LITERATURE-BASED CAUSAL LOOP DIAGRAMS OF PATENT MANAGEMENT PROCESS IN PHARMACEUTICAL INDUSTRY

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08.07.2019

Seçil Gençler

ABSTRACT

In competitive environment of the pharmaceutical industry new inventions and patents are the key points. In order to be one step further from their rivals, the companies invest to R&D efforts and try to find new inventions. At this moment, patents are an important point to recoup the investment. So the companies lobby for the more strict patent law to prevent imitation. Thus even in the developing countries, they have to invest R&D and invent new products to be able to survive in the market. All of these happenings increase the importance of the patents and patent management day by day. Also this situation can lead to Turkish pharmaceutical industry to invest R&D or have patent licenses of other firms' products increasingly.

In scope of this study, it was concluded that in patent management, research capability, reaching knowledge, productivity of R&D efforts, strength of patent management in a country, drug prices and R&D expenses are important parameters which should be considered in decisions related with patents and choosing the strategies regarding them.

Key Words: patent, patent management, R&D, innovation, drug price

ÖZET

Yeni keşif ve patentler, ilaç endüstrisinin rekabetçi yapısı içerisinde anahtar noktalardandır. Şirketler rakiplerinden bir adım önde olabilmek için AR&GE çabalarına yatırım yaparak yeni keşiflerde bulunmaya çalışırlar. Bu amaçla patentler AR&GE için yapılan yatırımları tazmin etmek için önemli bir noktadır. Bu denenle şirketler taklitleri önlemek için daha sıkı patent yasalarının uygulanması yönünde kulis yaparlar. Dolayısıyla, gelişmekte olan ülkelerde bile şirketler AR&GE için yatırım yapmak ve yeni ürünler keşfetmek zorundadırlar. Bütün bunlar patentlerin ve patent yönetiminin önemini gün ve gün arttırmaktadır. Ayrıca bu durum Türk İlaç Endüstrisinin de AR&GE yatırımlarının artmasına yol açabilecektir.

Bu çalışma kapsamında, patent yönetiminde araştırma yeterliliği, bilgiye ulaşma, AR&GE çabalarının üretkenliği, bir ülkedeki patent yönetiminin gücü, ilaç fiyatları ve AR&GE harcamaları, patentlerle ilgili kararlar alınması ve onlarla ilgili stratejiler geliştirilmesi için önemli parametreler olduğu sonucuna varılmıştır.

Anahtar Kelimeler: patent, patent yönetimi, AR&GE, inovasyon, ilaç fiyatları

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DEFINITIONS

“**Innovation** → an invention is developed at the end of a process by passing all of the steps of innovation”(Meniere, 2008).

“**Patent Premium** → a proportioanl increase in the value of the discovery by patenting it” (Arora,2007).

“**Patent** → a system designed to provide incentives for innovations in mechanics, chemistry and pharmaceutical industry” (Meniere, 2008).

“**Organizational coupling** → management and organization partnerships and network between partners” (Swan, 2007; cited Owen-Smith and Powell, 2004).

“**Loosely coupled innovation projects** → projects which have more informal and autonomous structure” (Swan, 2007; cited Owen-Smith and Powell, 2004).

“**Tightly coupled innovation projects** → more central and hierarchical style projects. There are legally binding contracts such as patent protection and detailed financial responsibilities” (Swan, 2007; cited Owen-Smith and Powell, 2004).

“**Knowledge boundaries** → the ways which differentiates from high to low and combines the different expertness area of the knowledge” (Swan, 2007; cited Carlile, 2004).

“**Research Productivity** → number of patent (applications)/ R&D expenditure”(Rassenfosse and Pottlsberghe, 2007)

“**Patent Propensity** → percentage of innovations that are patented” (Rassenfosse and Pottlsberghe, 2007)

“**Researcher Efficiency** → number of patents per researcher” (Rassenfosse and Pottlsberghe, 2007)

1 INTRODUCTION

The study plans to look at dynamics of the patent management in pharmaceutical Industry. Pharmaceutical Industry is technology-based industry and there is high competition among the companies. Most of the pharmaceutical companies are large, multinational and research intensive. Because of the competitive structure of the industry, there is a race between the firms to invent new inventions in order to become in front of the rivals. So the firms give weight to R&D performance but R&D expenditures are so high to be able to invent new drugs. In order to recoup expenditures, firms are trying to gain patents and put pressure on the national governments and related institutions to enforce the existing patent laws. As the firms have more patents, the need of management of patents arises. Especially in recent years, the patent management for the firms has a crucial and strategic importance to maintain profitability and growth of the firm which indicate firm performance. Thus, the study aims to provide a significant contribution to understand the dynamics of the patent management and make decision making process easier about patent management using the causal loop diagrams.

1.1 Problem Statement

The study wants to answer the question of what dynamics influence patent management processes on firm performance when firms take decisions in Pharmaceutical Industry.

This research intended to provide solutions patent management related problems. In order to completed this research successfully, a detailed examination of management, research and data questions were preferred as a starting point.

Management questions to be addressed in the research were introduced in Section 1.3. Section 1.4 introduces research question, which is mainly about the outcomes and intentions of this study. This section basically converts managerial questions into research questions.

Section 1.5 and 1.6 are dedicated for the explanation of the data collection issue as well as the research methodology.

1.2 Purpose of the Study

"Managers' roles are to make decisions and shape organizational structures, strategies, and decision rules that influence how decisions are made" (Forrester, 1965; cited in Sterman, 2000). So the purpose of the study is to design a model in order to understand how the patent management works in pharmaceutical industry, the underlying factors in patent management and their connection with the firm performance in order to make decisions easier and more accurate for the managers.

1.3 Management Questions

Management questions which was determined in scope of this study focused on the dynamics of the patent management. The questions that the study tries to find answers are,

1. How the patent management process works?
2. What is the cause and effect relation between the factors in the patent management and how do they affect the firm performance?
3. How do managers improve their firms' patent operations?
4. How do managers take right steps in patent management to improve firm performance?

And the study shows the relations between the factors which have effect on patent management and aims providing possible helping solutions in taking decisions for the managers in pharma companies.

1.4 Research Questions

The research questions to be addressed in the study are;

1. What are the components of causal loops in patent management?

2. What is the dynamics of the causal loops in management?

These two research questions (or more) are explaining the approach to our research problem.

1.5 Research Design

System thinking approach, system dynamics modeling and causal loop diagrams as its tool will be used to explain the cause and effect relation between the variables.

1.6 Data Collection

The related secondary data necessary for the study will be obtained through literature review. The articles were collected by using Academic Search and Business Management databases of Yeditepe University.

2 THEORETICAL BACKGROUND

The pharmaceutical industry is a very competitive industry so firms have to be R&D intensive and invent new products in order to survive. They also have to patent their inventions to protect their efforts. This creates a need for patent management.

In order to understand patent management, we must understand pharmaceutical industry and the relation between pharmaceutical industry and patents. Like we mentioned above the pharmaceutical industry is a R&D intensive industry because there is high competition and the firms are forced for innovation. Driving forces can be defined as follows,

1. Scientific and technological advances
2. Raw materials (availability and scarcity)
3. Market demand
4. Competition
5. Societal needs
6. Governmental legislation that affects R&D efforts and the settings of an industrial sector
7. Company scientific, technological and market specialization

According to Achilladelis (2001), "Under the influence of these environmental forces, companies developed in-house capabilities to increase their sensitivity and ability to respond them. Already researches show that radical inventions take commercial successes and a good market performance so companies spend more on R&D to perpetuate their advantage. This shows that large pharmaceutical companies are able to survive upheavals associated with the succession of generations of medical technologies by their strong commitment to R&D and innovation, by the high profitability of new drugs and by their adaptability to a changing competitive environment."

"The R&D efforts are so expensive for companies and they need a patent protection to recoup the R&D costs by preventing imitations. For this, industry's strategy is,

1. To have an ample supply of R&D projects and patents in pipeline
2. To lobby the governments and related institutions like FDA and get extension of time on their patents in order to recoup their investment costs" (Ramrattan, 2006).

The life time of a patent for pharmaceutical product is about 20 year-period. This period may change according to country or region since different patent law can be applied in different countries and regions. A pharmaceutical company can meet the investments in R&D about to 8 years with the real lifetime of a patent. (Cauwenbergh, 2002).

Patent protection is very important to recoup the R&D costs especially in pharmaceutical industry. But there are different approaches about the impact of patents on innovation. Literature suggests that patent protection both stimulate and prevents innovation. Patenting typical invention can not be profitable (Arora, 2007). Also fees (like administrative fees) have a significant and negative impact on the number of invention that is patented (Rassenfose and Pottelsberghe, 2009). So companies have to decide if the invention will be patented or not, in order to gain the best benefit.

According to Nogues (1990), “Research efforts lead to inventions through productivity effect and inventions lead to patents through propensity to patent. Also a stronger IP (intellectual property) system leads to more patent filings. The coverage in terms of patentable subject matters, enforcement mechanisms and the lack of restrictions on patent rights, all significantly contribute to a stronger demand for patents (Rassenfosse and Pottelsberghe, 2009). So, even though most inventions are not worth patenting, patents are valuable as a subset of innovations and consequently patents do provides incentives for R&D. Already the results of many researches have been made show that many innovations produced by the pharmaceutical drug industry would not have been developed or introduced in the absence of patent protection.”

According to Nogues (1990), “Patents are also powerful instrument for sustaining drug prices. When a company patents their invention it creates a monopoly in the market and the price elasticity of demand for patents is inelastic. In this point we also must consider that although patents provide a monopoly, prices will also reflect the extent of competition among different patented drugs in given therapeutic classes but still patents appear to be a major factor in sustaining drug prices. When patents sustain high prices, which in turn provide rents to undertake further R&D, which in turn allows invention of new drugs, etc.” We can illustrate it as;

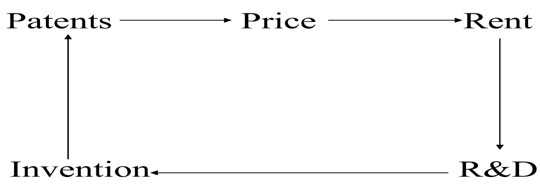

*Figure.1*_The loop between patent, price, R&D and invention (Nogues, 1990)

When we look at all of these factors that we have mentioned above, it is seen that management of patents is critical for companies because patent management is related with the key areas of a company for the firm performance. Thus, companies use patent management to make strategic moves.

As it was defined in literature also argues that the reason for establishment of a patent system is providing a protection for a company's obtained technological knowledge through R&D by making investments for a defined period temporarily. Capital market is reached better and licencing revenues is received via patents. Therefore patents can be used as performance indicator for both researchers and companies (Arundel et. al., 1995; Cohen et. al., 2002; Schalk et. al., 1999; cited in K. Blind, 2007).

Various motives for patenting can be divided into;

1. Protection of the technological knowledge
2. Blocking competitors from usage of knowledge and technology obtained through R&D
3. Increasing company reputation

4. Using patents in performance evaluation and determining rewards for employees and department (Blind et. al., 2006; cited in Blind, 2007).

"A firm will patent defensively in order to stop other firms from patenting one of its inventions and suing it for infringement, even though the firm does not need patent on the invention to earn a return on in its investment (Arundel and Patel, 2003; cited in Blind, 2007). Also a large patent portfolio enhances the bargaining power of a company in negotiations about mergers, license contracts or research co-operations to evaluate the research efforts and results of their counterparts." (Noel and Schankerman, 2006; cited in Blind, 2007).

As a result patents are really important in pharmaceutical industry and with an effective patent management; the companies can improve their performances. By understanding the dynamics of the patent management, the managers make their companies more advantageous in the competitive environment of pharmaceutical industry.

3 OUTLINE

3.1 Study Plan

Literature was reviewed and the related articles with patent management were found. Since the found articles were centered in mainly four areas, the articles were grouped into four main titles along with the expert opinion. The articles under the each main title were grouped into the 3 subtitle again based on their focus subjects. Thus outline of the literature was formed as;

1. Discovery
   a. Pharmaceutical Industry
   b. R&D
   c. Innovation
2. Patent System
   a. Patent Protection
   b. Patent Application and Patentability
   c. Patent Information
3. Life Cycle
   a. Patent Life
   b. Patent Extensions
   c. Patent Expiry
4. Patent Issues
   a. Price
   b. Generic Drugs
   c. Patent Infringements and Litigations

There are 5 articles under each subtitle. All of the articles which are summarized are composed under related subtitles in Turkish then these subtitles are combined in order to compose the research notes for each main title. Research notes of the each main title are put together and the literature review are formed. Then causal loop diagrams are drawn by using system thinking approach. These loops explain the dynamics of the patent management and the relations between the related factors. After necessary testing for robustness and sensitivity, the possible policy developments and implications are evaluated by using the result of the study.

3.2 Research Justification

According to Meredith (1989), set of methods shows same model jointly is called a research paradigm and a framework was formed regarding it by determining two dimensions as ‘’rational/ existential’’ and ‘’natural/artificial’’.

“Rational/Existential” dimension is related with generating knowledge that is the viewpoint of the researcher. Rationalism and existentialism are two edges of this dimension. Rationalism is about pure logic. Existentialism is about getting knowledge through people.This dimension have four perspectives;

1-Axiomatic (a high degree of knowledge is assumed about the goals and structure of an organization.),

2-Logical positivist /empiricist (assumes that phenomenon under study can be isolated from the concept),

3-Interpretive (includes the context of phenomenon as part of the object of the study. The purpose is to understand how others construe, conceptualize and understand events and concepts.),

4-Critical theory (synthesis of the positivist and interpretive perspectives), "Natural/Artificial" dimension is related with information type and source of the information. This dimension have two edges as natural and artificial. Natural edge get information with explanation from concrete and objective data. Artifical edge is about getting knowledge via making interpretations.This dimension is divided into three category

1- Object reality (refers to direct observation by researcher of the phenomenon),

2-People's perception of object reality (related to research conducted through somebody else's eyes as in surveys),

3-Artificial reconstruction of object reality (all modelling and systems analytic efforts in operations).

Table 1 summarizes the two dimensions introduced by Meredith et al. (1989) and methodologies related with them. According to this research framework, our research methods are historical analysis that lies in the intersection of interpretive and people's perceptions of object reality and conceptual modelling that lies in the intersection of interpretive and artificial reconstruction of object reality. These methods were highlighted (written bold) within the table.

Table 1 "*A Framework for Research Methods*" (Adopted from Meredith et al., 1989)

<table>
<tr><td colspan="3" rowspan="2"></td><td colspan="3">Source of Information used in the Research</td></tr>
<tr><td>NATURAL</td><td></td><td>ARTIFICIAL</td></tr>
<tr><td rowspan="5">Epistemological Structure of the Research Process</td><td rowspan="5">RATIONAL
↕
EXISTENTIAL</td><td></td><td>Direct Observation of Object Reality</td><td>People's Perceptions of Object Reality</td><td>Artificial Reconstruction of Object Reality</td></tr>
<tr><td>Axiomatic</td><td></td><td></td><td>*Reason / Logic / Theorems
* Normative Modeling
* Descriptive Modeling</td></tr>
<tr><td>Logical Positivist / Empiricist</td><td>* Field Studies
* Field Experiments</td><td>* Structured Interviews
* Survey Research</td><td>* Prototyping
* Physical Modeling
* Laboratory Experiments
* Simulation</td></tr>
<tr><td>Interpretive</td><td>* Action Research
* Case Studies</td><td>* Historical Analysis
* Delphi
* Intensive Interviews
* Expert Panels
* Futures / Scenarios</td><td>* Conceptual Modeling
* Hermeneutics</td></tr>
<tr><td>Critical Theory</td><td></td><td>* Introspective Reflection</td><td></td></tr>
</table>

"Historical analysis is an interpretive method and there is subjectivism in this method. Interpretism and subjectivity allow the researcher to take into consideration their particular insights. Objectivity is valuable for prediction but since the goal of research is also understanding, subjectivity has its place here too. The historical approach examines historical documents or less formally recorded data to evaluate factors, make comparisons, have insights and analyze the situation from a certain perspective. Researcher cannot manipulate the variables in this kind of analysis. But researcher can select some factors and have comments about them" (Meredith, J. R., Raturi, A., Amoako-Gyampah, K., & Kaplan, B.; 1989).

"Conceptual modelling is more existential than rational. It is used in mental modelling. System models with feedback loops, fishbone cause-effect diagrams, Gannt charts are examples for this kind of modelling. Conceptual modelling is also used in meta analysis which is for formulating a larger and more integrated perspective of a phenomenon through studies in literature" (Meredith, J. R., Raturi, A., Amoako-Gyampah, K., & Kaplan, B.; 1989).

4 LITERATURE REVIEW

The literature was reviewed in patent management perspective and they were grouped under 4 title as The Impact of Patents on Pharmaceutical Industry, Benefits of Patent Protection Systems, The Importance of Life Cycle Management of Patents Not to Lose the Advantage and Patent Issues.

4.1 The Impact of Patents on Pharmaceutical Industry and Its Relations with R&D and Innovation

Pharmaceutical companies tend to get patents for their inventions at the end of their R&D and innovation efforts in order to keep their profitability since they are in very competitive environment. In this part, the impact of patents on pharmaceutical industry and its relation with R&D and innovation were examined.

4.1.1 Relation between R&D and patents

4.1.1.1 Dimensions of R&D and patent relationship

Pharmaceutical Companies gives high importance to R&D studies due to competitive structure of pharma sector. Necessity of protection of a discovery since the investment is great during inventing process makes patent protection system indispensable for pharma companies. Therefore researching the dimensions of relations between R&D and patent attracts academicians.

According to De Rassenfosse ve Van Pottelsberghe'ye (2009), the relationship between R&D and patent is being affected from 2 dimensions.

1. Productivity Effect: Research efforts in companies results with discoveries because of productivity effect

2. Tendency to Patent Effect: Discoveries are patented with the effect of tendency to patent

In literature, studies about patents concentrate on just one dimension. Most of the study consider patent number as indication of tendency to patent. On the other hand, some studies emphasis that patents can be the indication of research productivity which there is no persuasive evidence has been found yet to deny the correction of this approach (de Rassenfosse and van Pottelsberghe, 2009). Therefore patents can be used as indication of mentioned two dimensions.

4.1.1.2 Tendency to patent effect

According to study of de Rassenfosse and van Pottelsberghe (in 2009), determining elements of tendency to patent for pharma companies can be grouped in two categories. Microeconomic and management literature emphasize that patent system and strategies is one of the important reason which impacts patenting performance. Explaining this with an example, patent system in Europe does not allow to patenting every technology while Patent system in USA is more flexible about patenting technologies. Therefore it is expected that number of patenting files is higher in America than Europe when the tendencies to patenting of American and European companies is compared (de Rassenfosse & van Pottelsberghe, 2009).

