GAZİANTEP UNIVERSITY GRADUATE
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TECHNOLOGY SELECTION AND NEW PRODUCT DELEVOPMENT BASED ON PATENT INFORMATION

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Technology Selection and New Product Development Based on Patent Information

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Prof. Dr. Türkay Dereli

by

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

TECHNOLOGY SELECTION AND NEW PRODUCT DELEVOPMENT BASED ON PATENT INFORMATION

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M.Sc. in Industrial Engineering
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In a rapidly changing world, survival of enterprises is getting harder and harder. As international competition continues to intensify, significant number of firms are failing and consequently closing down in each year. These failures create some questions like*: i) What is the role of technology selection in business success and failure? ii) Which technology is promising more for the future? iii) How can the change in technology be traced and foresighted? iv) Which data resources can be utilized as the indicator of technological change?*

This research thesis was inspired by the questions (as well as the answers/decisions about these questions) raised and the perceived lack of appropriate solutions to the *accurate-technology selection problem.* In this regard this thesis proposes four different frameworks to qualify the technology selection process. They all utilize the "patent information" to supply decision support to the entrepreneurs. All of the frameworks are developed on the assumption that patent information is the one of the best indicator of technology change.

The proposed frameworks include: Construction of "Patent Alert System" (PAS); utilization of Analytical Hierarchy Process (AHP) for trendy technology selection; classification of technologies using fuzzy classifiers; and finally a new product development framework.

The proposed PAS; enables users to set or configure alert(s) for the trend changes in any technology area by using the associated patent data. The second framework; facilitate the selection of trendy technology using patent statistics. The third one utilizes fuzzy classifiers to categorize technology as: dated, classic and trendy. And the final framework employs 5W1H ("Who-When-Where-Why-What-How") and TRIZ (Theory of Inventive Problem Solving) procedure to the selected patents to create novel products. All these frameworks are exemplified by the cases.

In summary, the proposed technology selection frameworks provide several tools and offers significant contributions to the current implementations.

Key Words: Technology selection, Analytical Hierarchy Process (AHP), fuzzy classification, trend analysis

ÖZET

PATENT BİLGİSİNE DAYALI TEKNOLOJİ SEÇİMİ VE YENİ ÜRÜN GELİŞTİRME

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Tez Yöneticisi: Prof. Dr. Türkay DERELİ
Ocak 2008, 100 sayfa

Değişen koşullar işletmelerin ayakta kalmasını oldukça zorlu bir hale getirmektedir. Her yıl çok sayıda işletme yoğunlaşan uluslararası rekabet koşullarının da etksiyle başarısız olmakta ve kapanmaktadır. Bu başarısızlıkların gündeme getirdiği bazı soruları şu şekilde sıralamak mümkündür: *i) İş ve yatırım başarısı/başarısızlığında "teknoloji seçimi"nin rolü nedir? ii) Geleceğin parlak teknolojileri nelerdir? iii) Teknolojik değişim ne şekilde izlenebilir/öngörülebilir? iv) Teknolojik değişimin göstergesi olarak hangi veri kaynaklarından yararlanılabilinir?*

Yukarıda belirtilen sorular (bunlarla ilgili cevap ve kararlar) ve doğru teknoloji seçimi ile ilgili olarak genel bir çerçeve (çatı) modelin olmayışı, bu tezin yola çıkış noktası olmuştur. Bu bağlamda; bu tezde "teknoloji/yatırım seçimi"nin çeşitli süreçlerinde kullanılabilecek dört farklı çerçeve model sunulmaktadır. Önerilen çerçeve modellerin her biri "patent bilgisini" kullanarak potansiyel kullanıcılara karar desteği sağlamayı amaçlamaktadır. Bu model önerileri; "patentlerin teknolojik değişimin en iyi göstergelerinden biri olduğu" varsayımına dayanılarak tasarlanmıştır.

Önerilen çerçeve (çatı) modeller; Patent Alarm Sistemi'nin (PAS) yapılandırılması, Analitik Hiyerarşi Prosesi'nin (AHP) *yüksek eğilimli teknolojilerin (teknolojik eğilimlerin)* belirlenmesi için kullanılması; teknolojilerin *bulanık sınıflandırıcılar* kullanılarak sınıflandırılması ve son olarak da *yeni ürün geliştirme sistemi*nin oluşturulmasını içermektedir.

PAS; kullanıcıların izlemek istediği bir alanda yaşanacak teknolojik eğilim değişikliklerinden haberdar olmasını sağlayan bir sistemdir. Öngörülen ikinci *çerçeve (çatı) model*, patent istatistiklerini esas alarak teknoloji/yatırım planlayan girişimcilerin karar probleminin çözülmesine yöneliktir. Üçüncü model ise, teknolojilerin; *güncelliğini yitirmiş, güncel ve klasik* olarak sınıflandırılmasını sağlamak amacıyla tasarlanmış bir bulanık sınıflandırma yaklaşımıdır. Ele alınan dördüncü çerçeve model ise 5N1K (Ne, Nerede, Ne zaman, Neden, Nasıl, Kim) ve "yenilikçi ürün geliştirme teorisi"nin bereber kullanılarak yeni ürün geliştirilmesine yöneliktir. Tezde önerilen çerçeve modeller çeşitli vakalar ele alınarak örneklendirilmiştir.

