper is should be taken as the first study not only in investigating the barriers in the innovation process in Tureky, but also in developing a model which could be used in solving the innovation barriers. The findings of this research warn the related academicians, managers and policy makers about the importance of defining and determining the barriers to innovation.

Key Words: *Innovation Barriers, Innovation, Innovation Process in Turkey, Interpretive Structural Modelling*

JEL Classification: *O30, O31, M0*

Yapısal Yorumlayıcı Modelleme İle Inovasyon Sürecinde Karşılaşılan Engellerin İncelenmesi: Türkiye Gerçeği

ÖZET

Bu araştırmanın amacı, Türkiye koşullarında inovasyon sürecindeki engelleri belirlemek, engellerin arasındaki ilişkileri araştırmak ve engellerin diğer engellere ve inovasyon sisteminde etkisini ölçecek bir model geliştirmektir. Literatürde Türkiye'deki inovasyon engellerini belirleyen bir araştırma olmadığı için, inovasyon engelleri ile ilgili detaylı bir literatür taraması gerçekleştirilmiştir. Literatür taraması ile 32 iç ve 29 dış engel elde edilmesinden sonra, ikinci adım Türkiye için geçerli engellerin belirlenmesi olmuştur. Türkiye için geçerli engellerin oluşturulması

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için DELPHI çalışması gerçekleştirilmiştir. Türkiye için geçerli 12 engel belirlendikten sonra, engeller arasındaki ilişkilerin belirlenmesi için ISM(Yorumlayıcı Yapısal Modelleme) kullanılmıştır. Bu araştırmada uzmanların inovasyon engelleri ile ilgili düşünceleri temel alınmıştır. "Inovasyonun finansmanı" engelinin Türkiye'de inovasyon ile ilgili diğer tim engelleri etkilediği belirlenmiştir. Literatürde inovasyon ile ilgili şirket, sektör veya ülke düzeyinde çalışmalar bulunmasına rağmen, inovasyon engellerinin ilişkisini inceleyen çalışma bulunmamaktadır. Bu araştırma Türkiye'de inovasyon engellerini inceleyen, inovasyon engellerinin aralarındaki ilişkileri belirleyerek, inovasyon engellerinin çözümünde kullanılacak bir model geliştirmeyi amaçlayan ilk çalışmadır. Bu araştırmanın sonuçları akadamisyenler, politikacılar ve politika geliştiricileri inovasyon engellerinin tanımlanmasının önemi ile ilgili uyarmaktadır.

Anahtar Kelimeler: *Innovasyon Engelleri, Inovasyon, Türkiye'deki Inovasyon Süreci, Yorumlayıcı Yapısal Modelleme*

JEL Sınıflaması: *O30, O31, M0*

INTRODUCTION

It is an undeniable fact that innovation is one of the critical factors affecting the competitive advantage of organizations and countries. Innovations are the result of a joint effort of a number of parties involved in the process. The two most important stakeholders are firms and government. It is the innovation that enables organizations to effectively meet the demands of consumers, utilize the strategic market opportunities with their strengths and move ahead in competition. Innovative ideas, products and processes are increasingly thought to be important in strengthening the competitive powers of organizations (Tiwari, 2007) as well as those of countries. Innovation, however, is a hard and risky process. Particularly, the developing countries encounter a great variety of barriers in innovation process such as limited resources, investing and trading capacities in new products, services and processes. (Tiwari and Buse, 2007). Most of the researches on the barriers encountered by and affecting the innovation processes seem to have been conducted especially through small scale businesses and analyzed how managers of a certain industry perceive the barriers (Acs and Audtresch, 1990; Yinenpaa 1998; Mohnen and Rosa, 1999; Baldwin and Gellatly, 2004; Tiwari and Buse, 2007). Being aware of the barriers affecting the innovation process and having the ability to tackle with them are thought to increase the success of the innovation process. Oslo Manual also recommends that information on factors assisting or hampering innovation activities should be collected (OECD, 1997). So, this research aims to investigate the innovation barriers in Turkey since Turkey is one of the catching up countries which has an innovation performance below the EU27 average (European Innovation Scoreboard,2009). Innovation barriers not only affect the innovation process but also influence one another. Therefore, it is important to undestand their interrelations. There seems to have been no research that viewed the issue through a holistic aproach, defining and determining the barriers as well as their interrelations by means of an interpretive structural modelling method.

Hence, the first step in effective management of the process is determining the barriers affecting the success of the innovation process and their interrelations. In this context, the purpose of this research is

- to identify and rank the innovation barriers
- to develop a model which shows the relatonships between these identified barriers using ISM and
- to discuss the managerial implications for improving national innovation system of Turkey.

In this study, first, a literature review of innovation and innovation barriers will be given. In the methodology, there are two stages. In the first stage, innovation barriers defined in literature review will be examined whether they are also valid for Turkey. After defining innovation barriers for Turkey, the relations among the innovation barriers will be examined through Interpretive Structural Modelling. Using the results obtained in this modelling, a road map to solve the innovation barriers will be presented. As a last step, recommendations to solve innovation barriers will be developed.