In a similar way, increases or decreases in number of patenting files can be observed due to structure of patent system in that country. In this way, it can be said that structure of patent system is a way to use in determining tendency to a patent in a country along with comparing tendency to patent between countries.

De Rassenfosse and van Pottelsberghe (2009) comments that stronger patent system causes an increase in number of patent files. In addition, situation about the substances can be patented, enhancing mechanism in patent and absence of restrictive rules patent rights have contributions to demand in patenting.

Politics in science-technology area can have a role on tendency to patent through the type of research institution (public researchs vs private sector researchs) or the research type (basic research vs applied research). In other words it is assumed that financial resource and type of R&D have an impact on tendency to patent logicaly. Another item should be mentioned is if the ratio of efforts of research and development in business sector increases, this may show itself as an increase in number of patent filings per researcher considering the fact that researchs in business world focuse on applied researchs and product development (de Rassenfosse and van Pottelsberghe, 2009).

4.1.1.3 Productivity effect

Determining factors of research productivity can be grouped as education politics and science-technology politics. It is stated that going up educational level in a country may cause an increase in productivity of R&D efforts by increasing creativity, talents and capacity of absorbing new knowledge (de Rassenfosse & van Pottelsberghe; 2009). De Rassenfosse and van Pottelsberghe (2009) concluded that the researchers have higher educational level are more productive. It can be thought that productivity differentiates according to type of research institution and research type from the view of science-technology politics.

In the study of Arora (2007), determining factors of research productivity are described as in house R & D capacity of a company, spreadings from R & D efforts of rival companies and extra industrial resources of knowledge.

In the study, spreadings from R&D efforts of rival companies are measured with level in house R&D efforts are coincide with R&D efforts of rival company to what extent, while amount of knowledge gained from external sources is measured with the R&D expenses of university for R&D unit of the company.

4.1.1.4 Productivity effect

De Rassenfosse (2009) takes number of primary patent files (NPF) in every national patent office as independent variable when R&D and patent relationship is assessed from the dimension of tendency to patent. The independent variable is determined as number of triadic patents (TRIADIC) when R&D and patent relationship is assessed from the dimension of research productivity. Triadic patents are those patents filed in American, European and Japan patent offices. The independent variables are defined as NPF, TRIADIC and PF_CORR (the variable obtained by adding number of primary patent filings to American and European Patent Offices directly to number of primary patent files in national patent offices). At this point, it can be thought that patents taken from American and European Patent Offices are more valuable than the patents taken from national patent offices since taking from patent from American and European Offices needs higher charges and transfer costs. In addition TRIADIC \ PF_CORR = 1\9 according to study of Rassenfosse (2009) which means every one of nine patents has enough high value for global protection strategy.

Hahn and Shaver (2005) researched whether increasing research capability of companies contributed to getting more patents and they found that the companies engaged in international R&D increased their research capability by reaching knowledge and research capability in other countries which had an positive effect on increase of patent number.

Hahn and Shaver (2005) underlined that engaging R&D efforts in both their countries and international area have subsidiary quality for the companies. Hahn and Shaver used number of patents gained before in order to measure research capability of companies. Drug Patent Stock variable which has accounts belong to the 3-year period before the focused year was used by Hahn and Shaver for this. But Chadha (2008) stated in his study that eventhough patents are considered as outcome of R&D process, patents are not excellent indicators since not all of the discoveries are patented but patents can be used in measurements regarding innovation since reaching detailed information about patents is easy. Process patents can be used as indicator of innovation in developing countries especially because R&D activities have a adjusting structure in developing countries

4.1.1.5 Patent premium

As it was mentioned before, one of the points to take into consideration to analyze the relation between R&D patents is only profitable discoveries at the end of R&D efforts will be patented by the companies (Arora, 2007). This can be schemed as below;

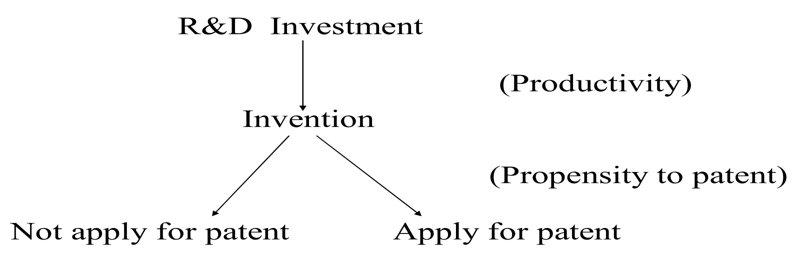

Figure.2. R&D and patenting (Arora, 2007)

Patenting discoveries causes a proportioanl increase in the value of the discovery before it is patented. This is called patent premium. Patent premium can be measured with variables as patent usefulness, size of the company and technology rivals. An increase in patent premium increases R&D, Patent filings, tendency to patents and number of patent filing per dollar spent R&D efforts (Arora,2007). Briefly, patents are valuable in pharmaceutical sector especialy since patents promote R&D efforts eventhough not all of the discoveries at the end of the R&D efforts are worth to be patented.

4.1.2 Affect of innovations on patents

Patent system is a system designed to provide incentives for innovations in mechanics, chemistry and pharmaceutical industry (Meniere, 2008).

4.1.2.1 Pharmaceutical companies and innovation

Pharma industry is a sector where innovation is very important. But it should be noted that 70% of the innovations are done by 30% of the pharma companies eventhough there are thousands companies around the world. And these companies are in the pharma sector more than hundred years and still keep their innovative spirit. The factors behind the succsess of these companies can be listed as below;

1. Having competitive advantage in long term scientific / technological and marketing areas

2. In house R&D and the strategical merging and acquisitions with other companies

3. High Level R&D expenses (Achilladelis et. al., 2001)

Accoding to company data, invention and patent number are related with R&D expense level. Additionally economical researchers proved that level of R&D expenses are determined with cash flow (Achilladelis et. al. 2001).

4.1.2.2 Cycle of discovery

In pharma industry where there is intense competition, it is crucial for companies to have innovation process and having an invention at the end of the innovation process in order to be able to remain standing. It should be stated that to have an invention only is not enough, that inevtion should be made commercial and put on to the market at the same time. Noteboom (2006) analyzed in his research how exploration and exploitation processes are overlapped in each other. Exploitation process starts with a product, concept or technology obtained at the end of the innovation process is revealed as a design. Along with decreased uncertainness, demand increases and new producers show up.

There are different phases between innovation and exploiatation circle. The phases from exploration toward exploiatation are consolidation and generalization and the phases from exploiatation to exploration are differentiation and reciprocation. The results of the research shows that it is quite hard to skip one or more of these phases during the process. For instance empirical evidences indicates that the companies which skip differentiation and / or reciprocatiom phases has more disadvantage than the ones which does not skip any phases (Nooteboom, 2006).

4.1.2.3 Modes of innovation

Swan (2007) has found 2 dimension which helps in characterizing innovation studies at the end of his literature studies which also refers to his research in 2005. He named these dimensions as organizational coupling and knowledge boundaries.

Organizational coupling consists of management and organization partnerships and network between partners. In this dimension, the changes can be observed from “networked and loosely coupled” style towards more “hierarchical and tightly coupled” style. In loosely coupled innovation projects there is more informal and autonomous structure while there is more central and hierarchical style in tightly coupled innovation projects. Additionally, in tightly coupled style projects, there are legally binding contracts such as patent protection and detailed financial responsibilities (Swan, 2007; cited Owen-Smith and Powell, 2004).

Knowledge boundaries dimension is related with the ways which differentiates from high to low and combines the different expertness area of the knowledge. High knowledge level comes out in high novelty situations. These situations are encountered when the medical needs are vague and / or conflicted and clinical studies are hard to predict (Swan, 2007; cited Carlile, 2004).

4.1.2.4 Mechanisms connects innovation process to macro capabilities

Swan (2007) in his research found mechanisims which activates innovation process for different projects and categorized these mechanisms as complementing capabilities and associational capabilities.

According to research complementing capabilities are;

1. Reaching to personnel who work in critical points to obtain information (having network in critical areas such as academic community, commercial contacts etc),

2. Constituting scientific and commercial reliability to obtain resources through research funds and partnerships (choosing a right manager in order to have close connections with other companies),

3. Symbolic figureheads (leader scientists who they are effect on organization with their vision, commitment and experience),

4. Career apprehension and values to motivate personnel during commercialization activities of invention.

In this mechanism, reaching to personnel who work in critical points to obtain information increases the capacity of absorbtion by developing the capabilities for internalizing and convertion to commercial product of the information.

The prestigious close relations with other organizations established by managers and the existence of symbolic figureheads are the factors which are effective on obtaining funds needed for innovation studies.

Attention grabbing point in mechanisms related with complementing capabilities is these mechanisims become prominent in companies which are loosely coupled organizations than the ones which are thightly coupled. Because these type of capabilities are effective on the motivation of the scientists by moving between academia and industry. As second, these type of capabilities are effective on getting resources which are important for innovation process.

In a tightly coupled innovation project, this kind of mechanisms are needed less since R&D is run by a big biotechnology or pharmaceutical company which promotes its own scientists with its own resources (Swan, 2007).

According reseach of Swan (2007), mechanisms related with associational capabilities are;

1. Aligning expectations and interests,
2. Developing existed network to create new resources and supporting projects which are riskier and long-term,
3. Using networks to shape regulations and assuring the approval
4. Product magnet (innovation which attracts various stakeholders and helps providing willingness to work in the organization from different organizations).

These mechanisms are more effective on projects which are characterized with high knowledge boundaries. The reason for this is the high innovative nature and long innovation life cycle of the innovations in these projects.

When we look at the mechanisms in both complementary and associational capabilities, it is seen that these mechanisims has a role in shaping the innovation projects but at the same time can be shaped by the projects. Another point to consider is these mechanisms do not work separately but together (Swan, 2007).

4.1.2.5 Patent

When an invention is developed at the end of a process by passing all of the steps of innovation, some conditions should be met to patent this invention. The conditions in Europe are;

1. Novelty
2. It is possible to have industrial applications

3. Consisting an innovative step to solve a technical problem

In USA conditions are the invention should be novel, useful and non-obvious which means it should not be defined as obvious by an expert in a related area (Meniere, 2008).

According to Edwin Mansfield (1986), patent is at the heart of the policies related with technological novelties. As a result, patent system is a subject which managers, economists and academicians are interested in.

When patent system and its effects are considered, there are two important questions. First of these, what would be the decrease ratio on inventions which are developed and commercialized when there is no patent protection. The second is in which content companies use the patents and what are the differences regarding the tendency to patent between companies (Mansfield, 1986).

4.1.2.6 The effect of patent protection on developing inventions and commercialization

According to results of research of Edwin Mansfield (1986) about the effect of patent protection on developing inventions and commercialization of them, patent systme has a crucial role on developing 30% and more of inventions and commercialization in pharma and chemistry industry. When this is compared with other industries, patent system is mostly important in pharma industry along with chemistry industry. Already Mansfield underlines that the results of his research and other researches before him are consistent.

4.1.2.7 Tendency to patenting: The differences between industries and companies

Another point should be considered regarding patents, every invention which can have patent might not be patented by the companies. In some situations, firms may trust to commercial secrets to protect their inventions. One of the reason of this, technology proceeds fastly and until the firm have the patent of their invention, it might be old. At the same time another reason is the paten protection may not be useful when the technological progress is hard and copying the invention is very expensive (Mansfield, 1986).

Among the industries, when the patenting ration of the inventions which can be patented (tendency to patenting) is analyzed, the pharma industry is the first group industries which patents the inventions can be patented by having %80 patent ratio. The ratio in second group is 60% (Mansfield, 1986).

According to research of Mansfield (1986), the size of the firm is measured with the sales in 1982 and there is a positive correlation with the inventions which can be patented. This correlation is statistically important in pharma, chemistry and petrol industries where the the patents are more important than the other industries. It is seen that big companies in these industries are convinced that patent protection is useful against smaller companies.

Therefore it is seen that the reson of observation of the dollar paid for R&D per patent number is smaller in big pharma companies compared to small companies is not related with differences in ratio for inventions which can be patented. Instead of this, it can be considered that this is related with the the dollar paid for R&D per the invention which can be patented number (Mansfield, 1986).

4.1.2.8 Tendency to patenting: differentiation through time

Percentage of inventions which are patented can differentiate thrugh time among the companies and industries. When Mansfiel (1986) compared the patented invention percentage from the different industries as two groups between 1965 – 1969 and 1980-1982, while half of the companies reported that there was no change in their percentages, the other half reported that there was an increase in their percentage.

In order to understand better the increase in percentage of inventions which are patented, when it was asked the reason of increase to randomly selected companies among the companies which has increase in the percentage, most taken answer was there was a change in their product range towards the sophisticated products which are most probable to have patent. Other reasons are increase in perceived competition and technical progressions which decreases the disadvantages of patenting.

4.1.2.9 Problems related with patenting

Application of patent system can be problematic in some areas. One of the most common problem is related with cumulative inventions. As it was stated in literature before, when a final product is comprised of a couple of inventions which compliment each other, the distribution of the patents among the different owners, this might endanger the commercialization of the product due to problems such as licance fees and disputes (Meniere, 2008).

Which patent policy is going to be applied when the different companies developed inventions which compliment each other for a product in the industry is an important problem. According to the literature 2 different policy can be applied in this kind of situations. One of these patenting the inventions separately and the other is patenting inventions which compliment each other together as a cluster. Deciding which policy will be applied is important for the companies. Because according to the policy they apply, they might withdraw from the patenting competition.

Optimal patenting rule related with inventions compliment each other is based on the balance between the advantage taken with patent right and loss of earnings due to distrubition of patents which compliment each other (Meniere, 2008).

Meniere created a model in his research (2008) in order to analyze how the which policy applied is decided in this kind of situations. In the model, it was assumed that companies developed two inventions which compliments each other exactly in a situation where there is an intense R&D competition between these two companies and the model is used to compare two patenting policy which could be applied in this situation.

In first secenario, each invention can be patented separately by firms. Patent right declaration of the first invention might lead the second firm to stop of developing of the second invention. Because if the company continues to R&D and get the second invention which compliments the first invention and get the patent right of this second invention, the second company may have to share the rent with the first company.

In this situation, patent right decleration expands the profited invention range and the productivity of R&D investments. The second company which could not get the patent right of the first invention quits the competition if the expected market share is low. In this way, increase in R&D expenses are limited and avoids scattering cost due to distribution of patents

In second situation, the inventions which compliments each are patented together as a cluster. Thus a company should develop the inventions which compliments each other on its own to have the patent which means the patent should include these two inventions.

Also in this situation, scattering cost is avoided. Absence of patent right decleration causes an increase in R&D expenses. If this policy is compared with the policy which inventions are patented sepeately, it is seen that R&D productivity increases when the expected developing delays are short. But it might slow down the developing inventions less valuable.

4.1.3 Challanges in pharmaceutical industry

4.1.3.1 The structure of pharmaceutical industry

In pharmaceutical industry, companies in competition with each other in scope of R&D and marketing. In general other companies tend to imitate the moves of the leader company (Ramrattan and Szelberg, 2006).

Ramrattan and Szelberg's research (2006) shows that small scaled companies are leader in total factor productivity and big scaled companies do not have any advantage over small scaled companies on this subject. This situation can be explained as small scaled companies choose to develop new molecules instead of new chemical entity.

"Pharmaceutical industry structure appears fragmented at best, with wave of mergers accuring to confront globalization and intellectual property rights. At the firm level, big changes such as NAFTA[1] did not effect pharmaceutical firms noticeably when it was compared with the firms in other sectors. The threat of patent expirations

[1] NAFTA (North American Free Trade Aggreement)

has an effect on on the increased merging activity within the industry. Through merging, pharmaceutical companies improve their advertising, R&D and productivity while decreasing the costs" (Ramrattan and Szelberg, 2006).

4.1.3.2 Socioeconomic and scientific challanges

Many changes have happened in socioeconomic and scientific and these have affected the pharmaceutical industry. These changes are;

1 Showing up of biotechnology

2 Importance of social security and care

3 Increased costs for new medicines and developing time

4 Globalization of pharmaceutical industry

5 Showing up trade blocks

6 Having an increase in awareness for patients (Cauwenbergh, 2002)

With showing up biotechnology, increases importance of the biotechnology resulted with increased competition to have intellectual property as many as possible. The important point is big pharmaceutical companies could not notice the biotechnology as a promising sector for their long-term investments during these changes. In addition to this, most of the companies adopted the mergering and/or acquisition with other companies strategy instead of having a R&D approach in biotechnology especially in dermatology (Cauwenbergh, 2002).

Social security has a major effect on the way of strategies and behavior of the pharmaceutical companies. The increased economical load for patient caused an involvement of goverment in order to control the prices of the drugs through social security system. This limits cost of health care for patient. Also it adds costs to pharma industry (Cauwenbergh, 2002).

Regarding increased costs for new medicines and developing time, Cauwenbergh states in his research (2002), eventhough new drugs coming to the market is slowed it is still steady. Bringing a new drug through registration process started to be longer than it was. Eventhough this doubles development time, the actual cost is more than doubled.

Globalization in pharma industry has increased. Besides the marketing power, globalization provides opportunities for cost savings, sharing of knowledge and access the different markets. Also it provides access to new product pipelines without a merging or acquisition (Cauwenbergh, 2002).

Trade blocks such as NAFTA or EU implemented specific regulations for different industries including pharmaceutical industry. And this causes some priorities are different from one region to the other for pharmaceutical industry (Cauwenbergh, 2002).

Improved access to the information resources such as internet made easier to reach information for patients and this caused patients start to come to conclusion on their health status. And pharmaceutical firms started to use this patient awareness for their advertisements (Cauwenbergh, 2002).

This interruption in R&D activities of big pharma companies caused many scientists becoming jobless or to be trained in other areas of the pharmaceutical companies. (Cauwenbergh,2002)

Scientist drift from big pharma companies in dermatology area to small scale pharma companies leaded small-scale companies reached to information regarding interrupted medicine developing process and had a chance to develop new medicines. Thus this caused to decrease in R&D budget since the medicine had already developed partially and remaining developing time was shorter (Cauwenbergh, 2002).

As it was stated in Cauwenbergh's research (2002), big pharma companies missed the chance by choosing emerging/acquisitons instead of continuing R&D processes and lost position to smaller companies in a niche market. At this point, it could be questioned why the big pharma companies chose the emerging/acquisition way.

Heracleous and Murray (2001) stated in their research that the reason of why the big pharma companies chose emerging/acquisition way as they thought they needed a bigger volume for necessary investments since R&D investments had long and not certain pay back period.

According to research of Heracleous and Murray (2001), CEOs of pharmaceutical companies does not share the idea of aim of mergin/acqusitions between the companies was reducing the costs in short term, the pharmaceutical industry observers claim the opposite.

Another point is after the merging/acquisitions, most of the companies had lower market shares than before and there is no evidence regarding more resources were transferred to R&D after merging/acquisitions of the companies (Heracleous ve Murray, 2001). From this point, as it was stated in research of Cauwenbergh (2002), it can be concluded that merging/acquisition strategy causes discontinuity and interruption in existed R&D studies

4.1.3.3 Corporate challanges

Internalization is the growing tendency of corporations to operate across national boundaries; an approach to designing products and services that are easily adaptable to different cultures and languages. Internalization affects both resources and product market of an organization and improves its capabilities. Indian pharmaceutical companies used internalization of resources in order to improve their capabilities against corporate changes and created their own indigenious growth model. In this model FDIs (foreign direct investments) are important (Chittor et al., 2008).

At the beginning internalization was against Indian pharmaceutical companies but later they achived to turn it to their advantage. By using growth model, they increased their R&D capabilities and this way they improve in discovering new chemical entities and enhanced their marketing capabilities (Chittor et al., 2008).

4.1.3.4 Challanges in intellectual property rights

The intensity of competition in pharmaceutical industry, the competition between pharmaceutical companies for developing new drugs and enormity of R&D investments for this have increased the importance of the intellectual property rights in pharmaceutical industry. And this caused to necessity of protecting intellectual property rights thightly. Due to this, reinforcements have been done in TRIPs agreement which countries have to stick to.

Developed countries and developing countries gave different reactions to the changes in TRIPs[2] agreement. Considering that most of the big pharmaceutical

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[2] "The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is an international legal agreement between all the member nations of the World Trade Organization (WTO)."

countries which invest to R&D most are from developed countries, the changes in this agreement were more beneficial to these countries and companies.

From the developing countries perspective, it can be said that the pharma companies in these countries showed different approaches. For instance, the pharma companies in Indian pharma industry developed different strategies according to their size.

Large-scale Indian pharma companies adopted MNE model which means companies became integrated with both R&D and marketing and distributing and developed themselves in this way (Rao, 2008).

Middle-scaled Indian pharma companies focused on producing the drugs with patent without violating TRIPs agreement by reverse engineering and developed themselves in this way. Small-scale Indian pharma companies were focused on producing for large-scale and middle-scale pharma companies (Rao, 2008).

Additionally Rao's research (2008) shows that R&D ivestments among Indian pharma companies were increasing and the companies were giving more importance to novel drugs. Therefore the enforcements in TRIPs agreement will have an positive effect on Indian Pharma companies in long term in order to pass from generic companies to innovator pharma companies.

4.2 Benefits of Patent Protection Systems

4.2.1 Enforcement in patent protection and the effect on patent industry

4.2.1.1 Pharma industry and patents

The numbers indicate that in an environment where there is no patent protection, many novel drugs launched to the market could not be developed or marketed (Nogues, 1990). Even this result is enough to show how patent protection is important crucially for the companies in pharmaceutical industry where there is intense competition.

As it was noted before, the importance of patent protection for pharma industry is seen clearly when the pharma industry is compared with other industries (Nogues, 1990).

When the pharmaceutical industry was analyzed, it is seen that companies are divided to two as originator pharma companies and generic pharma companies. The patents are the main focus in competition between these two types companies.

The aim of originator pharmaceutical companies is to have payback of their investments in R&D by patenting their novel drugs which they get at the end of intense, tiring and expensive R&D process and taking advantage of the patent protection as long as possible. But the generic pharmaceutical companies aim to find a way for getting over patents without violating them legally and launching their versions to the market in shortest time possible.

Also the patents, are one of the most effective the factors for determining drug prices therefore they might cause a company becomes a monopol in pharmaceutical industry. But the rise of the competition between originator and generic pharmaceutical companies is a factor which causes a decrease in drug prices (Nogues, 1999).

It is seen that the competition between generic pharmaceutical companies and the originator pharmaceutical companies whose biggest advantage is their investments on R&D and the inventions and patents they obtain at the end of R&D process will increase as long as the stagnation in R&D productivity continues (Nogues, 1999).

Because all of these reasons, originator pharmaceutical companies develops strategies against their rivalry with generic pharmaceutical companies. While one part of these strategies is towards market, other part is related with legal regulations and patents are the most important for pharmaceutical companies within these (Nogues, 1999).

4.2.1.2 Patents as research tool

While patent protection is in encouraging in some situations during R&D process, in some situation it might have reverse effect. Patent protection may increase the cost of getting research tools. Already many researchers have concluded that aggressive patent behavior threatens the fundamental scientific researchs (Penin and Wack, 2008).

There are different approaches around the world regarding when to have patent application. For instance, patent application is not done until reaching and using the information in Japan and Korea, there is no necessity such this in other countries. Companies may not want to declare much information during patent application since this may give other companies the opportunity of reaching their research information. But not applying to patents because of this reason may also be harmful for them in the same way (Richards, 2008).

4.2.1.3 Improvements in patent law

High cost research and development works and the inventions and novelties at the end of this makes patents and patent protection system irreplaceable for pharmaceutical industry. Due to this, there are a lot of research in literature regarding the the effect of improvements in patents and patent system on pharmaceutical companies and pharmaceutical industry.

More empowered patent law may affect companies in two ways. If pharmaceutical company applies powerful research and development program, empowerements in patent law contributes to company to increase the company value. If the pharmaceutical company does not have any solid research and development, empowerements in patent law cause decrease in their company value (Kawaura et al., 1995).

Kawaura (1995) detailed the effects of empowered patent laws on value of pharmaceutical companies as below;

1. Due to improvements in patent law, the pharmaceutical companies which have an R&D program focused on developing new drugs gains more profit than the pharmaceutical companies which have R&D program focused on imitating patented drugs

2. After the improvements in patent law, the stock value of pharmaceutical companies which have an R&D program focused on developing new drugs increased.

3. Based on the improvements in patent law, a decrease happened in funds of imitating R&D programs. And this indicates that an empowered patent law causes changes in R&D activities.

Additionally Pazderka (1999) recorded that there was an increase pharmeceautical R&D expenses between pharma companies and also when it was compared with other companies in all industries in Canada after the improvements in patent law in 1987.

At the same time, according to results of Pazderka, there was a growth in pharmaceutical R&D expenses in Canada along with other OECD countries.

These studies indicates that empowered patent protection is the most important factor for R&D expenses since it effects expenses in R&D in an increasing way in pharma sector. (Pazderka, 1999)

On the other hand, empowerements in patent law might indicate that patent protection has started to get weaken for the R&D focused pharmaceutical companies. More to this, competition with generic pharmaceutical companies has increased. From this point of view, markets of developing countries have more potential for originator pharma countries. Due to this, establishing patent law in developing countries while empowering patent law in developed countries is crucial for strategies of pharmaceutical countries and gaining market shares (Nogues, 1999).

4.2.2 Importance of patent applications and patenting activities

"Number of characteristics which includes technological fields, types of applicants, countries of origin and examiners' experience are related with share of examiner citations in patents. Examiner shares are the highest in fields where intellectual property are fragmented while examiner shares are the lowest in fields where patents are more important. This reflects a strategic preference for broad patent portfolios with relatively low value placed on any single patent. It is also found that shares of examiner citations are especially high among foreign firms. The research interprets low applicant shares of citations as indication of low applicant search effort." (Alcacer, Michelle Gittelman, Bhaven Sampat, 2009).

"In pre-grant publication system (PP), the content of patent applications are automatically published after a certain period of time from the application date. Under a confidential filing system (CF), patent applications are kept confidential until a patent is granted. If an application is rejected, then no information is revealed" (Aoki, 2008).

"PP may discourage the dissemination of R&D knowledge due to exponents of PP overlook the fact that PP has an adverse effect on the propensity to file for patents. When patent protection is weak, firms prefer not file for a patent so PP is irrelevant. When patent protection is strong, firms files for a patent under both systems, but PP hurts it because it leads to a larger technological spillover. PP also hurts firms when patent protection is intermediate, because then firms choose to file for a patent only under CF system" (Aoki, 2008).

According to Chadha's study in 2008, "it seems firms which have R&D efforts get higher returns from their research efforts in the developing countries. The companies have R&D activities get high returns from successful R&D since large majority of the firms do not invest in R&D in developing countries. The results supports that stronger patent laws which increase the patent length cause greater patenting activity. This implies that pharmaceutical industry and technology – intensive industries require patent protection to to recoup their R&D costs and this encourages them to have R&D activities" (Chadha, 2008).

4.2.3 Usage of patent knowledge

"Patent information users highly benefit from value-added patent information in terms of comprehensiveness and search precision. Patent full-text databases are usually very timely resources providing fast access to all details of patent claims and the description. So they are useful to retrieve relevant records not available from searching the CAS-files and Derwent WPI. The first level patent information on its own is not sufficient to support business critical decisions. There is a very high risk to miss relevant inventions.” (Emmerich, C.; 2008).

According to Yang and Akers’ study in 2008, information regarding the chemical structure is very important in pharma industry. And there are different types of tools used in text mining and visualization of functions in order to reach this information. Also these tools can be designed for different user groups and provides different aspects regarding text mining and visualization of functions. But the major limitation for these tools is the lack of chemical structure mining capability with the possible exceptions.

“One of the main problems which the information professional encounter during customisation process is different users of the same search profile may have different needs in terms of desired level of detail. In order to handle this contradiction, it is important to be able to adjust the level of detail of the search profiles. Thus different users with different versions of the patent awareness bulletins are provided. Also not only the content but the format of the bulletins must be adjusted depending on the desired level of detail. Due to this, the information analyst must be flexible by considering using different tools and techniques” (Doğanavşargil and Fattori; 2008).

4.3 The Importance of Life Cycle Management of Patents Not To Lose The Advantage

4.3.1 Optimal patent length

4.3.1.1 Patent length

When the cost of imitating of an innovation is positive, increase in the patent period may not have an effect or cause an decrease on both R&D activities and patent promotions (Galliani, 1992).

Increasing patent length encourages the rivals to imitate patented products more. If these rivals enters to the market until the profit are distributed, increasing patent length increases the competitive products. Because promotions for R&D decreases and the knowledge about the innovation are disclosed more due to increasing patent length (Galliani, 1992).

Extent of the patent is affected from either R&D cost of imitated products which do not violets a patent or profit flow gained by imitators (Galliani, 1992).

It should be noted that optimal patent length is short enough to prevent imitation of the patented products.

4.3.1.2 Elements affecting patent length

More of the data related with patent length can be reached from public or paid services but attention is needed about the information related with patent length, especially for the applications had been filed before GATT Agreement was legislated. Therefore it is a wise choice to check all of the information regarding patent length with the information in first page or front face of the patent (Clark ve Berven, 2004).

The important point is that gained information regarding both patent and market exclusivity from various public and commercial sources should be reviewed carefully to calculate patent length correctly. In addition legal and regulatory factors can have a role in determining the patent length.

At first patent type should be defined to define patent length. There is also many factors affects patent length in addition to patent type. These factors are;

1 GATT (General Aggreement on Tariffs and Trade)

2 Terminal disclaimer

3 Maintanence fees

4 Amendments about Patent length

5 Interventions

6 Patent Right violations

The factors affect Market exclusivity are,

1 Hatch- Waxman extensions which give permission to a innovator pharma company to withdraw the lost period from patent length due to approval process of the pharmaceuticals

2 NCE (New Chemical Entity) exclusivity

3 Data exclusivity

4 Pediatric exclusivity

5 ANDA first filler exclusivity (Clark ve Berven,2004)

4.3.1.3 Do different patent lengths affect financial situation of the companies?

Optimal patent policies can be defined as trying to gain maximum profit by differentiating the patent lengths of innovations by companies. Optimal patent policies depend on how social and private benefits differentiate with superiority of the innovation and regarding this, how other policies affect these relations.

Longer patent length for more superior innovations causes an increase in income of the companies. This may cause that companies directing their R&D

activities to make superior innovations. But optimal patent length increases when patent length increases. (Cornelli and Schankerman, 1999).

Goverments offer companies promotive - competitive patent length menu and along with this total patent fee. Every company chooses patent length they prefer. Thus companies can apply their own optimal patent policy. The patent length menus goverments offer are equal to annual renewal fee list goverments offer. If a company learns the value of their innovation after patenting, annual renewal fee becomes more important for the company (Cornelli ve Schankerman, 1999).

It is seen that when companies have different R&D activities, differentiated patent lengths may have an additive effect on the income of the company. While only one type patent length provides more R&D promotions to the companies have low productivity level, this promotion can be less to the companies have high productivity level (Cornelli and Schankerman, 1999).

The study of Chou and Shy (1993) shows when innovation level is higher under one-period patent system when it is compared with infinite patent length system.

4.3.1.4 Patent length and innovation

If patent policy is explained as instrument which affects income flow gained from the sales of the patented products, infinite length patents will be optimal policy to be used when patent width is costly at deadweight loss (Gilbert ve Shapiro, 1990).

In addition study of Gilbert and Shapiro (1990) shows that proper intellectual property right behavior comes with more careful patent policies and along with this longer patent lengths.

If a firm which has patent does not think that incentive gained through patent is not enough, a more powerful patent protection such as extending patent lenghts can be obtained against violations. But long patent lengths excessively can also be dangerous for the firms due to creating monopolies and delaying innovations in the firm because of this (Gilbert ve Shapiro, 1990)

4.3.2 Strategies about end of patent time

4.3.2.1 Strategies after end of patent time

Researchers state that main problem for originator drug manufacturers after end of patent time is high price can not be sustained eventhough the product is still the same (Raasch, 2008).

A research in America shows that the consumers think the original drugs with patents deserve the price they pay since they think these drugs more effective against the illness and they have less side effects. Therefore the best strategy should be carried out after end of patent time for an original drug is protecting the image of the product and even improving it (Mehta, 1997).

Additionaly, researchers states that consumers buy generic drugs continiously as one quarter of original drugs since generic drugs can not satisfy consumers regarding quality of the drugs sufficiently (Mehta, 1997).

Eventhough generic drug manufacturers can not satisfy the consumers as much as originator drug manufacturers, decreasing the price before end of patent time which means applying defensive strategies will be unsuccessful for the originator drug manufacturers (Mehta, 1997).

Another strategy used for originator drug firms is increasing incentives and promotions intended to doctors and trying to protect market leadership with this way.

This strategy can be successful in short time and delay entering of generic drugs to the market but it can be hard to continue heavy promotion expenses in the long run (Mehta, 1997).

Creating its own generic drug can be another strategy for originator drug manufacturers but according to cases in research of Mehta (1997), this can end branded product which is more profitable.

According to conclusion of Mehta's research (1997), the best strategy could be applied in competition with generic drug companies is a combined strategy which includes R&D, enhancing quality perception and marketing to different groups. The originator drug company using this strategy does not decrease the price but differentiates its marketing strategies with different plans for various targeted categories.

The important point for originator drug companies when they develop their strategies against generic drug companies is starting to form their strategy before 3-5 years of patents' ending.

By developing the existing product more and convincing consumers about little price differences worth for a better quality drug, existing consumer profile can be protected, even the life cycle of product can be extended by adding more consumers to it (Mehta, 1997).

4.3.2.2 Patent protection

There are three criteria to have patent for an invention. These are;

1. Novelty

2. Expediency

3. Being evident (Pearce, 2006)

When these criterias are met, the patent protection time is about 17 years. This time should be used for the firms to enhance their brand name. Because brand names makes entering of generic drugs to market harder due to popularity of brand name (Agraval and Thakkar)

Pearce stated in his research (2006), there can 3 strategy for a product which is about to lose its patent protection. These are;

1. Getting into market with its own generic drug
2. Getting into market with a new product under existing brand (line extension)
3. Extending patent time by doing some improvents and renewals on the product (Layering Innovation)

In getting into market with its own generic drug strategy, the aim of the originator drug firm is competing with its own generic against other generics which will have lower prices thus sustaining its profitable situation even dissuading entering of generic firms to market.

In getting into market with a new product under existing brand (line extension) strategy, the aim is marketing corrected versions of current drug thus trying to passing of consumers to new version of the drug before entering of generic drugs to the market.

In extending patent time by doing some improvements and renewals strategy, the aim is getting additional patent time due to changes in active compounds, strength, dosage and usage area.

The strategies developed before end of patent time can help to maximize the chance of sustaining competition advantage of originator drug companies against generic drug companies.

When it is looked to how end of patent times and entering of generic drugs to market affects the countries in Europe, it is seen that Germany and England are the most effected countries. In these two countries, the market shares of original drugs decrease rapidly with enter of generic drugs to market (Datamonitor, 2005)

In Italy and Spain, the effect of competition with generic drugs on sales of originator drug is in low level when it is compared to Germany and England. In these countries, there are limited incentives for generic drug companies and this stricts generic drug enter. But generic drug companies think that they have growing potention in England and Germany markets since markets reached to a certain saturation (Datamonitor, 2005).

A research indicates that originator drug manufacturers which generic drug manufacturers competes with have more sales in the market when it is compared with the other originator drug manufacturers which generic drug manufacturers have less competition. This shows that generic drug companies consider market shares of the brands when they select target molecule/ product (Datamonitor, 2005).

The originator drug firms which their patent time about to end can choose to market their drugs in niche markets (Agraval ve Thakkar, 1997).

Another strategy can be changing prescriptive drug status to unprescribed (over the counter). In unprescribed drug category, the decrease in sales volume will be less in competing with generic drugs or the originator drug firms can increase life cycle of the product by doing some modifications on the drug (Agraval ve Thakkar, 1997).

A combination of good brand image and considerable prices for price strategy can prevent enter of generic drugs to market or decrease it at least (Agraval ve Thakkar, 1997).

As another strategy, originator drug firms can create legal barriers in order to prevent entering of generic drugs to market or production of generic version of their drugs (Agraval ve Thakkar, 1997).

Patents are needed to meet costs spent during R&D but it is not a must to met these cost during patent time. If marketing strategies are planned well, originator drug firms can gain earnings even after end of patent time (Agraval ve Thakkar, 1997).

2 factor effects the sale of the original drug in competition with generic drugs. First of this is level of entering generic drug from original drug and second is price difference with generic drugs (Everton, 2006).

Medical service providers encourage using generic drugs instead of original drug. The level of this encouragement is related with how much generic drug is considered equivalent to original drug (Everton, 2006).

4.3.3 Patent extensions

4.3.3.1 Competition with generic drug companies

First generic drug manufacturer decreases sales of originator drug company at 30% rate and a competition with 5 or 6 generic drug companies decrease drug prices of originator company at 70%-80% rate (Weissman, 2002).