I. LITERATURE REVIEW

The need for innovation in today's rapidly changing business environment is higher than it has ever been. The chances for survival of the organization that are not ready to continuously renew their products, services and processes are under serious threats (Tidd et al, 2005). Innovation has been defined in various ways by a number of researchers. According to Drucker (1985), innovation is a means of entrepreneurship and an action that provides resources to form a capacity so as to reach welfare. Porter (1990) suggests that innovation provides competitive advantage and it comprises both new technologies and new methods. Rogers (1995) defines innovation as an idea, a practice (application) or an object that is perceived as something new. Damanpour(1996) defines innovation as a change put forward in the outputs, structure or processes of an organization that facilitates its integration with the environment. According to Elçi(2006), innovation is the continuous changes and differentiations in the products, services and working methods.

The definitions seem to have certain similarities as well as differences. Considering all the points mentioned in these definitions, innovation could be defined to be creative and implementing something new in one or more of the systems regarding products, services, distribution, working, marketing and technology.

In the broadest sense; innovation, changing the knowledge into an economic and social value, is the sum of technical and social processes (Elçi, 2006). This process comprises three basic stages as determining the need, commencement and implementation (Durna, 2002). The very first stage is being aware of the need for innovation. In order for the innovation process to get started, the organization should feel the need for innovation. The need might arise from the environmental factors (customer demands, incentives, legal liabilities, competitors' practice, public awareness); the internal dynamics of the organization (wish for competitive power / superiority, the employees' knowledge, ideas, experience and skills, creativeness, technological development, a

motivative working environment); the intereffectiveness of the organization and the environment (providing information about competitors, relaying the image of the organization in a correct manner).

The second stage is commencing the innovation. This stage comprises getting aware of the innovation opportunities, searching for the methods to practice, and choosing the proper one. At this stage, there is a need for a culture that supports developing new ideas. Implementation is the last stage of the process. This stage includes using the results of the new ideas and observing their effects.

The relevant researches reveal that the organizations which use the innovation process effectively are able to improve their processes, differentiate their products and services, and enlarge their market shares and grow more than do their competitors (Tidd et al, 2005; Geroski, Machin and Van Reenen, 1993; Geroski and Machin, 1993). Innovation has an important and positive relation with managerial performance (Vincent, Bharadwaj and Challagalla, 2004) and the innovative organizations grow more than those who are not innovative (Hoogstraaten, 2005).

Innovation consists of more than several stages and results from factors both inside and outside the organization. In order to have an efficient and effective innovation process, all of the factors which occur both inside and outside the organization, and the interactions between these factors must be managed.

The most important problem in managing the innovation process is uncertainities in the innovation process. In this context, firms should define the internal and external factors in the innovation process. They should also employ some solutions to control the uncertainities which will arise from the interactions between the internal and external factors in the innovation process. Hence, management of uncertainites and barriers become an important issue in the management of innovations.

Innovation is a process that includes risks and uncertainty. While it provides growth, profitability and competitiveness, unlike the activities of the routine management, it requires knowledge, skills, financial and human resources, efforts, patience and state support. In the innovation process, organizations encounter a great number of barriers which they have to overcome.

A. INNOVATION BARRIERS

Some of the barriers could facilitate and motivate starting innovation while some others could place negative effects on the process. The relevant literature seems to be highly rich.

In innovation literature; enablers and barriers in innovation process is discussed widely. In the literature, innovation barriers are studied in different dimensions.

In some, they are categorized with respect to competence areas. Larsen and Lewis (2007) categorized innovation barries as: financial barriers, marketing barriers, management and personal characteristics barriers and other barriers. Blasco (et al 2008) categorized innovation barriers as: cost barriers, knowledge

barriers and market barriers. Arvid (et al 2009) categorized innovation barriers as: financial barriers, risk barriers, competence barriers, organizational barriers and legal barriers. Marketing skills such as customer focus (Clifford and Cavanagh, 1985; Mondiano and Ni-chlonna, 1986; Tonge, Larsen, 1998), face to face contact with customers (Foley and Green, 1995) and marketing intelligence (Freel 2000; Wren, Souder ve Berkowitz, 2000) have been cited as the most critical barriers for new product success. Competitors, suppliers and customer opinions, international market characteristics, domestic market characteristics, strong project leaders, access to financial, personnel and practical resources, skills, expreience and good judgement taxation of new products, process and services, in appropriate government tax have been widely reported as barriers that affect the success of innovation process (Cooper and Klevinsmidt, 1995; Foley and Gren 1995; Knight 1996, Tidd, Bessant and Pavitt, 1997, Pihkala et.al 2002).