"A lawsuit regarding validity of patent is very complicated and effects entering of generic drug company to the market. And this shows that originator drug companies try to delay entering of generic drug companies to the market while generic drug companies try to enter to the market as soon as possible" (Weissman, 2003).

Consumer groups are sided with generic pharma companies since they reach affordable drugs this way. Therefore consumer groups push the political establishments on behalf of generic drug producers. One hand governments and other political corporations encourage for R&D developments, on the other hand they try to find a solution to reach generic drugs early and easily.

4.3.3.2 Patent extension situations during R&D period

At discovery step of the drug, first aim of the firms is to keep other firms out by using intellectual property rights. Therefore prepared and tested components during this step are patented. In many situations active component is protected by one patent family but in some cases main patents can be divided to a couple of separate patents. From perspective of generic pharma companies, it is important to consider that there will be more than one main patent when the patent portfolio is checked.

When the applicant drup is determined, an intense test period is started in order to check if the drug is safe and effective on people. During development period, the firm will be interested ib toxicology and pharmacology and pharmaceutical, chemical / biological development. Also findings during these can be patented by the firm. (Hutchins, 2003)

If the active component is a mix of isomers, in situations where one isomer is more active or important or unexpected advantage, a separate patent can be taken for more active isomer. Patent application for this isomer is filed after taking patent of main component and it may add one year in USA and three years out of USA to patent protection.

Also during development step, determining new and advantegaous crystal forms may allow extending patent period (Hutchins, 2003).

Due to the delays occur during patent application period, about five-year additions can be done to patent period (Clift, 2008).

Having patent for more effective and more economical process will protect originator firm against generic firms effectively (Hutchins, 2003).

When the drug is marketed, originator firm may try to find ways for additional patents by searching new dosage forms developments for the drug (Clift, 2008).

If firms do tests for pediatric convenience, an extension until 6 months can be provided (Clift, 2008).

In situations where there is no patent extensions, 39% of all sales is defenseless in competition with generic drugs. Also it is notable that 20% of gross income for patented drugs are gained during patent extension period (Clift, 2008).

4.3.3.3 Patent extensions and legal basis

Waxman Hatch Agreement provides additional 3 year market exclusivity for new drugs which requires clinical drugs. If patent is invalid for new chemical compounds (NCE) or there is no any situation which violates the patent, ANDA (an abbreviated new drug application) can be given to generic drug firm. If originator firm files a suit within 45 days, FDA doesn't approve ANDA (Bhat, 2005). FDA waits for ending of patent or void of the patent by the court otherwise 30 months pass for ANDA approval and originator firm delay the entering of generic drug companies to the market (Bhat, 2005).

4.3.3.4 Secondary patents

In normal, firms take several patents for one drug. At first active components, medical applications, formulation and process are patented. Due to effect of patents on market exclusivity of the patents and increase on earnings, firms extended the patents to areas such as packaging, dosage distrubitimg systems (Bhat, 2005).

Secondary patents are the patents are taken in new dosage usage or new medical application of a patented drug. It is started when the originator firm files a suit for patenting these new areas. When the secondary patents are obtained, the originator firm gains additional patent period extension before the current patent expires. Even the secondary patent period is short, the firm can meet the expenses of the suit and gain income (Burdon ve Sloper, 2003).

4.4 Patent Issues

4.4.3 Counterfeiting and measurements against it

Counterfeiting drugs had been discounted in the past. Today, drug manufacturers has started a war against counterfeit drugs and spends money for this more than past. The reason of attitude change of drug companies can be summed under the three factors;

1. Increased level globalization
2. Technological advances

3. The conflicts on agreement related with intellectual property rights of WTO and problems in reaching to drugs (2008, Lybecker).

Increased globalization and world trade has caused an increase in counterfeit drugs. The reason for this is decreasing the costs of counterfeit drugs and making easy entering to the market.

Technological advances has been helpful both to real drug manufacturers and counterfeit drug manufacturers. Technological advances help to decrease the costs for the counterfeit drug manufacturers. But technological advances also have offered options to the real drug manufacturers to save their drugs and they have had advantages against counterfeit drug manufacturers.

The real drug manufacturers have intellectual property rights and this make them the ones which determines the price of the drug. The high prices causes problems in reaching to drugs in poor and developed countries this makes easy counterfeit drugs which have low prices to enter to the markets (Lybecker, 2008).

According to the search of WHO[3] in 1992, counterfeit drugs are met more in places where there are weak controls, challenges to reach to basic drugs, illegal market supply chains and there is no effective intellectual property rights. If these conditions are checked carefully, it is seen that they have the features of the markets of developed countries (Lybecker, 2008).

Eventhough counterfeit drugs are more common in poor and developed countries, a couple factors increase the possibility of counterfeit drugs enter to the markets of developed countries. These factors are increase in parallel trade, internet sales and product transshipments (Lybecker, 2008).

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[3] WHO: World Health Organization

According to Pfizer Welcomes (2006), counterfeit drug production changes country to country. WHO states that 10% of the drugs are counterfeit and this ratio increases to 25% in some countries (Barry Berman, 2008).

4.4.3.1. Cost of counterfeit drug manufacturing

Real cost of counterfeit drug manufacturing is not limited to decrease in sales. Total cost of counterfeit drug also consists of the damage in brand of the real drug and decrease in sales due to bad experience of the consumer related with the drug by thinking it is real. Also the cost for following and control of counterfeit drug manufacturing is in it (Barry Berman, 2008).

From social perspective, total cost of counterfeit drug is related with lost in employment, decrease in income and sales taxes income and increase in expenses regarding trade deficit (Berry Brerman, 2008).

Additionally, counterfeit drug manufacturing effects profitability of markets of developed countries by causing decrease in attractiveness for foreign investment and incentives for R&D (Lybecker, 2007).

Also it should be noted that counterfeit drugs manufactures are unfair competitors. Because they do not spend for promotion, trade mark license, quality control, marketing tests and they have no R&D, design and engineerring (except copying the product) costs (Barry Berman, 2008).

4.4.3.2 Strategies Against Counterfeit Drug Manufacturing

Real drug manufacturers feel the necessity of developing effective strategies against the war with counterfeit drug manufacturers. But for this, first the structure of market should be understood well.

Barry Berman (2008) stated in his study that there are 4 factors for noticing and decreasing counterfeiting activities. These are;

1. Noticing counterfeiting activities early,
2. Budgeting of monitoring counterfeiting activities, exposing and removing them
3. Strategies based on demand for dissuading counterfeiting,
4. Strategies based on offer for dissuading counterfeiting

Importance of noticing counterfeiting activities early must be emphasized. Because noticing early decreases the lost in image of the real manufactures and sales. At the same time it minimize the social cost of counterfeiting activities.

A strategy against counterfeiting activities which focused on demand consists of tendency of consumers, identity inspection technologies and advertisements about the risks of counterfeiting. A strategy against counterfeiting activities which focused on supply consists of controlling subcontractor sellers, websites, decreasing illegal enterings to markets and using the advanced technologies to control supply chain. (2008, Berry Berman).

According to study of Lybecker in 2007, the strategies which cause increase in cost of counterfeiting decrease the ratio of counterfeit drugs in market. Cost of counterfeiting can be increased in many ways. First, advanced technologies against counterfeiting activities push counterfeit drug manufacturer to copy new drug and package of the real drug and this change increase the cost. Additionally strategies regarding increasing the safety of supply chain has effect in increase of the cost of counterfeit drug manufacturing in order to make the drugs integrated to the market.

Eventhough it seems that education campaigns against counterfeiting activities has less effect, this may increase the awareness. But these campaigns has no effect on the war with counterfeit drug manufacturing, they just increase the awareness of the consumers (Lybecker, 2007).

5 METHODOLOGY

This study is concerned with the managerial questions related with dynamics of the patent management. System thinking approach and causal loop diagrams were used in order to understand working mechanism of patent management in pharmaceutical industry and explain the cause and effect relations between the variables.

5.1 System Thinking Approach and System Dynamics

Managers are living in a complex business world. It is not easy for them to take right decisions, deal with the changes and choose right policies in this complex world. So they are looking for new ways of thinking and acting like scientists and philosophers in order to do right things. And system thinking is an approach which is developed to help them.

"System thinking is the ability to see the world as a complex system, in which we understand that you can't just do one thing and that everything is connected to everything else. System thinking tools and processes help us to understand complexity, design better operating policies and guide change in systems from smallest business to the planet as a whole" (Sterman, 2000).

"System thinking requires learning about complex dynamic systems and there are successful approaches for this which are;

1. Tools to achieve and represent the mental models about nature of difficult problems
2. Formal models and simulation methods to test and improve the mental models, design new policies and practice new skills

3. Methods to sharpen scientific reasoning skills improve group processes and overcome defensive routines for individuals and teams.” (Sterman, 2000).

“By using system thinking, we are trying to understand complex systems and improve the mental models and thereby the quality of decisions that will be made can be improved with the help of the mental models. System dynamic is related with extending of mental models through the creation of explicit models. In system dynamic modeling, the feedback processes along with stock and flow structures, time delays and nonlinearities are important to determine the dynamics of the system. Also it is important to be careful about not to model the system because a model must solve a particular problem. The goal in the modeling is to improve the performance of the system and develop a model which is applicable” (Sterman, 2000).

The steps of a modeling process are,

1. Problem articulation
2. Formulation of dynamic hypothesis
3. Formulation of a simulation model
4. Testing
5. Policy design and evaluation

System dynamics have 4 important components to develop the model,

1. Causal loop diagrams (consists of variables connected by arrows denoting the causal influences among the variables).
2. Stock and flow diagrams (is drawn with the help of rates (flows) and stocks (levels). Stocks represent variables that accumulate during selected time interval. They increase and decrease only with ‘’ rate’’ variables).
3. Equations (system dynamics equations)
4. Simulation

“System dynamics with all of its characteristics is a powerful method to gain useful insight into situation of dynamic complexity and policy resistance. It is increasingly used to design more successful policies in companies and public settings” (Sterman, 2000).

Both system thinking and system dynamics will help us to built mental models and reflect them externally in a right and improved way.

5.2 Mental (Conceptual) Modelling

“In conceptual modelling, mental model of the focused relationships is created and then framework that captures the essence of the system under investigation is evaluated” (Meredith, J. R., Raturi, A., Amoako-Gyampah, K., & Kaplan, B.; 1989).

Mental models are simply related with a person’s perception about something and its representation and they have cardinal importance for the field of system dynamics. But there are many different definitions about what mental models are in the literature.

“Some researchers offer that mental models are a mental image or a verbal description can form a model of corporate organization and its process. They are the models to substitute in our thinking for real system that is presented” (Forrester, 1971; cited in Doyle and Ford, 1998).

Some describe mental models as “a dynamic pattern of connections comprising a core network of familiar facts and concepts and a vast matrix of potential connections that are stimulated by thinking and by the flow of conversation” (Morecroft, 1994, cited in Doyle and Ford 1998)

According to Doyle and Ford (1999), “a mental model of a dynamic system is a relatively enduring and accessible but limited, internal conceptual representation of an external system whose structure is analogous to the perceived structure of that system. Mental models are the product that modelers take from students and clients, disassemble, reconfigure, subtract from and return with value added.”

Also researchers must take into consideration limitations of mental models. Mental models can be fuzzy and implicit containing rich details (Richardson and Pugh, 1981; cited in Doyle and Ford, 1998). It is suggested that mental models are extremely simple compared to the reality (Meadow et. al., 1992; cited in Doyle and Ford, 1998). Mental models are vastly simplified compared to the complexity of the systems themselves and dynamically deficient because of the reasons like people ignore feedback processes, fail to appreciate time delays between action and response and are insensitive to nonlinearities (Sterman, 1994; cited in Doyle and Ford, 1998).

“An understanding of exactly what mental models is what properties and characteristics that they have and how they influence and are influenced by learning and decision making is essential for such an enterprise to succeed” (Doyle and Ford, 1998).

5.3 Causal Loops

Casual loops are the tools to express a mental model. Causal loop diagrams are helpful to how the relations (influences and effects) between variables and develop a quantitative model to provide control (Coyle, 2008).

Causal loops are also excellent for

1. Quickly capturing the hypothesis about causes of dynamics
2. Eliciting and capturing the mental models of individuals or teams
3. Communicating the important feedbacks you believe are responsible for a problem (Coyle, 2008).

"A causal loop diagram consists of variables connected by arrows denoting the causal influences among the variables. Variables are related by causal links, shown by arrows. Each causal link has a polarity, either positive (+) or negative (-) to indicate how dependant variable changes when the independent variable changes. A positive link means that if the cause increases, the effect increases and if the causes decreases, the effect decreases while the negative link means the opposite of it. The important point is link polarities describe the structure of the system. They do not describe the behavior of the variables. That is what would happen if there were a change" (Sterman, 2000).

The algorithm for causal loop goes as follows,

1. Recognize key variables
2. 'Identify system resources and their states.'
3. Construct flow modules
4. If more than one state is involved, cascade modules to produce a chain of resource conversion
5. Identify the behavioral, information and control links
6. Identify similar links between modules of different resource types
7. Identify any new states of existing resources, or new resources, which affect the modules
8. Carry out a qualitative analysis of the overall diagram (Coyle, 2008).

To be effective, the rules for causal loop diagrams should be followed, like selection of variable names, layout and assignment of link and loop polarities (Sterman, 2000).

The relations among the factors that are related to the patent management are forming through the study improving by using system thinking and causal loop diagrams. The model illustrated below is an initial point for the study. This model will be developed and expanded in the following steps of the study.

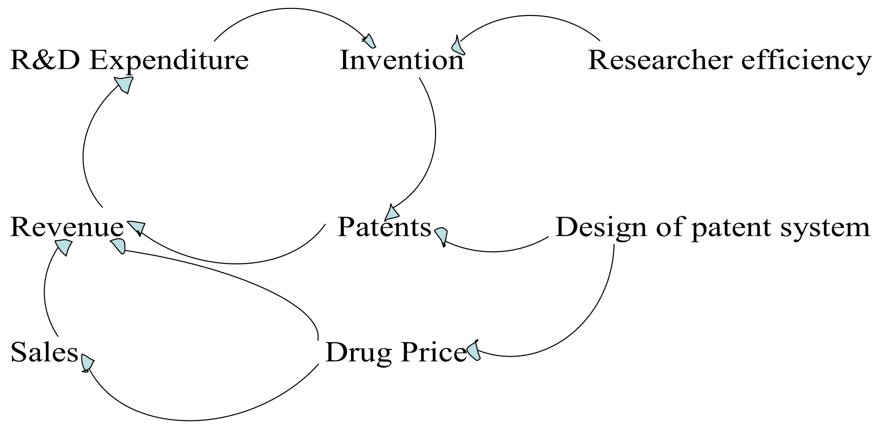

Figure. *3_* Causal loop Example

6 PROPOSED DYNAMIC MODELLINGS

Patent management system and related parameters regarding them and relations between them were studied through literature review. The relations between parameters were shown with causal loop diagrams using mental modelling. In order to do this, the related parts were taken from articles and causal loops were illustrated and drawn based on the information given in articles. Each causal loop drawn was given under the related part from the related articles. It should be emphasized that causal loops indicates that the mental models created from the articles in order to be able to create one patent management model through literature review by combining them.

Causal Loops were grouped under seven titles as Innovation, Productivity of R&D, Research Capability, Tendency to Patenting, Patent Protection System, Patent Length and Generic and Counterfeit Drugs. Causal Loops generated under this titles which were extracted from literature reviews were combined. Since innovation is a wide process on its own, the causal loops under this title were combined separately by combining only some important causal loops. And two models as Organization Model for Innovation and Reputation Model for Innovation were created.

Other causal loops under Productivity of R&D, Research Capability, Tendency to Patenting, Patent Protection System, Patent Length and Generic and Counterfeit Drugs were combined together and one model was created which also includes innovation as a parameter. This model was named as Patent Management Model.

6.1 Innovation

Innovation is an invention is developed at the end of a process by passing all of the steps of innovation (Meniere, 2008). What is meant with innovation in this study is the product innovation in pharmaceutical industry. Since patent system is for providing incentives for innovations according to Meniere, 2008; innovation is a crucial part of patent management. Created causal loops regarding innovation projects, centralization of projects, knowledge boundaries, organizational coupling, development of science and technology and commercialization of them, establishing and increasing credibility, relations and networks and their effects on innovation were given below. Each causal loop drawn was given under the related part from the related articles.

> "*Innovation projects were persued by partners joined in a loosely coupled network of organizations, with the work being conducted across several organizations, each of which had significant autonomy in the management of their own work. Allocation of resources to tasks (including people, equipment and finances), where discussed was negotiated through largely informal means. Thus, management in such projects was decentralized and vertical dependency on centralized resources was law*" (Alter and Hage, 1993).

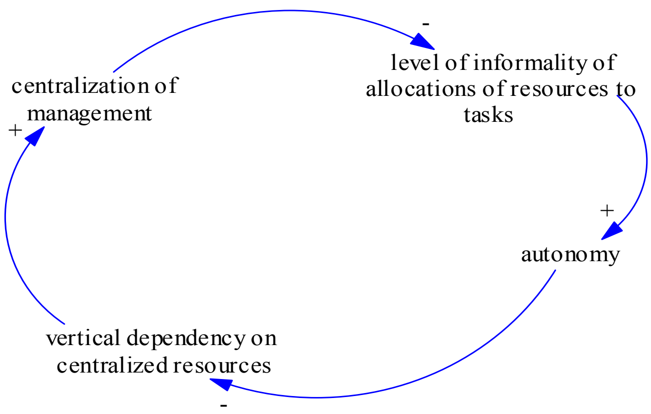

*Figure-4*_"Centralization of Management" illustrated from Alter and Hage, 1993

"Most innovation activity was carried out and coordinated within a large focal firm but clearly identified parts of the work being formally contracted to other parties. Management was relatively hierarchical and there was high dependecy on centralized resources, knowledge flows occuring via closed conduits or pipelies. Legally binding contracts existed to secure deliverables and protection of IP and allocation of tasks" (Owen-Smith and Powell, 2004)

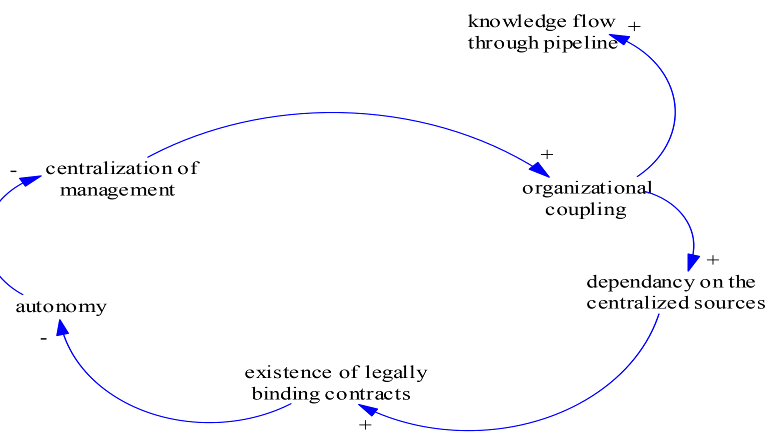

Figure-5 _"Centralization of Management" illustared from Owen-Smith and Powell, 2004

"High knowledge boundaries are related with situations where there were high novelty areas involved, medical need was ambigous and/or contested and where implications for clinical practice were difficult to forecast. In such projects, the intensity of knowledge sharing between those involved in upstream science and those involved downstream application (clinical practice) was greater" (Carlile, 2004).

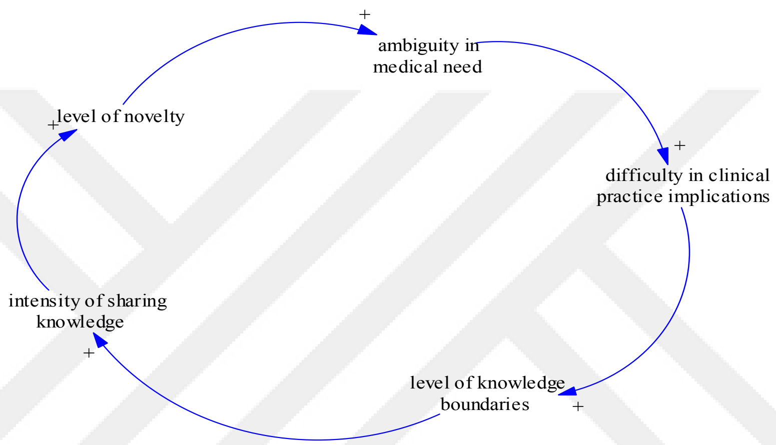

Figure-6_"Knowledge Boundaries" illustrated from Carlile, 2004

"Loosely coupled organizational relationship and low knowledge boundaries were typically populated by small early stage spin-off companies. These companies are started by academics with entrepreneurial interests and/or commercial experience. There was high dependency on parent university and multiple sources of funding were sought for facilities, equipment, consumables and specialist expertise" (Powell et. al., 1996).

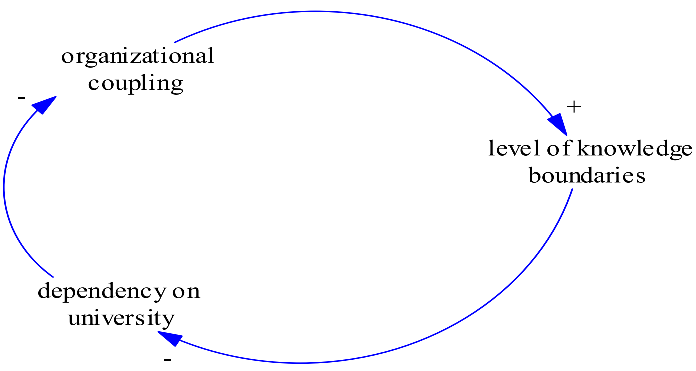

*Figure-7*_"Organizational Coupling" illustrated from Powell et. al.,1996

"The development of the science and technology requires relatively low levels of knowledge integration across the groups involved" (Thompson, 1967).

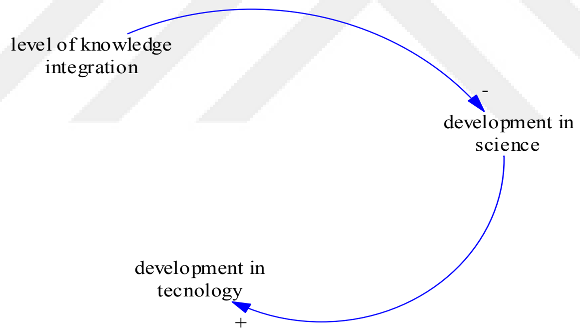

*Figure-8*_"Development Science and Technology" illustrated from Thompson, 1967

"Commercialization of science into new medical treatments depends crucially on overlapping, but distinctive scientific and technological network at institutional level" (Murray, 2002).

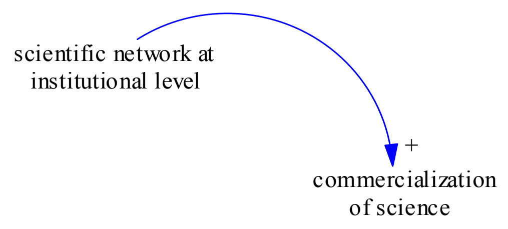

Figure-9_“Commercialization of Science” illustrated from Murray, 2002

“Connections to scientific networks via key individuals provides ‘knowledge spillover’ effects that shape technological progress and influence firms’ abilities in order to develop intellectual capital” (Zucker et. al., 1998).

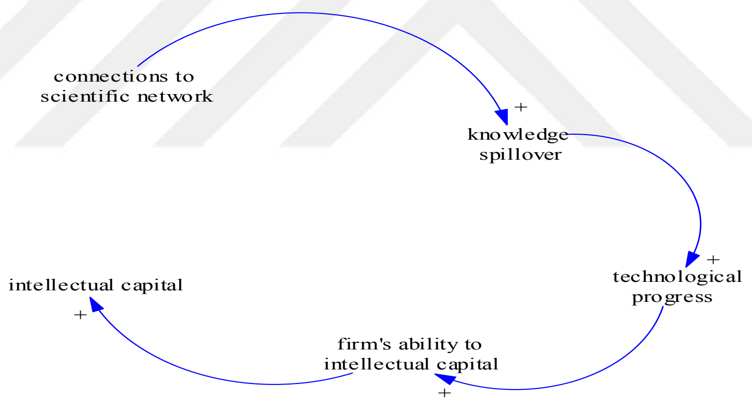

*Figure-10*_“Developing Intellectual Capital” illustrated from Zucker et. al., 1998

"The reputation of entreprenuers plus their business track record and presentability to outside investors, is importatnt in attracting funding" (Zider, 1998).

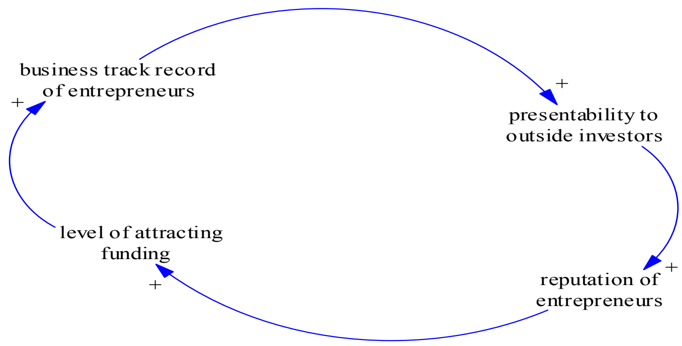

*Figure-11*_"Attracting funding" illustrated from Zider, 1998

"Establishing credibility for investment is via the scientific publication records of the biotechnology firm's scientific team" (Deeds et. al, 1997).

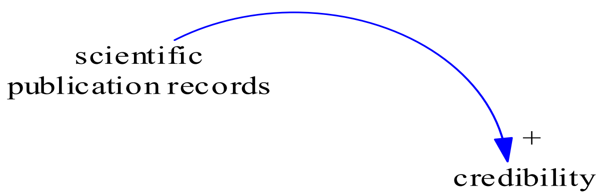

*Figure-12*_"Establishing credibility" illustrated from Deeds et. al, 1997

"The affiliations founders had with other organizations were also important for increasing credibility" (J. Swan et al., 2007).

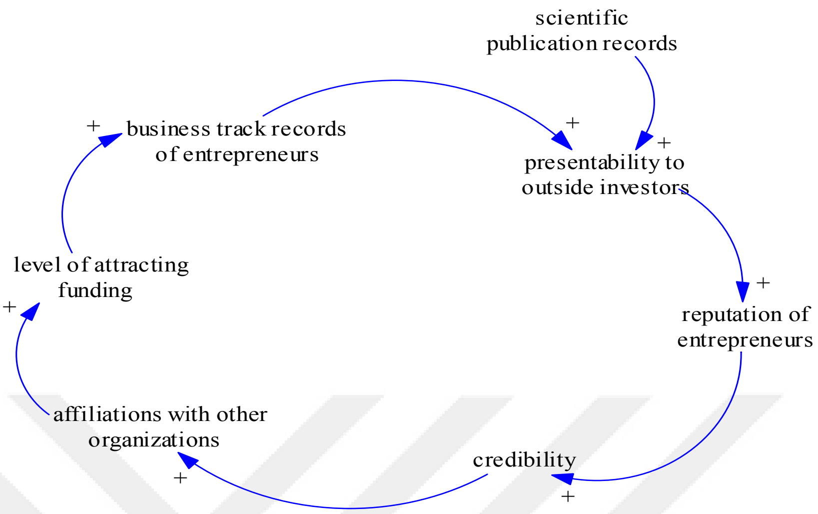

*Figure-13*_"Increasing Credibility" illustrated from J. Swan et al., 2007

"The affiliations that senior managers of biotechnology firms held with other organizations had an important symbolic value for prestigious investment banks when deciding whether to support initial public offerings. The greater the prestige of the relationships means the higher valuation. So the greater the likelihood of an innovation reaching development" (J. Swan et al., 2007).

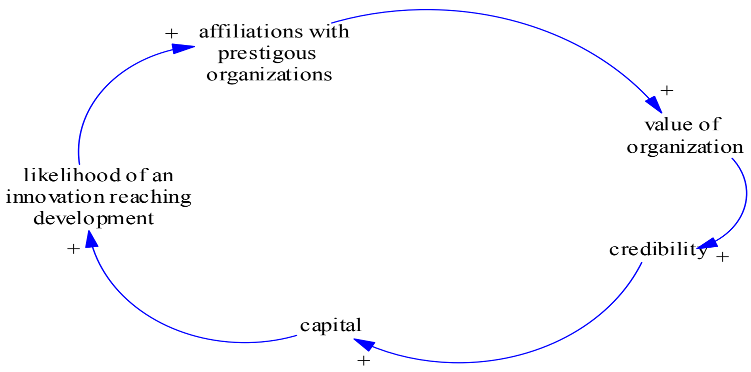

*Figure-14*_“Relationship Effect on Reaching Development” illustrated from

J. Swan et al., 2007

“The importance of ‘star scientists’ is related with the role such individuals play in linking commercial activity to the knowledge base of academia. Whilst this was important, ‘Figurehead’ term is used to highlight also their symbolic and motivational effects” (Zucker et al. , 1998).

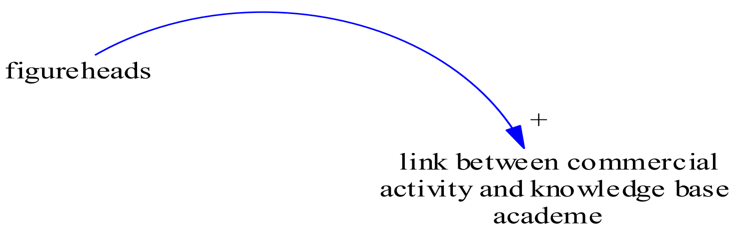

*Figure-15*_“Star Scientist” illustrated from Zucker et al., 1998

"The importance of reputation building and the symbolic value of affiliations is related with symbolic role played by 'Figureheads' (usually lead scientists with international reputations and commercial and/or clinical experience)" (J. Swan, et. al. 2007).

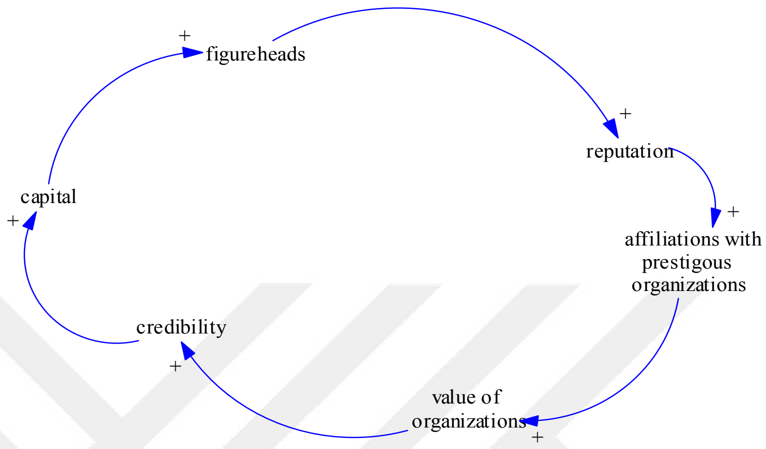

*Figure-16_* "Figureheads" illustrated from J. Swan, et. al., 2007

"Mechanisms relating to integrative capabilities were more crucial in projects characterised by loose organizational coupling rather than tight organizational coupling. This can be explained in terms of two major impacts of a nation's integrative capabilities. First, such capabilities have an impact on the motivation of scientists to engage in commercialization, moving between academia and industry and connecting basic Research and Development. Second, such capabilities have an impact on the ability to secure resources (e.g. from research funding, VC and through partnerships) needed to move innovation forward in situations where these resources are not available from and cannot be centrally controlled by one organization" (J. Swan, et. al. 2007).

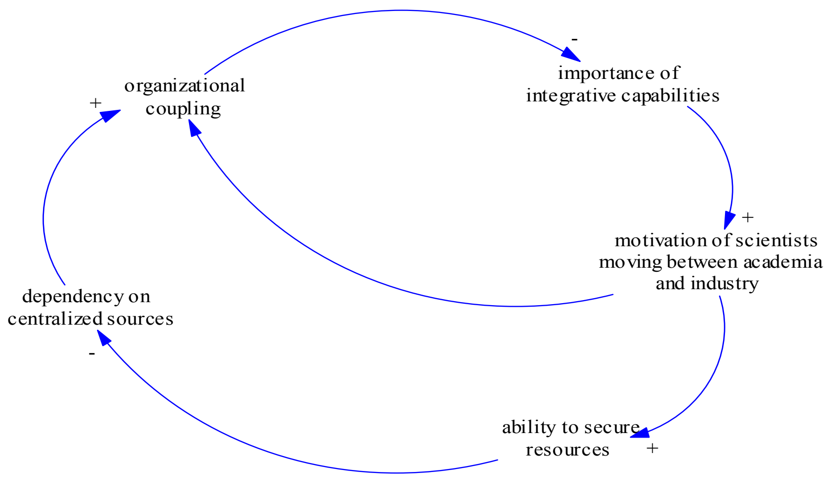

*Figure-17*_"Integrative Capabilities" illustrated from J. Swan, et. al., 2007

"Mechanisms related with relational capabilities were more crucial in the projects characterized by high knowledge boundaries. This is because of the highly novel nature of the innovations in these projects and the very long innovation life cycles. This means that there was a need to leverage resources constantly in order to support long term commercial developments. Moreover, for a project to be 'successful', it needed to deal with problems associated with the disruption to existing practices that these innovations could introduce" (J. Swan, et. al. 2007).

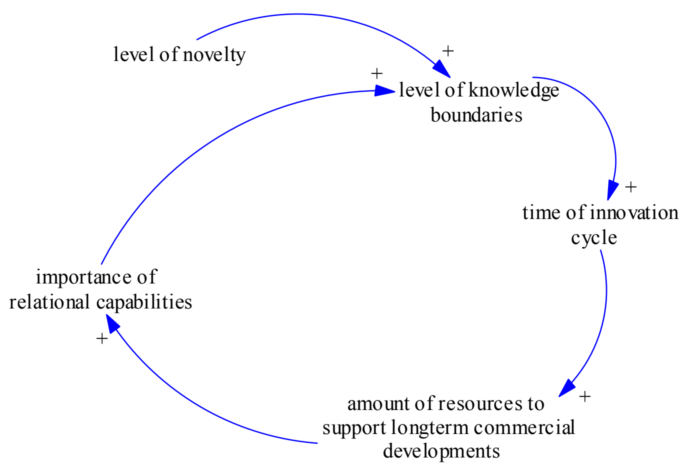

*Figure-18*_"Relational Capabilities" illustrated from J. Swan, et. al., 2007

"Biomedical innovation is defined as a process involving the creation and application of scientific and technological knowledge to improve the delivery of human healthcare and the treatment of disease. This definition is broad enough to include newdrugs, diagnostics and drug delivery regimes for human use, but excludes purely animal, agricultural and natural resource applications of biotechnology" (J. Swan et al., 2007).

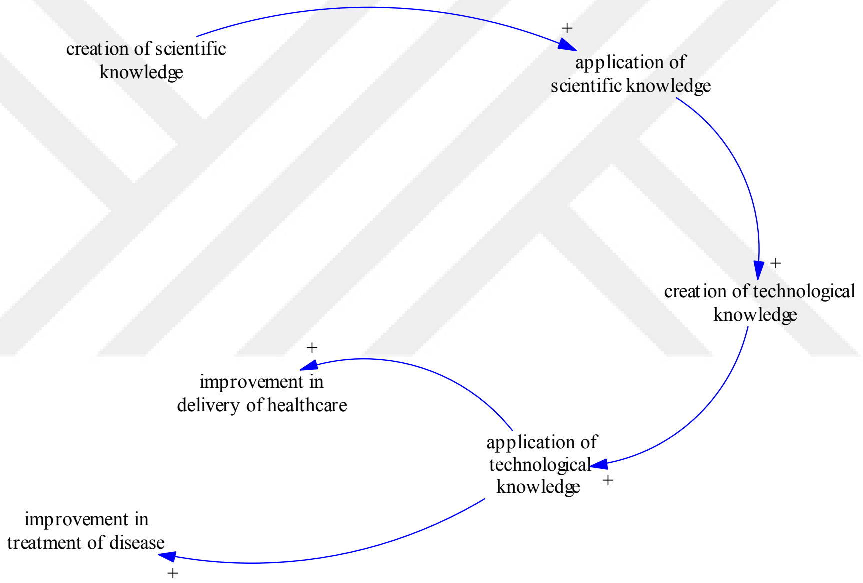

*Figure-19*_"Biomedical Innovation" illustrated from J. Swan et al., 2007

"In the biomedical domain, the potential for breakthroughs in science and technology to radically change medical treatments and diagnostic techniques, is high. However, exploitation of scientific breakthroughs for biomedical innovation is problematic, as witnessed by the high cost, duration and failure rates in product development" (J. Swan et al., 2007)

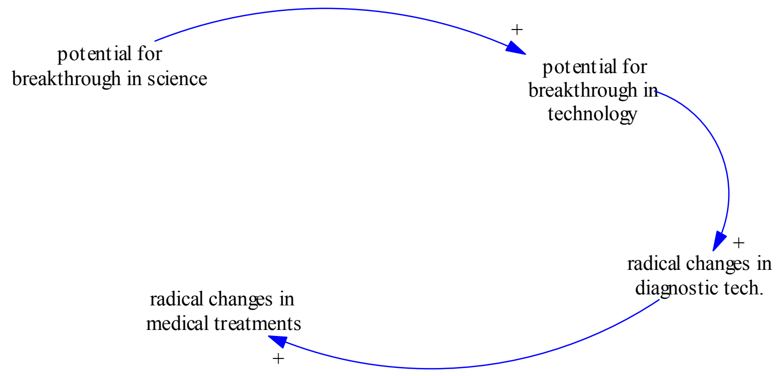

*Figure-20*_"Radical Changes in Medical Treatments" illustrated from J. Swan et al., 2007

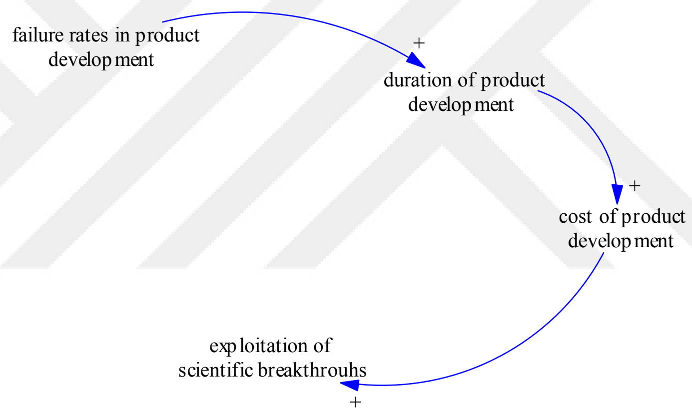

*Figure-21*_"Exploitation of Scientific Breakthroughs" illustrated from J. Swan et al., 2007

"When the knowledge base of an industry is both complex and expanding, and sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than individual'' (Powell et al.;1996).