Table 1: Internal and External Barriers in Literature

INTERNAL BARRIERS	
Financial Problems	Birley , Niktari, 1995; Uzun, 1997; Hadjimanolis, 1999; Galio, Legros, 2004 ; McAdam, McConvery and Armstrong, 2004; Larsen and Lewis, 2007; Segerra-Blasco, Garcio-Quevedo, Tervl-Carrizosa , 2008
Cost	Uzun, 1997; Galio, Legros, 2004; Saatçıoğlu, Özmen, 2007;Segerra- Blasco, Garcia- Quevedo, Tervl-Carrizosa, 2008
Qualified Staff	Mohen, Rosal, 1999; Napier et al 2004; Galio, Legros, 2004;Larsen, Lewis, 2007; Sund, 2008; Ren, 2009
Lack of Information on Technologies	Galio , Legrios, 2004; Saatçıoğlu, Özmen, 2007; Segerra-Balsco, Garcia-Quevedo, Tervl-Carrizosa, 2008
Lack of Information on Markets	Galio, Legros, 2004; Larsen, Lewis, 2007; Segerra- Blasco, Garcia-Quevedo, Tervl-Carrizosa, 2008, Tiwari, Buse, 2007
Education	Platier, 1984; Larsen, Lewis, 2007
Management Expertise	Birley , Niktari, 1995, McAdam, McConvery, Armstrong, 2004
Competence	Mohen, Rossal, 1999;Stendhal, Rose, 2008
Time	Hadjimaolis, 1999; Larsen, Lewis, 2007
Inadequate R&D, Design and Test in the firm	Hadjimanolis, 1999; Larsen, Lewis, 2007
Culture	Palmer, Noone, 2000; Napier et al, 2004; Sund, 2008
Bureaucracy	Palmer, Noone, 2000; Sund, 2008
Resistance to Change	Galio, Legros, 2004; Stendhall, Rose,2008
Organizational Structure	McAdam, McConvery , Armstrong, 2004
Lack of Use of Employees Ideas	McAdam, McConvery , Armstrong, 2004
Lack of Suggestions for Innovations	McAdam, McConvery , Armstrong, 2004
Research Management and Protection	Larsen, Lewis, 2007; Tiwari, Buse, 2007
Restrictions Imposed by Location	Larsen, Lewis, 2007
Problem of Global Distribut	Larsen, Lewis, 2007
Stress	Larsen, Lewis, 2007
Knowledge of the New Product	Larsen, Lewis, 2007

Development Process	
Project Management	Tiwari, Buse, 2007
Internationalization	Tiwari, Buse, 2007
Conceptualization	Tiwari, Buse, 2007
Innovation not a priority	Stendhal, Rose, 2008
No need to innovate	Stendhal, Rose, 2008
Long Internal Decision-Making Process	Sund, 2008
Competition from Other Prioritized Projects	Ren, 2009
Existing Configurations	Ren, 2009
Insufficient Tools for Decision-making and Process-modelling	Ren, 2009
Concerns for Job Security	Ren, 2009
EXTERNAL BARRIERS	
Finance	Platier, 1984; Hadjimanolis, 1999; Saatcioglu, Özmen, 2007; Tiwari, Buse, 2007; Segerra- Blasco, Garcia- Quevedo, Tervl-Carrizosa, 2008
Norms and Standards	Platier, 1984; Galip, Legros, 2004
Problems with Inputs	Hadjimanolis, 1999; Stendhal, Rose, 2008
Regulations	Palmer, Noone, 2000 ; Sund, 2008
Macroeconomic Conditions	Napier et al 2004; Ren, 2009
Legislation	Galip, Legros, 2004
High Perceived Risks	Uzun, 1997
Government Market Regulation Policies	Hadjimanolis, 1999
Access to Technology Providers	Hadjimaolis, 1999
Government's Environment	Hadjimanolis, 1999
Labour and Consumer Protection Policies	Hadjimaolis, 1999
Federal Laws	Palmer,Noone, 2000
Accredition Guidelines	Palmer,Noone, 2000
Lack of Customer Responsiveness to New Products and Process	Galio, Legros, 2004
High Long-term Inflation	Napier et al 2004
High Economic Risks	Saatçioğlu, Özmen, 2007
Competitors Copying Products	Larsen, Lewis, 2007
Finding Suitable Human Resource	Tiwari, Buse, 2007
Bureacuracy	Tiwari, Buse, 2007
Trouble Finding Right Cooperation Partners	Tiwari, Buse, 2007
Uncertain Demand	Segerra- Blasco, Garcia- Quevedo, Tervl-Carrizosa, 2008
Lack of Demand for Innovation	Segerra- Blasco, Garcia- Quevedo, Tervl-Carrizosa, 2008
Innovation is Risky	Stendhal, Rose; 2008
Size of the Home Market	Sund, 2008

One of the conventional means is to analyze them in two categories – external and internal barriers (Piatrier, 1984). The external barriers could be subdivided into such items as supply, demand, and the relevant environment. The

supply barriers comprise difficulties in reaching technological knowledge, raw material and finance. Demand barriers include customer needs, perceptions of the risks of innovation and constraints in the domestic or foreign markets. The enviromental barriers cover legislation and political issues. The internal barriers could be related with certain resource-based issues such as the financial resources of the firm, technical competence and time, culture and system related issues as methods, human nature-related issues as the attitudes of managers towards risks and the resistance of employees against innovation.