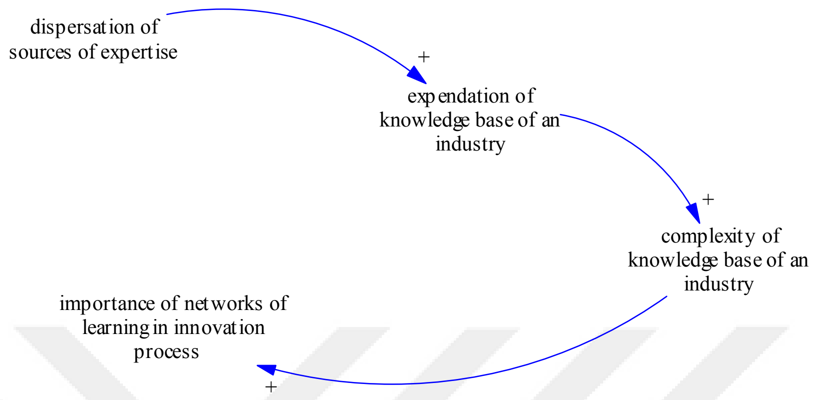

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*Figure-22*_"Networks of Learning in Innovation" illustrated from Powell et al., 1996

"The work has shown how systematic variation in the composition of networks across nations, and within regions, influences the ability to integrate scientific, clinical and commercial expertise" (Owen-Smith et al., 2002; Owen-Smith and Powell, 2004).

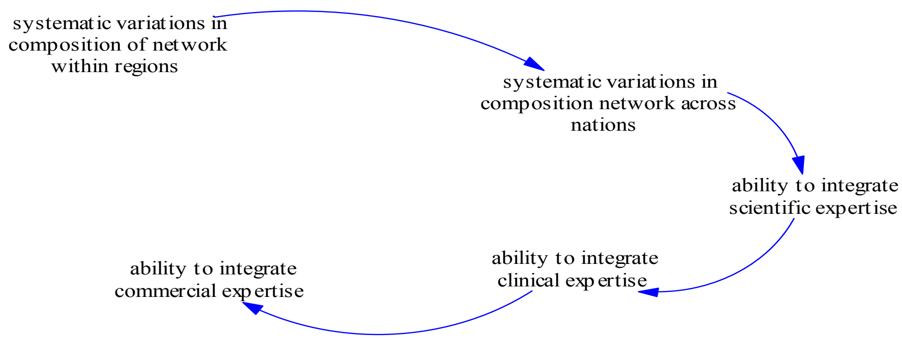

*Figure-23*_"Systematic Variation in Composition of Networks" illustrated from Owen-Smith et al., 2002 and Owen-Smith and Powell, 2004

"The ability of scientists to move back and forth between basic science and clinical development; and the ability of organizations within an innovation system to collaborate with other diverse organizations are important. In keeping with 'national innovation systems' approaches, theirwork suggests that these capabilities stem from macro-level institutional differences in the structure and operation of networks and, thus, differ across nations" (Carlsson, 2002; Nelson, 1993).

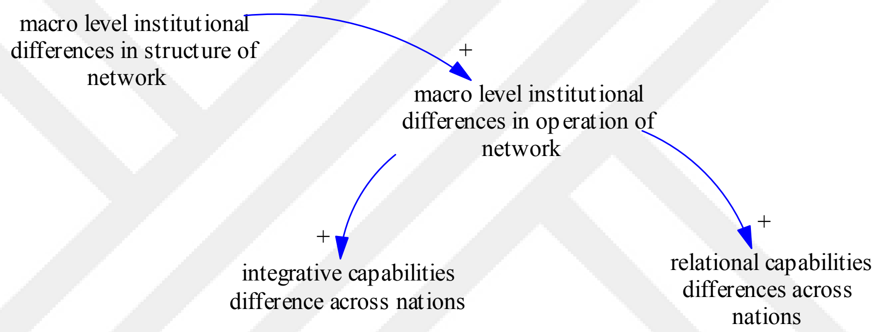

*Figure -24*_"Differences in Operation of Network" illustrated from Carlsson, 2002 and Nelson, 1993

"Integrative capabilities facilitate the translation of basic research into commercial applications through the movement of scientists and their enhanced labour market mobility" (J. Swan et al., 2007).

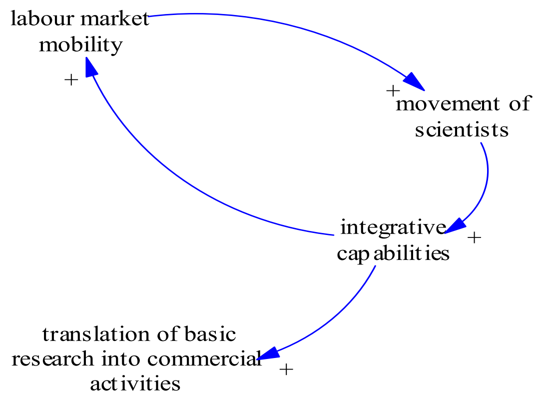

*Figure-25*_"Movement of Scientists" illustrated from J. Swan et al., 2007

"The linkages have been found to be influenced by the macro institutional context, including political (e.g. policy initiatives, regulation), social (e.g. relations between scientists and technologists, the mobility of the scientific labour force) and cultural (e.g. values regarding academic participation in commercial activities) factors" (Owen-Smith et al.,2002).

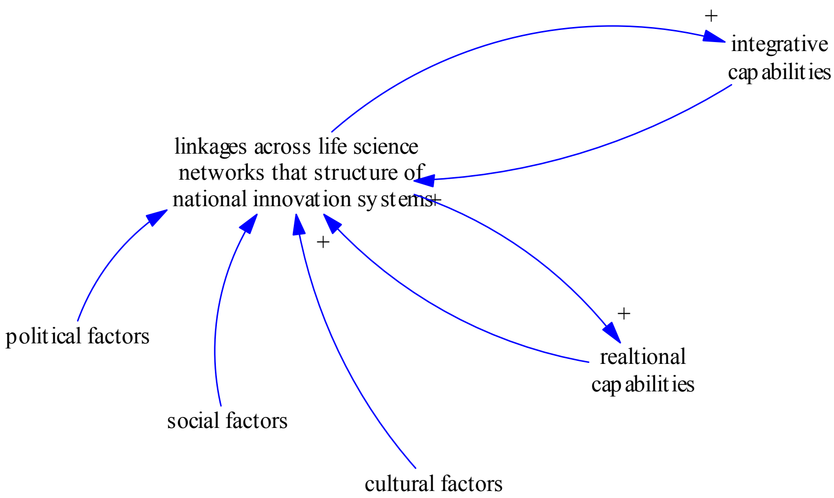

*Figure-26*_"Linkages Across Life Science Networks" illustrated

from Owen-Smith et al.,2002

"In the biotechnology sector, 'open' channels have been found to be particularly helpful in facilitating opportunities for knowledge creation through the enhanced likelihood of 'spillover effects'. Knowledge is more likely to 'leak' though more open channels" (Owen-Smith and Powell, 2004; Murray, 2002; Kreiner and Schultz, 1993).

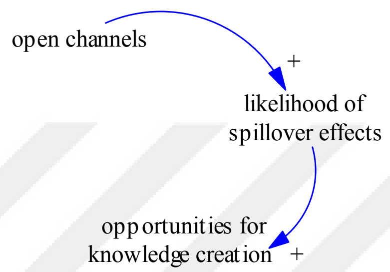

*Figure- 27*_"Opportunities for knowledge Creation" illustrated from Owen-Smith and Powell, 2004; Murray, 2002; Kreiner and Schultz, 1993

"Innovation outcomes are attributable to informal, unpredictable relationships generated through indirect ties, which create access to expertise beyond formal alliance partnerships as well as being influenced by direct relationships between organizations" (Salman and Saives, 2005)

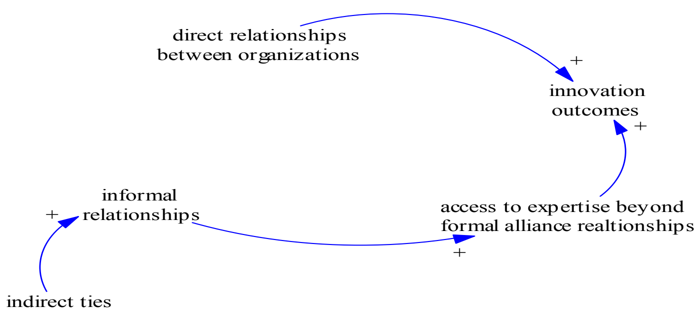

*Figure-28*_"Innovation Outcome" illustrated from Salman and Saives, 2005

"Relational capabilities at the macro level (as indicated in prior research by the density and scope of network ties within regions and nations) would appear to be related to the ability of the organizations involved in innovation processes to acquire and create relevant expertise, with informal networks being especially important in this respect at project level" (J. Swan et al., 2007)

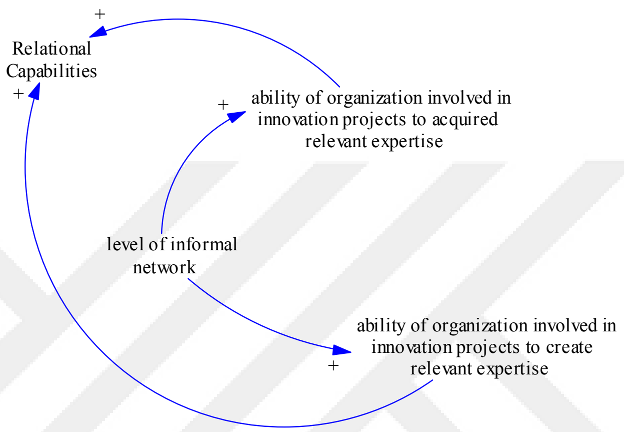

*Figure-29*_"Ability of Organizations" illustrated from J. Swan et al., 2007

"Exploitation starts when variety of content (of a concept, technology, product or practice) that emerges from exploration is reduced into a dominant design, as suggested in the innovation literature. As a result of reduced uncertainty, demand increases, and new producers jump on the bandwagon" (Nooteboom, 2006).

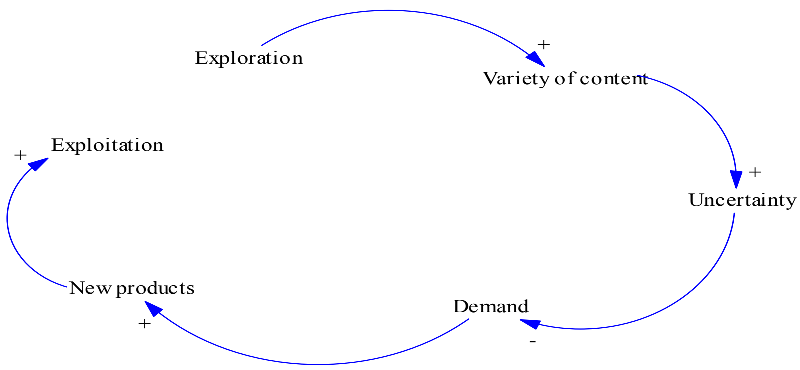

*Figure-30*_"Exploitation" illustrated from Nooteboom, 2006

"When novelty gets consolidated in dominant designs, knowledge gets more codified, which enables a more rapid diffusion. A need and a basis arise for more formal governance. There is a need because realations become more distant and therefore less personalised and codification of knowledge yields a greater risk of spillover" (Nooteboom, 2004).

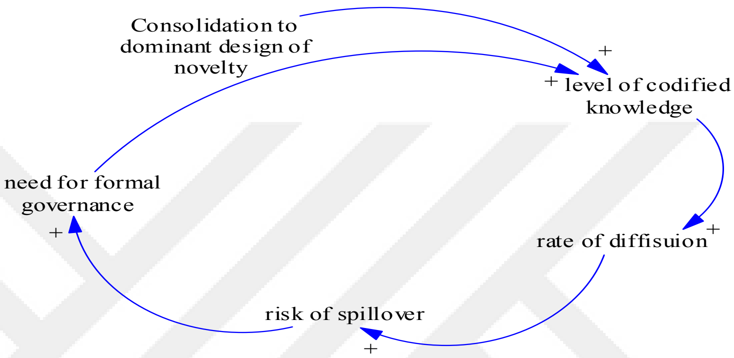

*Figure-31*_ "Level of Codified Knowledge" illustrated from Nooteboom, 2004

"There is more information about options, outcomes and tasks for constructing contractual arrangements, and codification of knowledge yields better opportunities for contract specification and monitoring" (Nooteboom, 2004)

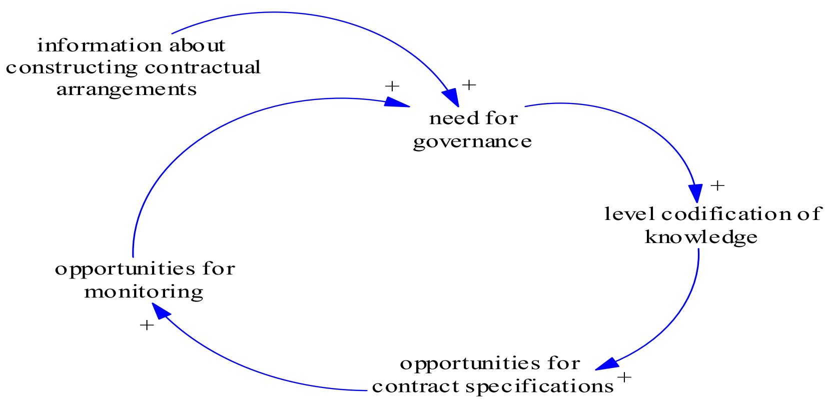

*Figure-32*_"Contract Specification and Monitoring" illustrated from Nooteboom, 2004

"The network structure needs to be dense to yield reputation mechanisms, needed in view of the limited feasibility of contructual control. Moreover density enables to utilize third parties to aid judgement of the meaning and value of knowledge, and to aid in its absorption. The cost of redundant relations is both limited in view of limited size of relation-specific investments and limited relevance since exploration competition is less on price than on feasibility and fast prototyping" (Nooteboom et. al., 2006).

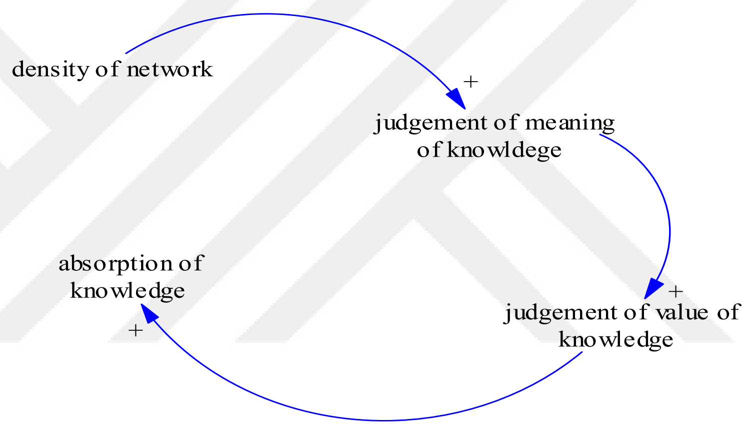

*Figure-33_* "Network Structure" illustrated from Nooteboom, 2006

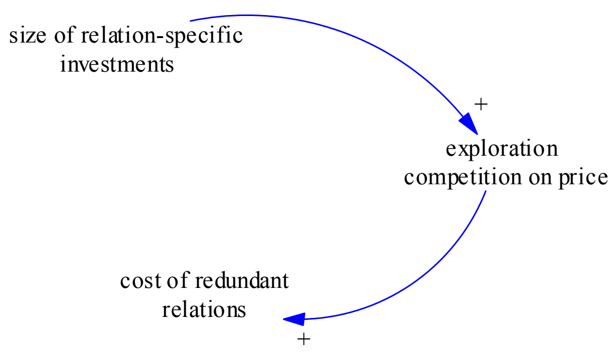

*Figure-34_* "Exploration Competition on Price" illustrated from Nooteboom, 2006

"In exploration uncertainty is wide raging, covering many possible issues of technology market and organization, and as a result ties tend to be strong in the range of issues in volved as well as in trust and openness, while generally weak in formal control. So, trust is needed next to reputation mechanism, due to limited feasibility of contractual control" (Nooteboom et. al., 2006)

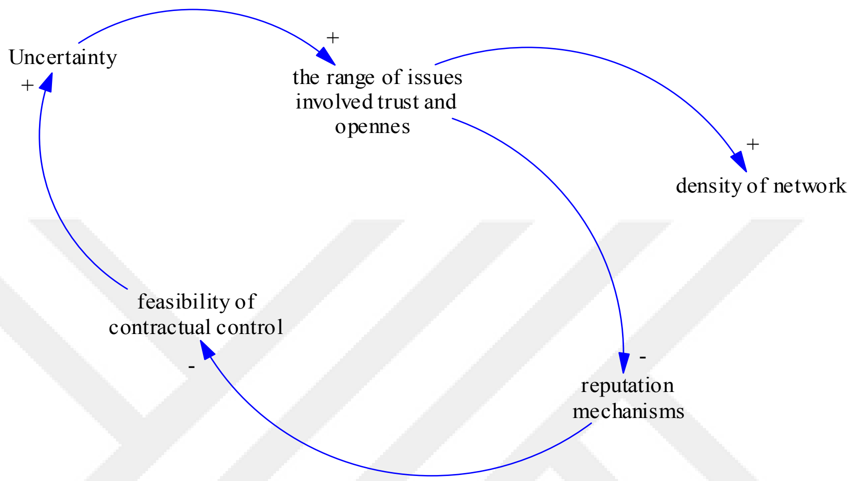

*Figure-35_* "Explariation Uncertainty" illustrated from Nooteboom, 2006

"When innovations are patentable separately, the disclosure of interim patents extends the range of profitable innovations and improves the efficiency of R&D investments. A firm abandons the race after the first patent if the expected market profit is low, which limits R&D cost duplications and avoids the cost generated by scattered patents" (Yann Meniere, 2007).

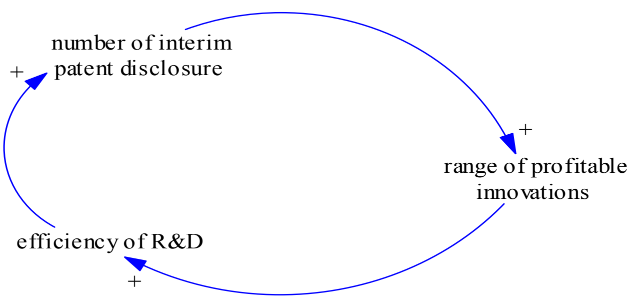

*Figure-36_* "Number of Interim Patent Disclosure" illustrated from Yann Meniere, 2007

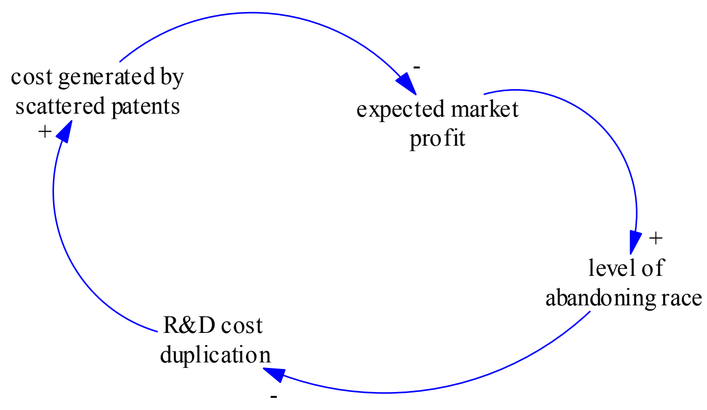

*Figure-37_* " Expected Market Profit" illustrated from Yann Meniere, 2007

"When innovations must be bundled prior to patenting, the scattering cost is always avoided. But the absence of patent disclosure generates useless R&D duplications. Compared with separate patents, this policy generally improves the efficiency of R&D when the expected development delay is short, although it may also slow down the development of the lowest value innovations" (Yann Meniere, 2007).

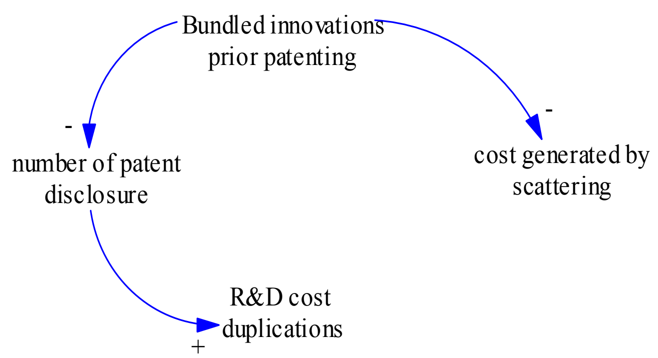

*Figure-38_* "R&D Duplications" illustrated from Yann Meniere, 2007

“There is a positive correlation between a firm’s size and the percentage of its patentable invention that were patented. In each of the three industries (pharmaceuticals, chemicals, and petroleum) where patents seem to be most important, this correlation is statistically significant. Apparently, the very large firms in these industries tend to be even more convinced than their smaller rivals that patent protection is worthwhile. Thus, the frequently-observed tendency for the number of patents per dollar of R and D to be lower among the largest firms than among smaller ones does not seem to be due to differences in the percentage of patentable inventions that are patented. Instead, it seems to be attributable to differences between the largest firms and their smaller rivals in the number of patentable inventions per dollar of R and D” (Edwin Mansfield, 1986)

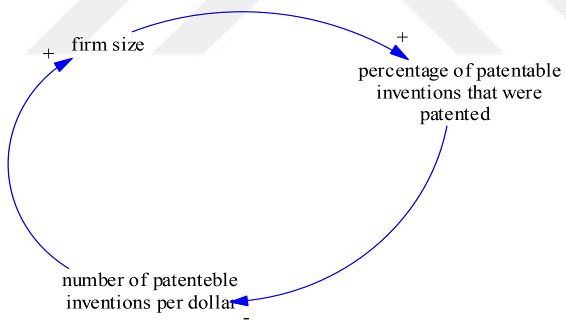

*Figure-39_* “Number of Patentable Inventions” illustrated from Edwin Mansfield, 1986

“In order to understand better why so many of the firms increased the percentage of inventions patented, a random sample of the firms that reported such an increase was chosen and asked why it had occurred. The most frequently-cited reason was that the firm's product mix had changed. There was a shift toward more sophisticated product lines where inventions are more likely to be patented.

Other reasons were increases in perceived competition, greater sophistication with regard to patents, and technical developments that reduced some of the disadvantages of patenting" (Edwin Mansfield, 1986)

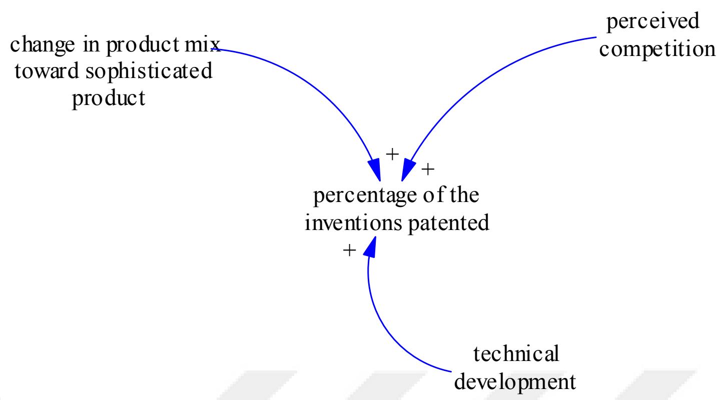

*Figure-40_* " Percentage of Inventions Patented" illustrated from Edwin Mansfield, 1986

"A decrease in the number of inventions resulted in a decrease in the rate of technological change which depended on whether the average economic importance of an invention changed during this period. It is quite possible that firms confronted with considerable increases in the costs of carrying out R&D during this period, found it profitable to develop fewer inventions of minor or marginal importance, and that the decrease in the number of inventions exaggerates the reduction in the rate of technological change" (Edwin Mansfield, 1986).

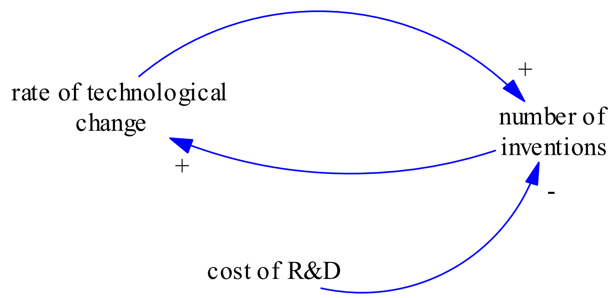

Figure-41_ "Number of Inventions" illustrated *from Edwin Mansfield, 1986*

Important Causal Loops diagrams created under innovation title were combined as in Figure 42 Organization Model for Innovation and Figure-43 Reputation Model for Innovation. Organization Model for Innovation explains how centralization or uncentralization of management and sources effect reaching to novelty.Reputation Model for Innovation explains how value and reputation of an organization can be increased and an innovation is received through it.

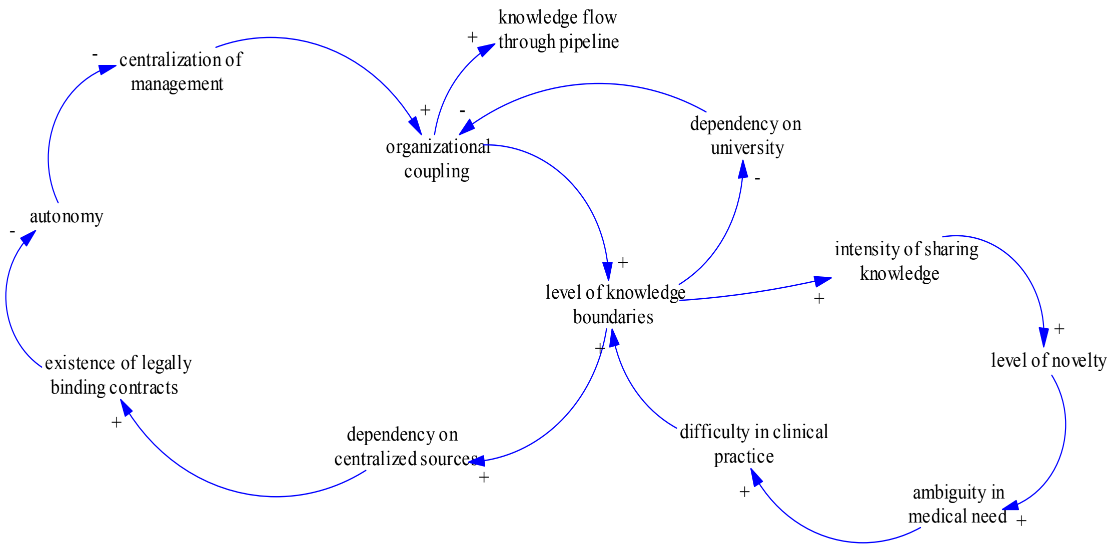

*Figure-42*_Organization Model for Innovation

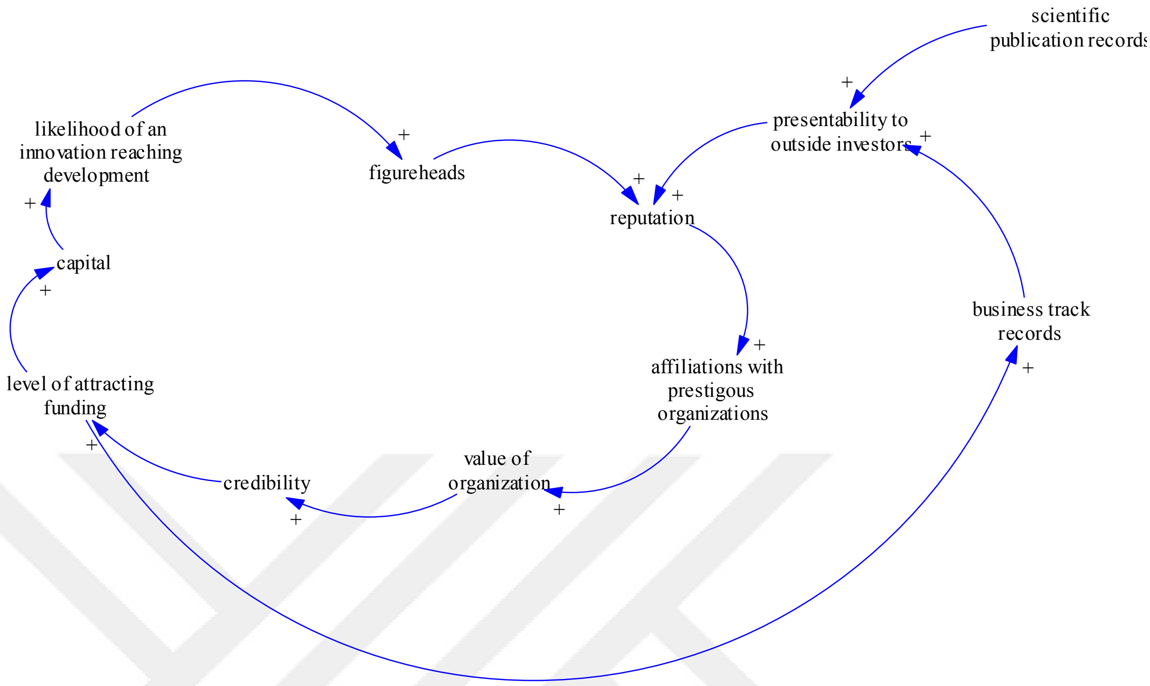

*Figure 43*_Reputation Model for Innovations

6.2 Productivity of R&D Efforts

According to De Rassenfosse ve Van Pottelsberghe (2009), productivity is research efforts in companies results with discoveries. Drawn causal loops regarding productivity of R&D efforts drawn were given under the related part from the related articles. At the last, these causal loops were combined as productivity model and given in Figure-47. Productivity model shows that productivity of R&D efforts is effected positively from education level through creativity and talents, R&D capacity and extraindustrial resources of knowledge.

"If the ratio of efforts of research and development in business sector increases, this may show itself as an increase in number of patent fillings per researcher considering the fact that researchs in business world focuse on applied researchs and product development" (de Rassenfosse & van Pottelsberghe, 2009).

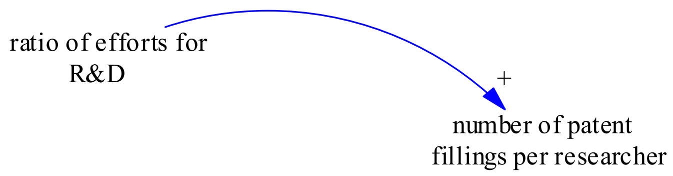

*Figure-44_* "Number of Patent Fillings per Researcher" illustrated from Da Rassenfosse and von Pottelsberghe, 2009

"Educational level in a country may cause an increase in productivity of R&D efforts by increasing creativity, talents and capacity of absorbing new knowledge. It was concluded that the researchers have higher educational level are more productive" (de Rassenfosse, van Pottelsberghe; 2009).

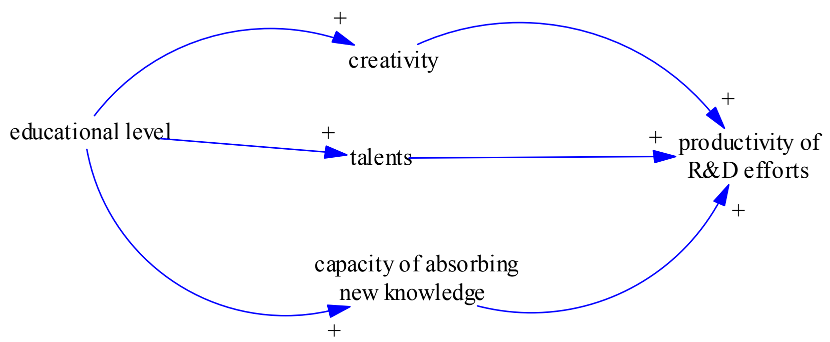

*Figure-45_* "Productivity of R&D Efforts" illustrated from Da Rassenfosse and von Pottelsberghe, 2009

In the study of Arora (2007), *"determining factors of research productivity are described as in house R&D capacity of a company, spreadings from R&D efforts of rival companies and extra industrial resources of knowledge"*.

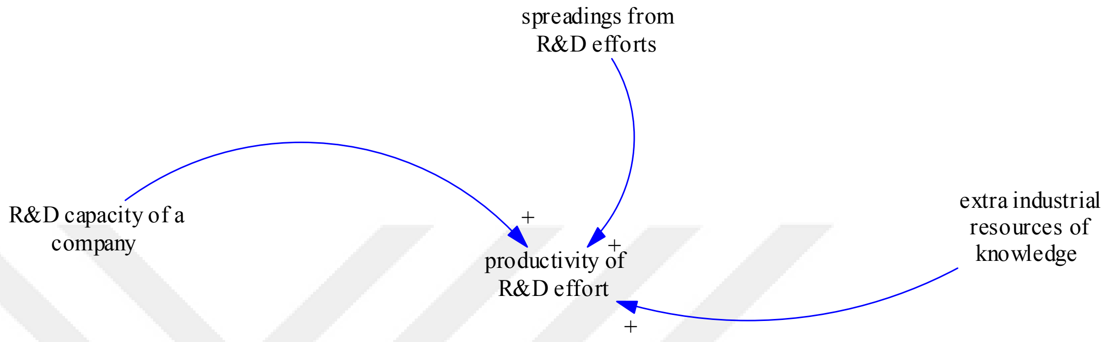

*Figure-46_* "Productivity of R&D Efforts" illustrated from Arora, 2007

The relations which effect productivity of R&D efforts are as in shown Figure-47 Productivity Model which was combined from causal loops Figure-45 and Figure-46.

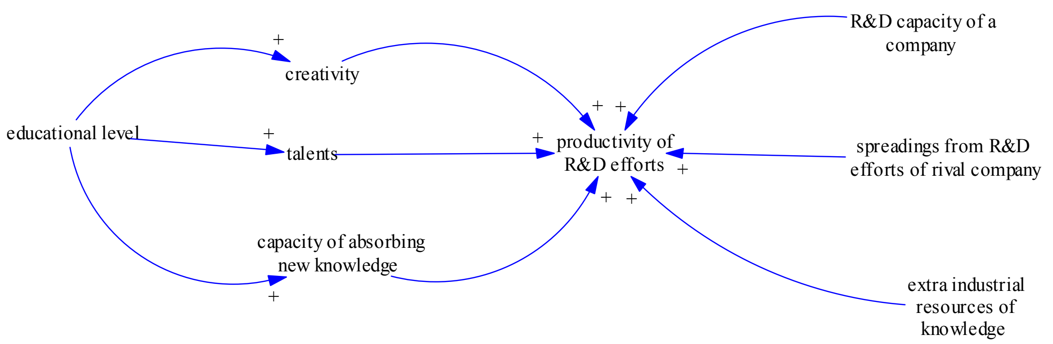

Figure-47_Productivity Model

6.3 Research Capability

As it can be seen in the drawn causal loop which was illustrated based on Hahn and Shaver (2005), research capability is affected positively from engaging in international R&D and reaching knowledge and research capability has a positive effect on number of patenting files.