In Table 1, internal and external barriers in literature are given. As Galio and Legros (2004) emphasized, an innovation system is based on a set or arrangement of components so related or connected to form a unity or organic linked to innovation. Innovation should be considered as resulting from the interactions between internal and external factors in the firm. In this context, as well as considering the internal and external factors seperately in the innovation process, the interactions between the internal and external factors in the innovation process should be considered in the innovation management process.

In this research, the focus is placed on the barriers affecting the performance of the innovation process. To analyze whether firms in Turkey face innovation barriers similar to those encountered in other countries, a new set of innovation barriers using the literature review is given. Then a model is developed which could be used to determine the relations of the barriers. Later, barriers are classsified with respect to their driver powers and dependence powers. The aim of this research is to determine the basic external and internal barriers that place important roles in the success of the innovation process in Turkey.

II. METHODOLOGY

The research was carried out using the interpretive structural modelling method, a method that is used to identify and clarify the factors causing a problem and their interrelations in terms of their power value (Mandal ve Deshmukh, 1994; Ravi et al 2005; Faisal et al 2006a, Faisal et al 2006b). It is an interactive planning methodology whereby a set of directly and indirectly related factors are structured into a comprehensive systematic model. For complex problems, like the one under consideration, a number of barriers may be affecting the innovation management. However, the direct and indirect relations between the barriers describe the situation far more accurately than do the individual barriers isolated. Therefore, ISM develops insights into collective understanding of these relationships.

The method constitutes 8 steps:

1) Identification of the factors, relevant to the problems or issues, which could be done by any group of problem-solving technique.

In this step, the innovation related literature was thoroughly reviewed. As a result of the review, 32 internal and 29 external barriers were found to be effective in innovation processes. A problem-solving group was formed comprising four academicians who have studies in innovation, seven experts

from Chambers, four R&D staff, two from a small scale company and two from a large scale one. The group was asked to analyze the listed internal and external barriers, take out the repeated ones and rearrange the list including the ones thought to be valid in relation with Turkey's conditions. The first tour resulted with reducing each of the external and internal groups to 30. Through the second tour 15, and the third tour 12 total barriers were determined.

2) Establishing a contextual relationship between elements with respect to the pairs of elements will be examined.

To investigate the relations between 12 barriers, a questionnaire was formed. The questionnaire was sent to 13 referees, 6 of whom were academicians who were working on different topics of innovation, 2 of whom were economy oriented, 2 of whom were management oriented and 2 of whom were engineering oriented. Five of seven referees were working for the R&D and supporting organizations related with innovation. Another 2 were from the companies with noticeable innovation performance.

The questionnaire was tested for content validity. Content validity primarily depends on an appeal to the propriety of content and the way it is presented (Nunally, 1978). The instrument developed in this study demonstrates the content validity as the selection of measurement items was based on both, an exhaustive review of the literature and detailed evaluations by academicians and executing managers during pre-testing.

3) Developing a structural self-interaction matrix (SSIM) of elements, which indicates pair-wise relationships between elements of the system.

To analyze the barriers, a contextual relation of "achieve" was chosen. This means that one barrier will achieve another barrier; the latter will be achieved by another barrier; the two barriers will help achieve each other or the barriers will be unrelated. For analyzing the barriers in developing SSIM, the following four symbols have been used to denote the direction of relationships between barriers (i and j):

V= Barrier i will help achieve barrier j;

A= Barrier j will be achieved by barrier i;

X= Barrier i and j will help achieve each other and

O= Barriers i and j are unrelated.

4) Developing a reachability matrix for transitivity. Transitivity of the contextual relation is a basic assumption in ISM which states that if element A is related to B and B is related to C, then A is necessarily related to C.

The SSIM has been converted into a binary matrix, called the reachability matrix by substituting X, A, V and O by 1 and 0. The substitution of 1s and 0s are as per the following rules:

- If the (i,j) entry in the SSIM is V, the (i,j) entry in the reachability matrix becomes 1 and the (j,i) entry becomes 0.
- If the (i,j) entry in the SSIM is A, the (i,j) entry in the reachability matrix becomes 0 and the (j,i) entry becomes 1.

- If the (i,j) entry in the SSIM is X, the (i,j) entry in the reachability matrix becomes 1 and the (j,i) entry also becomes 1.
- If the (i,j) entry in the SSIM is O, the (i,j) entry in the reachability matrix becomes 0 and the (j,i) entry also becomes 0.

5) Partitioning the reachability matrix into different levels.

From the final reachability matrix, the reachability and antecedent set (Warfield, 1974) for each barrier are found. The reachability matrix consists of the elements itself and other elements, which it may help achieve, whereas the antecedent set consists of the element itself and the other elements, which may help achieving it. Then the intersection of these sets is derived for all elements. The element for which the reachability and intersection sets are the same is the top-level element in the ISM hierarchy. The top-level element of the hierarchy would not help any other element above their own level. Once the top-level element is identified, it is seperated from the other elements. Then, the same process finds the next level of the element. This process continues till the levels of each element are found. These identified levels help in building the digraph and final model.

6) Driver power and dependence diagram:

The objective of MICMAC analysis is to analyze the driver power and dependence power of the variables (Mandal and Deshmukh, 1994). The variables are classified into four clusters (Figure 2). The first cluster consists of the "autonomous barriers" that have weak driver power and weak dependence. These barriers are relatively disconnected from the system, with which they have only few links, which may be strong. The second cluster consists of the dependent enablers that have weak driver power but strong dependence. Third cluster has the linkage barriers that have strong driving power but also strong dependence. These barriers are unstable in the fact that any action on these barriers will have an effect on the others and also a feedback on themselves. The fourth cluster includes the independent barriers having strong driving power but weak dependence. It is observed that a variable with a very strong driving power, called the key variables, falls into the category of independent or linkage barriers.

7) ISM based model.

From the final reachability matrix (Table 3) and level partitions, the structural model is generated by means of vertices or nodes and lines of edges. If there is a relationship between the barriers j and i, this is shown by an arrow which points to from i to j. This graph is called graph or digraph.

After removing the transitivities as described in ISM methodology, the diagram is finally converted into ISM as shown in Figure 2.

8) Reviewing the ISM model to check for conceptual inconsistency, and make the necessary modifications.

III. FINDINGS OF THE STUDY

1. Identification of the Elements.

12 barriers which were reduced from 32 internal and 29 external barriers by the problem solving group are presented in Table 2.

Table 2: Barriers in Innovation Process

BARRIERS
1. Lack of Qualified Personel
2. Patent and Licence Policy
3. Bureaucracy
4. Problems with Raw Materials
5. Lack of Incentives Applied by Government
6. Foreign Trade Policy
7. Competition Policy
8. Lack of R&D, Design, Test and Other Technical Problems in Companies
9. Time For Return for Innovation is too Long
10. Perception of Innovation as Risky
11. Too Difficult to Control Innovation Costs
12. Finance of Innovation

2. Structural Self Interaction Matrix

As it can be seen in Table 3 and explained in the methodology, SSIM reveals that:

- There appears no relationship between the "lack of qualified personnel" and "too difficult to control innovation costs".
- "The lack of qualified personnel" and "the lack of competition policy" seem to be interrelated affecting each other.
- "The lack of qualified personnel" diminishes the access to the incentives applied by the government.

Table 3. Structural Self Interaction Matrix (SSIM)

	Q12	Q11	Q10	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2
(Q1)Lack of qualified personnel	A	O	A	A	A	X	O	V	A	O	A
(Q2)Patent and licence policy	A	O	A	A	X	X	X	X	X	X	
(Q3)Bureaucracy	A	O	O	O	O	X	X	X	A		
(Q4)Problems with raw materials	X	X	A	O	X	V	V	V			
(Q5)Lack of Incentives applied by government	A	O	A	O	A	X	X				
(Q6)Foreign trade policy	A	O	O	O	O	X					
(Q7)Competition policy	A	O	A	O	O						
(Q8)R&D, design, test and other technical problems in companies	X	O	O	O							
(Q9)Time for return for innovation is too long	A	O	A								
(Q10)Perception of innovation as risky	A	O									
(Q11)Too difficult to control innovation costs	A										
(Q12)Finance of innovation											

- "The foreign trade policy" is affected by the "finance of innovation". There seems to be no relationship between the design and those items as "too difficult to control innovation costs", "perception of innovation as risky", "time for return for innovation too long" and "R&D".

- "Patent and licence policy" is affected by "finance of innovation", "perception of innovation as risky" and "time for return for innovation is too long". Furthermore, "patent and licence policy" affects and is affected by "R&D, test and other problems in companies", "competition policy", "foreign treade policy", "lack of incentives applied by government", "problems with raw materials" and "bureaucracy".

- "Bureaucracy" is affected by "finance of innovation" and "problems with raw materials". "Bureaucray" doesn't have a relation with "too difficult to control innovation costs", "time for return for innovation is too long", "R&D, design, test and other technical problems in companies". "Bureaucraycy" affects and is affected by "competition policy", "foreign trade policy", "lack of incentives applied by government".

- "Problems with raw materials" affects / is affected by "finance of innovation", "too difficult to control innovation costs", "R&D, design, test and other technical problems in companies". "Problems with raw materials" is affected by "perception of innovation as risky" and does not have a relation with "time for return for innovation is too long". Furthermore, "problems with raw materials" affects "competition policy", "foreign trade policy", and "lack of incentives applied by government".

- "Competition policy" is affected by "finance of innovation", "perception of innovation as risky" whereas not related with "too difficult to control innovation costs", "time for return for innovation is too long", "R&D, test and other technical problems in companies".

3.Reachability Matrix

Initial reachability matrix for barriers which is obtained by substituting X,A,V,O by 1 and 0 is shown in Table 4.