‘’Whether increasing research capability of companies contributed to getting more patents and they found that the companies engaged in international R&D increased their research capability by reaching knowledge and research capability in other countries which had an positive effect on increase of patent number’’ Hahn and Shaver (2005)

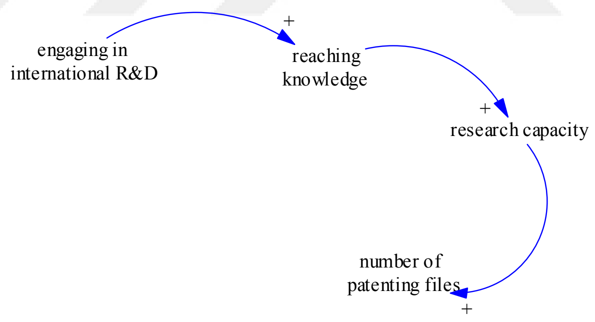

*Figure 48_* “Number of Patent Filling” illustrated from Hahn and Shaver,2005

6.4 Tendency to Patenting

According to Arora, 2007; “patent premium is proportional increase in the value of discovery by patenting discoveries.” As it was shown in drawn causal loop diagram based on Arora, 2007; patent premium and R&D efforts have positive effect on tendency to patenting and number of patenting files.

“An increase in patent premium increases R&D, Patent filings, tendency to patents and number of patent filing per dollar spent R&D efforts’’ (Arora,2007).

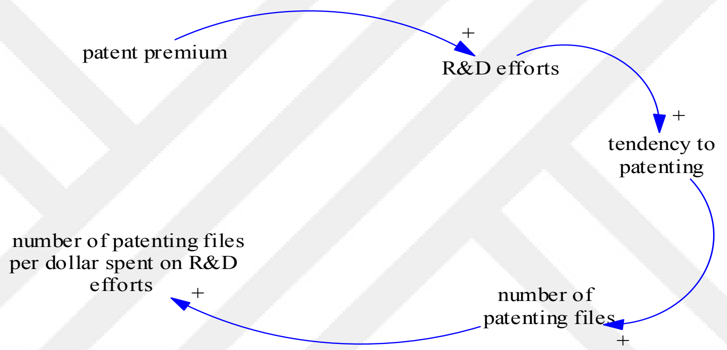

*Figure 49_* “Tendency to Patenting” illustrated from Arora, 2007

6.5 Patent Protection System

Created causal loops diagram regarding patent protection system were drawn and given under the related part from the related articles. Drawn causal loops show that when the strength of the paten system increases, this effects number of patents and R&D expenses positively.

‘’Increases or decreases in number of patenting files can be observed due to structure of patent system in that country. In this way, it can be said that structure of patent system is a way to use in determining tendency to a patent in a country along with comparing tendency to patent between countries. Stronger

patent system causes an increase in number of patent files. Additionally, situation about the substances can be patented, enhancing mechanism in patent and absence of restrictive rules patent rights have contributions to demand in patenting'' (De Rassenfosse & van Pottelsberghe, 2009)

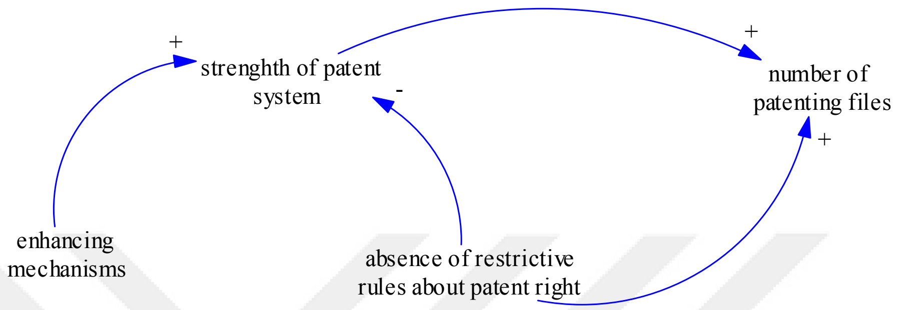

*Figure-50_* "Strenght of Patent System" illustrated from Da Rassenfosse and von Pottelsberghe, 2009

''Patents are one of the most effective the factors for determining drug prices therefore they might cause a company becomes a monopol in pharmaceutical industry. But the rise of the competition between originator and generic pharmaceutical companies is a factor which causes a decrease in drug prices. It is seen that the competition between generic pharmaceutical companies and the originator pharmaceutical companies whose biggest advantage is their investments on R&D and the inventions and patents they obtain at the end of R&D process will increase as long as the stagnation in R&D productivity continues'' (Nogues, 1999).

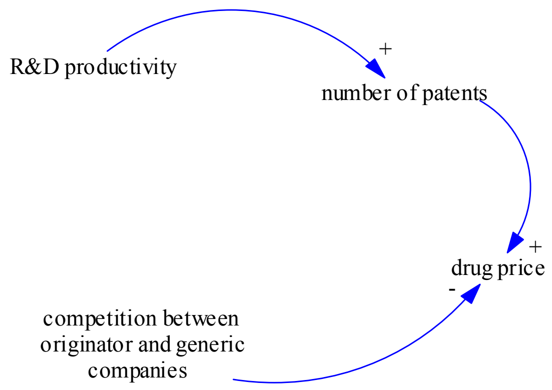

Figure-51_ " Number of Patents" illustrated *from Nogues, 1999*

''Studies indicates that empowered patent protection is the most important factor for R&D expenses since it effects expenses in R&D in an increasing way in pharma sector'' (Pazderka, 1999).

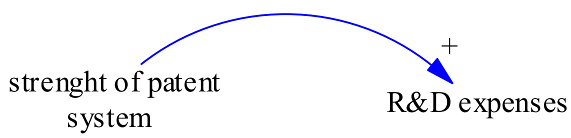

Figure-52_ " R&D Expenses" illustrated *from Pazderka, 1999*

6.6 Patent Length

Patent Length is the period given for patent protection. As it is shown in Figure-53, patent length has a positive impact on R&D activities, income and innovations.

''Longer patent length for more superior innovations causes an increase in income of the companies. This may cause that companies directing their R&D activities to make superior innovations. But optimal patent length increases when patent length increases'' (Cornelli and Schankerman, 1999)

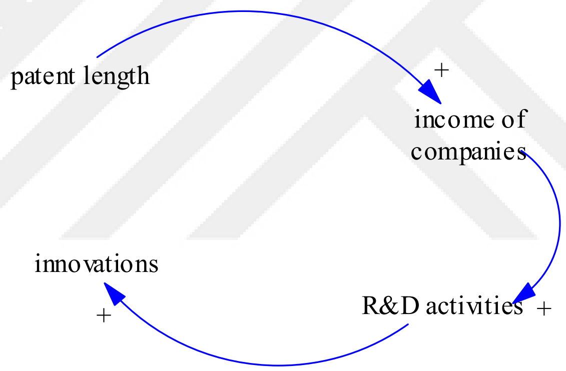

Figure-53_ " Patent Length" illustrated *from Cornelli and Schankerman, 1999*

6.7 Generic and Counterfeit Drugs

Created causal loops diagram regarding generic and counterfeit drugs were drawn and given under the related part from the related articles. Drawn causal loops shows that entry of generic drug has a negative impact on market share of original drug and entry of counterfeit drug increases since reaching to poor countries decreases due to increased drug prices because of patent protection.

‘’Limited incentives for generic drug companies and this stricts generic drug enter.A research indicates that originator pharmaceutical companies which generic drug manufacturers competes with, have more sales in the market when it is compared with the other originator pharmaceutical companies which generic drug manufacturers have less competition. This shows that generic drug companies consider market shares of the brands when they select target molecule/ product’’ (Datamonitor, 2005).

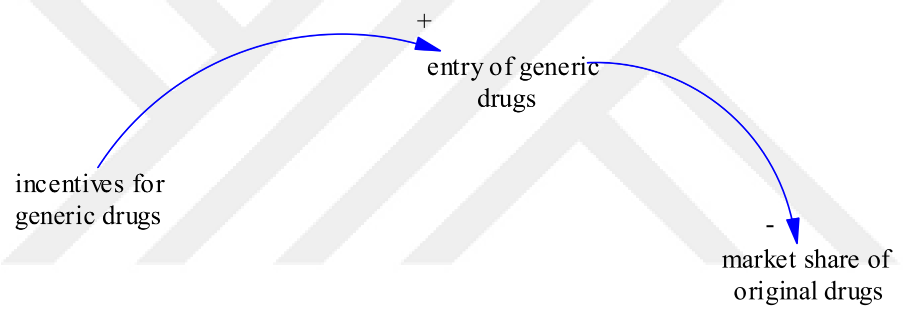

Figure-54_ “Generic Drugs” illustrated *from Datamonitor, 2005*

‘’Increased globalization and world trade has caused an increase in counterfeit drugs. The reason for this is decreasing the costs of counterfeit drugs and making easy entering to the market. Technological advances has been helpful both to real drug manufacturers and counterfeit drug manufacturers. Technological advances help to decrease the costs for the counterfeit drug manufacturers. But technological advances also have offered options to the real drug manufacturers to save their drugs and they have had advantages against counterfeit drug

manufacturers.The real drug manufacturers have intellectual property rights and this make them the ones which determines the price of the drug. The high prices causes problems in reaching to drugs in poor and developed countries this makes easy counterfeit drugs which have low prices to enter to the markets'' (Lybecker, 2008).

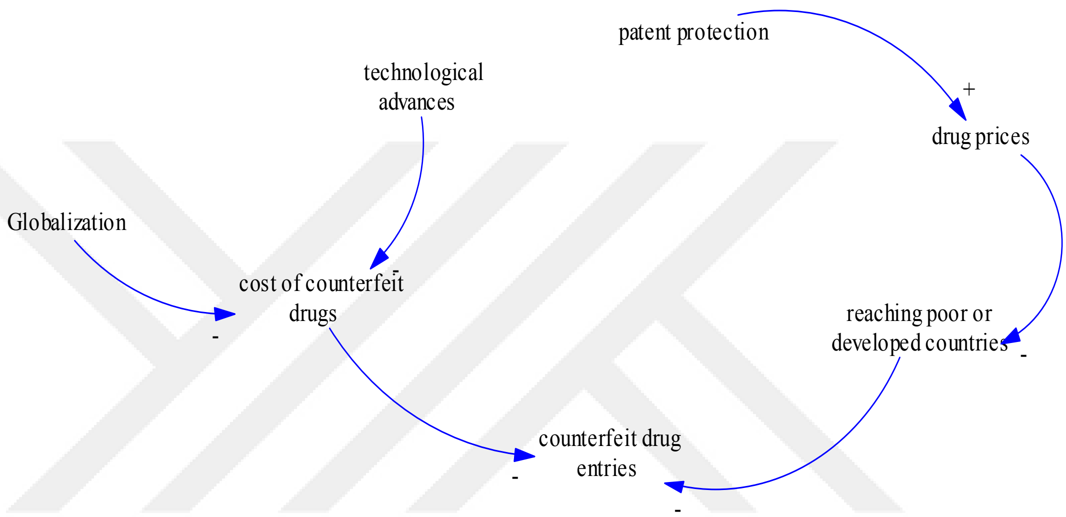

Figure-55_ "Cost of Counterfeit Drugs" illustrated *from Lybecker, 2008*

6.8 Patent Management Model

The causal loops generated under Productivity of R&D, Research Capability, Tendency to Patenting, Patent Protection System, Patent Length and Generic and Counterfeit Drugs were combined as one causal loop diagram which was named as Patent Management Model as shown in Figure-56. In this model every parameter related with patent management which were extracted from literature and how they affect each other is shown. According to Patent Management Model, research capability, reaching knowledge, productivity of R&D efforts, strength of patent management in a country, drug prices and R&D expenses are important parameters.

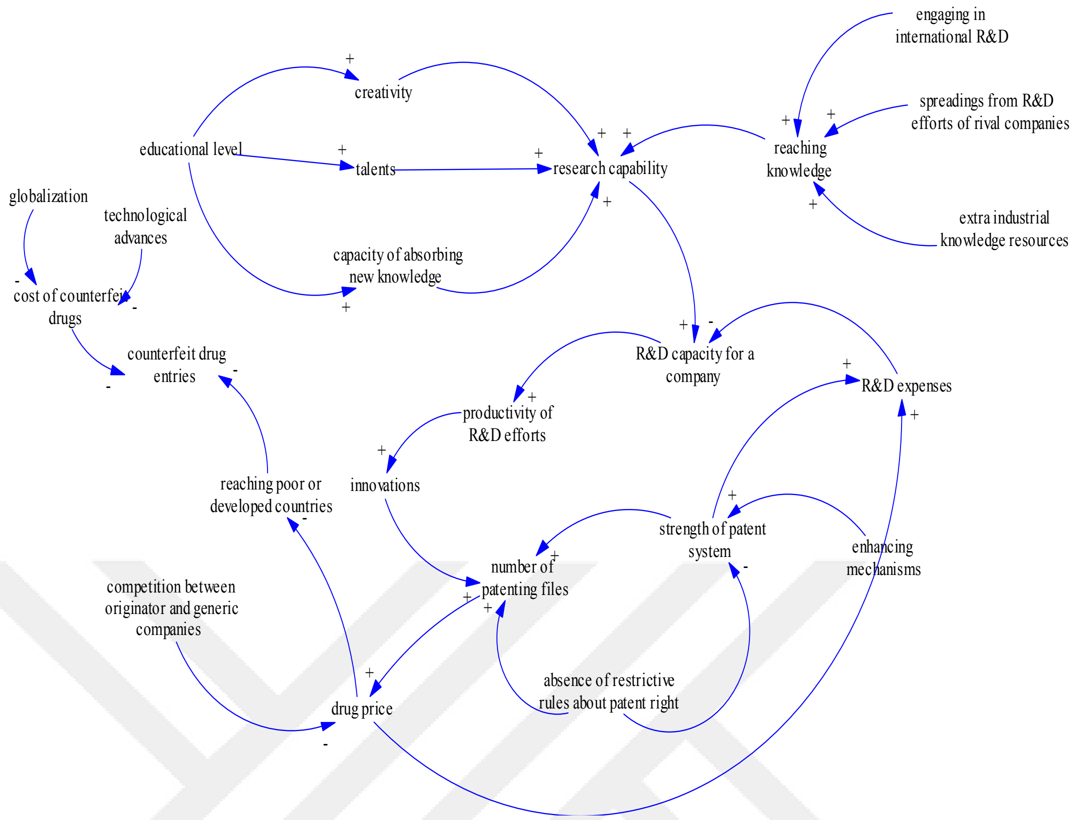

Figure-56 Patent Management Model

7 CONCLUSION AND DISCUSSION

In competitive environment of the pharmaceutical industry new inventions and patents are one of the key points. In order to be one step further from their rivals, the companies invest to R&D efforts and try to find new inventions. At this moment, patents are an important point to recoup the investment. So the companies lobby for the more strict patent law to prevent imitation. Thus even in the developing countries have to invest R&D and invent new products to be able to survive in the market like in India. All of these happenings increase the importance of the patents and patent management day by day. Also this situation can lead to Turkish pharmaceutical to invest R&D or have patent licenses of other firms' products increasingly.

In the study we used a new approach, System Thinking, to understand the dynamics of patent management better. When the causal loops are generated via system thinking approach through literature review. Causal Loops were generated under seven titles as Innovation, Productivity of R&D, Research Capability, Tendency to Patenting, Patent Protection System, Patent Length and Generic and Counterfeit Drugs. Causal Loops generated under this titles which were extracted from literature reviews were combined. Since innovation is a wide process on its own, the causal loops under this title were combined separately by combining only some important causal loops. Other causal loops under Productivity of R&D, Research Capability, Tendency to Patenting, Patent Protection System, Patent Length and Generic and Counterfeit Drugs were combined together and one model was generated which also includes innovation as a part. 3 models were created as Organization Model for Innovation, Reputation Model for Innovation and Patent Management System Model.

Organization Model for Innovation explains how centralization or uncentralization of management and sources effect reaching to novelty. According to this model, centralization of management increases organizational coupling, level of knowledge boundaries and existence of legally binding contracts. In an environment like this, autonomy in the organization decreases which increase the centralization.

Reputation Model for Innovation explains how value and reputation of an organization can be increased and an innovation is received through it. Reputation of an organization can be increased through symbolic figureheads, business track records, scientific publication records which they increases the presentability to outside investors of an organization. When reputation of an organization increased value of the organization increases also and by this way organization attracts more funding, capital and the organization can reach a developed innovation.

In Patent Management Model, every parameter related with patent management which were extracted from literature and how they affect each other is shown. According to this model, when research capability of an organization was increased with educational level of the people and by reaching knowledge. Organizations reach more knowledge when they were engaged in international R&D and when they have spreadings from R&D efforts of rival companies and extra industrial knowledge sources. Increased research capability in organization also increases R&D capacity, productivity of R&D efforts and innovations. In an environment where there is a strong patent protection system which was enhanced with mechanisms, organizations tend to patent their innovations which increases the number of patenting files. Patent protection increases drug prices but this effects reaching to poor or developed countries negatively and this causes counterfeit drug entries to the market in these kind of countries. Though drug prices increase with patent protection, competition with generic companies decreases the prices when the patent period ends, therefore originator drug companies may choose to find ways to extend their patent periods since a decrease in drug prices effects negatively their R&D expenses.

As conclusion, in patent management, research capability, reaching knowledge, productivity of R&D efforts, strength of patent management in a country, drug prices and R&D expenses are important parameters which should be considered in decisions related with patents and choosing the strategies regarding them.

7.1 Limitation of Study

As it was stated in framework of research method section, the methodology is artificial and interpretive.

Validity of an interpretive research can be questioned since it is not scientific but subjective and based on individual constructions. Knowledge has limited transferability and generalizations are usually are absent in this kind of researchs (Scotland, 2002)

Causal loop diagrams were created from the articles related with patent management. One of the limitations of the study is the non possibility of the combining all causal loops into one causal loop since there are many factors affecting patents. And the other limitation of the study eventhough eventhogh it was shown that how one variable is effected from the other variable, the positive or negative interaction can change when a variable is affected more than one variable.

7.2 Further Research

As it was stated in limitation of the study, the positive or negative interaction can change when a variable is affected more than one variable in the causal loop diagrams. Developing causal loop diagrams into stock and flow diagrams in order to show accumulation and determining positivite and negative effect on variables on each other more precisely can be an approach for future studies.

7.3 Managerial Implications

In the study we used a new approach, System Thinking, to understand the dynamics of patent management better. In order to do this, causal loops diagrams were generated from the related articles which shows the relations between the variables related with patent management. Thus we believe that this causal loop diagrams will be helpful in decisions regarding the patents and will lead a more effective and strategic management for the companies. In this way it will be helpful in increase their performances in competitive environment of pharmaceutical industry.

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