Table 4. Initial Reachability Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
(Q1)Lack of qualified personnel	1	0	0	0	1	0	1	0	0	0	0	0
(Q2)Patent and licence policy	1	1	1	1	1	1	1	1	0	0	0	0
(Q3)Bureaucracy	0	1	1	0	1	1	1	0	0	0	0	0
(Q4)Problems with raw materials	1	1	1	1	1	1	1	1	0	0	1	1
(Q5)Lack of Incentives applied by government	0	1	1	0	1	1	1	0	0	0	0	0
(Q6)Foreign trade policy	0	1	1	0	1	1	1	0	0	0	0	0
(Q7)Competition policy	1	1	1	0	1	1	1	0	0	0	0	0
(Q8)R&D, design, test and other technical problems in companies	1	1	0	1	1	0	0	1	0	0	0	1
(Q9)Time for return for innovation is too long	1	1	0	0	0	0	0	0	1	0	0	0
(Q10)Perception of innovation as risky	1	1	0	1	1	0	1	0	1	1	0	0
(Q11)Too difficult to control innovation costs	0	0	0	1	1	0	0	0	0	0	1	0
(Q12)Finance of innovation	1	1	1	1	1	1	1	1	1	1	1	1

4. Final Reachability Matrix

After incorporating the transivity as described in step (4) of the ISM methodology, the final reachability matrix is shown in Table 4, in which the driving power and dependence power of each barrier are also shown. Driving power of each barrier is the total number of barriers (including itself), which it may help achieve. On the other hand, dependence is the total number of barriers (including itself), which may help achieving it. These driving power and dependencies will be later used in the classification of barriers into the four groups of autonomous, dependent, linkage and independent (driver) barriers.

Table 5. Final reachability matrix

	1	2	3	4	5	6	7	8	9	10	11	12	Driving Power
(Q1)Lack of qualified personnel	1	0	0	0	1	0	1	0	0	0	0	0	3
(Q2)Patent and licence policy	1	1	1	1	1	1	1	1	0	0	0	0	8
(Q3)Bureaucracy	0	1	1	0	1	1	1	0	0	0	0	0	5
(Q4)Problems with raw materials	1	1	1	1	1	1	1	1	0	0	1	1	10
(Q5)Lack of Incentives applied by government	0	1	1	0	1	1	1	0	0	0	0	0	5
(Q6)Foreign trade policy	0	1	1	0	1	1	1	0	0	0	0	0	5
(Q7)Competition policy	1	1	1	0	1	1	1	0	0	0	0	0	6
(Q8)R&D, design, test and other technical problems in companies	1	1	0	1	1	0	0	1	0	0	0	1	6
(Q9)Time for return for innovation is too long	1	1	0	0	0	0	0	0	1	0	0	0	3
(Q10)Perception of innovation as risky	1	1	0	1	1	0	1	0	1	1	0	0	7
(Q11)Too difficult to control innovation costs	0	0	0	1	1	0	0	0	0	0	1	0	2
(Q12)Finance of innovation	1	1	1	1	1	1	1	1	1	1	1	1	12
Dependence Power	8	10	7	6	10	7	9	4	3	2	3	3	

5) Partioning Reachability Matrix

The barriers along with their reachability set, antecedent set, intersection set and the levels are shown in Table 6.

In Iteration 1; bureaucracy (barrier 3), lack of incentives applied by government (barrier 5), foreign trade policy (barrier 6), competition policy (barrier 7), too difficult to control innovation costs (barrier 11) are all found at the level 1. Therefore, they are positioned at the top of the ISM model.

In Iteration 2; lack of qualified personnel (barrier 1) has the same reachability set and intersection set. Therefore, lack of qualified personnel is found at the level 2.

In Iteration 3; patent and licence policy (barrier 2), problems with raw materials (barrier 4) and lack of R&D, design, test and other problems in

companies (barrier 8) have the same reachability and intersection set. Therefore, they are found at the level 3.

Table 6. Reachability Matrix with Levels

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
1(Lack of qualified personnel)	1,5,7	1,2,4,7,8,9,10	1,7	2
2(Patent and licence policy)	1,2,3,4,5,6,7,8	2,3,4,5,6,7,8,9,10,12	2,3,4,5,6,7,8	3
3(Bureaucracy)	2,3,5,6,7	2,3,4,5,6,7,12	2,3,5,6,7	1
4(Problems with raw materials)	1,2,3,4,5,6,7,8,11,12	2,4,8,10,11,12	2,4,8,11,12	3
5 (Lack of incentives applied by government)	2,3,5,6,7	1,2,3,4,5,6,7,8,10,12	2,3,5,6,7	1
6 (Foreign trade policy)	2,3,5,6,7	2,3,4,5,6,7,12	2,3,5,6,7	1
7 (Competition policy)	1,2,3,5,6,7	1,2,3,4,5,6,7,10,12	1,2,3,5,6,7	1
8 (R&D, Design, Test and other technical problems in companies)	1,2,4,5,8,12	2,4,8,12	2,4,8,12	3
9 (Time for return for innovation is too long)	1,2,9	9,10,12	9	4
10 (Perception of innovation as risky)	1,2,4,5,7,9,10	10,12	10	5
11 (Too difficult to control innovation costs)	4,11	4,11,12	4,11	1
12 (Finance of innovation)	1,2,3,4,5,6,7,8,9,10,11,12	4,8,12	4,8,12	6

In Iteration 4, time for innovation is too long (barrier 9) has the same reachability set and intersection set. Therefore, it is positioned at level 4.

In Iteration 5, perception of innovation as risky (barrier 10) has the same reachability set and intersection set. Therefore, barrier 10 is located at level 5.

In Iteration 6, finance of innovation (barrier 12) has the same reachability set and intersection set. Therefore, it is located at the bottom of the ISM model since there are no more barriers left for iteration.

6) Driver Power and Dependence Diagram

- The driver power-dependence matrix (Figure 1) indicates that "return of investment on innovation too long", and "difficult to control innovation costs" are the autonomous barriers for innovation management. These barriers appear as weak drivers and weak dependents. Therefore, they don't have much influence on the other variables of the system.

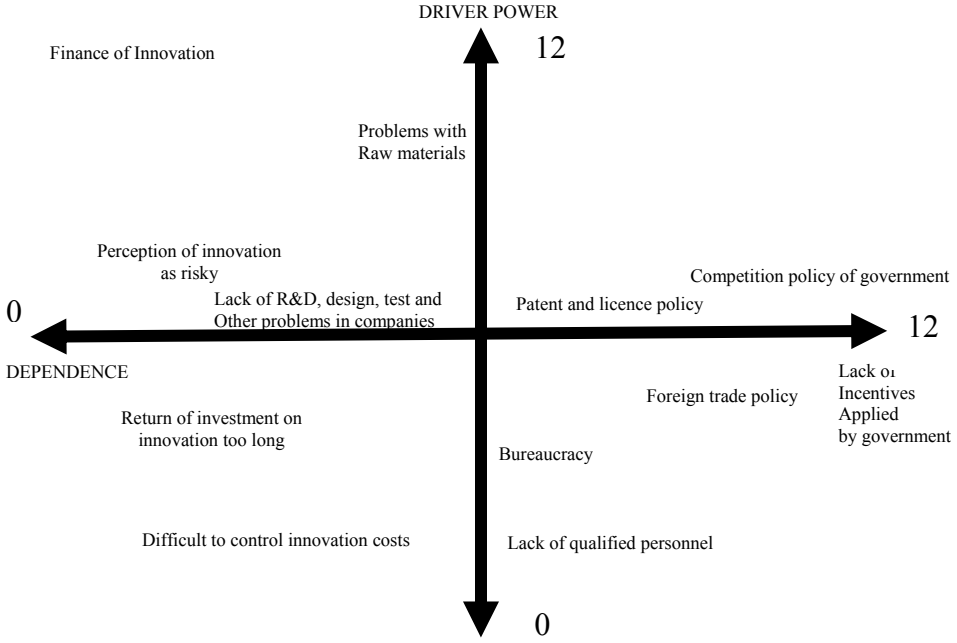

Figure 1. Driver Power and Dependence Diagram

- "Foreign trade policy", "incentives applied by government", "bureaucracy", "lack of qualified personnel" are weak drivers but strongly dependent on the other variables. They are seen at the top of the ISM hierarchy (Figure 2).

- "Patent and licence policy" and "competition policy of government" are seen as linkage variables that have a strong driving power as well as strong dependence. A little change in "patent and licence policy" and "competition policy of government" affects the system in a considerable manner.

"Finance of innovation", "problems with raw materials", "perception of innovation as risky" and "lack of R&D, design, test and other problems in companies" are variables that have greater driving powers. Thus, the management needs to address these innovation barriers. Management should devise strategies to enhance the deployment of independent variables so that the innovation performance should be improved.

7) ISM Based Model

As shown in Figure 2, at the bottom of ISM model, "finance of innovation" is located. This barrier affetcs all the other barriers. The government and the policies developed by the government are important in decreasing the risk of innovation(barrier 10). In order to decrease the risk of innovation, competition policy (barrier 7), and incentives applied by government (barrier 5) are to be considered.

One of the important actions related with innovation is patent and licence policy (barrier 2). Patent and licence policy (barrier 2), problems with raw materials (barrier 4) and lack of R&D, design, test and other technical problems in companies (barrier 8) also have two sided relations between each other. Lack of R&D, design, test and other technical problems in companies (barrier 8) and problems with raw materials (barrier 4) cause difficulties in creating innovative products and also cause difficulties in patent and licence policies (barrier 2). Lack of R&D, design, test and other technical problems in companies (barrier 8) cause difficulties in competition policy (barrier 7). One of the most important results of the research to consider is the two sided relations between policies developed by government, namely, patent and licence policy (barrier 2), competition policy (barrier 7), incentives applied by government (barrier 5), foreign trade policy (barrier 6) and the environment which affects the process of all these mentioned policies namely bureaucracy (barrier 3).

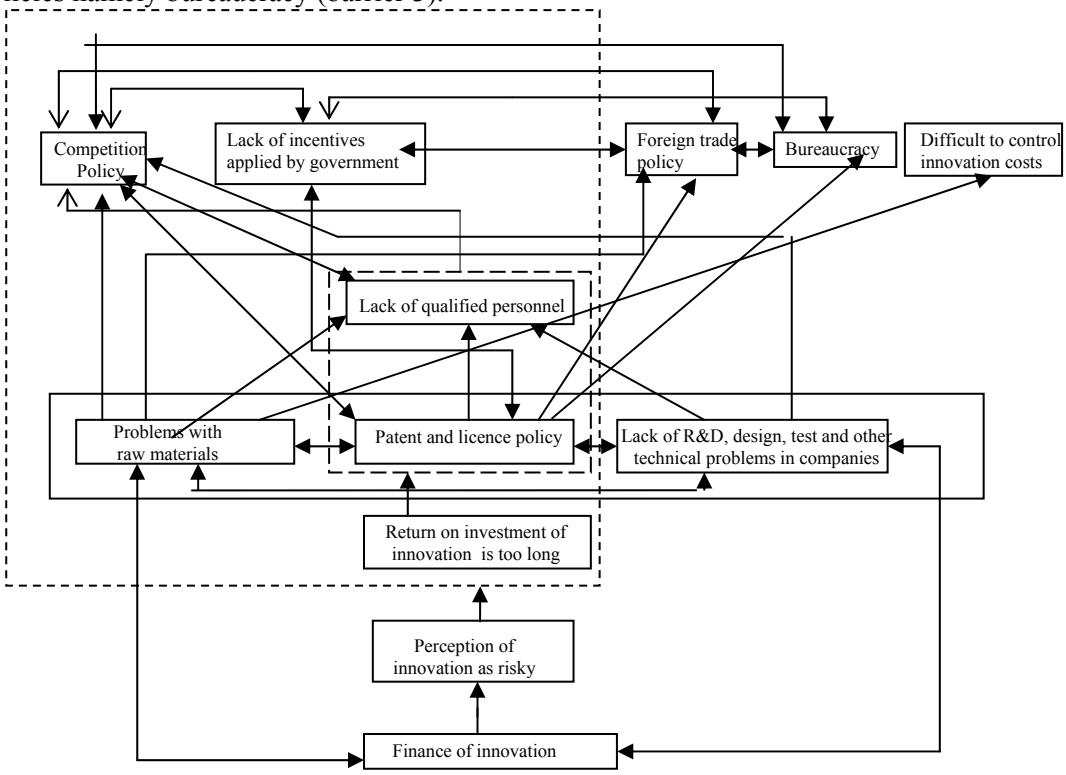

Figure 2. ISM based model

Step 8:

No conceptual inconsistency is found between the elements of the innovation system.

DISCUSSION AND CONCLUSIONS

One of the major objectives of this study is to identify and rank the innovation barriers in Turkey, to establish interrelations among these identified barriers using ISM and discuss the managerial implications for improving the national innovation system of Turkey.

In the first step of the research, 12 barriers were determined, utilizing the existing researches already carried out. These barriers are similar to those thought to be important in such previous researches as (Piatier, 1984; Lall, 1994; Birley and Nektari, 1995; Ylinenpaa, 1998; Hadjimanolis, 1999, Galia and Legros, 2004; Segerra-Blasco, Garcia-Quevedo, Tervel-Carrizoda, 2008). This research has revealed following fundamental points:

1- "Finance of innovation" is at the bottom level with highest driving power. It means "finance of innovation" is the major driver for the other barriers.

2- The driver power and dependence diagram (Figure 1) indicates that "return of investment on innovation too long" and "difficult to control innovation costs" are autonomous factors in the study. Autonomous variables generally appear and are relatively disconnected from the system. These variables do not have much influence on the other variables of the system.

3- "Foreign trade policy", "lack of incentives applied by government", "bureacuracy", "lack of qualified personnel" are weak drivers but strongly dependent on other variables.

4- "Finance of innovation", "problems with raw materials", "perception of innovation as risky" and "lack of R&D, design, test and other problems in companies" are at the bottom of the model having strong driving power. These variables will help organizations to achieve its desired objectives and are classified as independent variables or drivers.

5- "Patent and licence policy", and "competition policy of government" both affect and are affected by the other barriers; hence, any change in either of these two policies would cause serious effects on the innovation system.

While the dependent barriers are important in determining the structure of the innovation process; the independent ones are more important in improving the process. In order to better a innovation process, the first thing to do is to better the independent barriers, which cover "finance of innovation", "problems with raw materials", "lack of qualified personnel and "perception of innovation as risky".

Due to the scope covered as well as the method used, this research is thought to provide significant contribution to defining the right barriers and determining their interaction, and provide an agenda particularly concerning the unique features of Turkey's conditions. Determining the actual barriers would lead to reaching the desired conclusions; therefore, the future researches taking into consideration the barriers mentioned in the model and their interactions would provide considerable contributions to the analysis of the perceptions of the

barriers as well as to scrutinizing the performance of the process. The future researches are suggested to analyze the determined barriers one by one thoroughly along with their effects on broader context in different scale organizations and sectors.

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