Özetle, teknoloji seçim problemi için önerilen tüm çerçeve modeller karar desteği açısından önemli katkılar sağlayarak mevcut uygulamalara çeşitli faydalar sunulmaya çalışılmıştır.

Anahtar Kelimeler: Teknoloji seçimi, Yatırım Seçimi, Analitik Hiyerarşi Prosesi (AHP), Bulanık sınıflandırma, Eğilim analizi

ACKNOWLEDGEMENTS

"Man, unlike any other thing organic or inorganic in the universe, grows beyond his work, walks up the stairs of his concepts, emerges ahead of his accomplishments."

Samuel Johnson

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I would like to express my gratitude to my colleagues, who contributed greatly to the accomplishment of this thesis. I would like to thank all of them for their constructive comments, and support throughout my research process. My special thanks should be addressed to my good friends M. Şenol KANAT and Vahit KAPLANOĞLU. I should also present deepest thanks to my fiancée Z. Didem UNUTMAZ. Her help and support, as well as passion for research, have been invaluable for me in getting this study done.

And, of course, I feel very thankful to my parents who brought me up so far away from Gaziantep, gave me a positive vision of life and taught me all the good things in this life. I thank my mother, father, sister and all other family members for their support.

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LIST OF SYMBOLS / ABREVIATIONS

5W1H	"Who-When-Where- Why-What- How" Questioning Approach
AHP	Analytical Hierarchy Process
EPO	European Patent Office
ICT	Information and Communication Technology
IP	Intellectual Property
IPC	International Patent Classification
MCD	Master Classification Database
OBI	Greek Patent Office
PAS	Patent Alert System
XML	Extended Mark-Up Language
R&D	Research and Development
SPSS	Statistical Package for Social Sciences
TPO	Turkish Patent Institute
TRIZ	Theory of Inventive Problem Solving
ARIZ	Algorithm of Inventive Problem Solving
AIDA	Analysis of Interactive Decision Areas
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization
WPI	World Patent Information

CHAPTER 1

INTRODUCTION

"It is change, continuing change, inevitable change, that is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be..."

Isaac Asimov

1.1 General Remarks

Improvements in communication technologies and fundamental structural changes in many economies have caused many of companies to rearrange their management philosophies. Understanding the change, adapting to the change and further managing and leading the change, have been essential to survive. Therefore management philosophies modified themselves with extra stress on the change. Changes have affected all each other. Individual understandings like ethics, environmental conditions like global warming, technical changes like discovery of internet and many others have all influenced each other. There have been certain debates to determine which one is the result and which one is the reason. These debates have all been the topics of several discussions. These debates are not overrated much by the practitioners. Enterprises have understood that they have to find urgent solutions to survive in this turbulent change. Each change has shown that any change comes with its novel advantages and disadvantages. The firms which are able to turn those advantages into bright opportunities have much more chance to survive. Through the storm of these changes, scientists have started study more on changes. The fundamental research question is about the extracting the direction of the change. It has been essential to predict future direction of change just to converge a right conclusion of any sensible decision.

This thesis bases on a crucial and sensitive decision problem. The problem is selection of new technology to invest. Companies make capital/new business investments in order to create and take advantage of profit opportunities.

Opportunities are the decision options in capital investment problems. Different source of data and their processed form - information- can be employed to select technology investments. Thus, intelligent selection of the information source along with a valid framework is essential to reduce the failure risk of wrong investment selection. This research thesis was inspired by the perceived lack of an appropriate solution to technology investment project(s) selection. Through the thesis; patent information –since they are considered as the best indicator of technology changes- has been utilized to in four frameworks which can properly support decision makers of technology investment.

In this introduction part, readers will be able to find more detailed information on the definition of the problem and statement of thesis with proposed solution methodologies and finally a roadmap is readily available for readers to watch the rest of the thesis.

1.2 Problem Statement

Business failure is certainly not a novel phenomenon in the liberal economies. They have affected several parties in the economy with their tragic results. Its first and most serious effect occurs on the entrepreneurs. The entrepreneurs lost their resources and consequently their assurance. In national scope, failures waste the country's resources and discourage others to invest on novel businesses (Dereli and Durmuşoğlu, 2007). Business failures also damage to the efficient operation of a market economy (Storey, Keasey, Watson, & Wynarczyk, 1987). Hence, there have been several studies on success or failure of businesses. The development of failure prediction models dates back to the 1960s (Beaver (1966), Marcus (1967), Altman (1968)). These early studies mostly focus on the financial ratios. Later on, the researches contributed to the prediction of business failure/success in various aspects (Altman, 1983; Alves, 1978; D'Aveni, 1989; Dugan & Zavgren, 1989; Gilbert, Menon, & Schwartz, 1990; Hofer & Sanberg, 1987; Koh & Killough, 1990; Ibrahim & Goodwin, 1986; Keats & Bracker, 1988; Pech & Alistair, 1993; Shelton, 1986; Stockton, 1989) and they have benefited both to current entrepreneurs and those who provide capital for their ventures. However, there is a certain problem on all of these studies due to lack of appropriate data identifying establishments correctly and making it possible to follow their progress over time (Persson, 2004). Therefore; most of the studies on business failure and success are empirical studies.

Geroski (1995) also makes an empirical work and defines a number of stylized facts and stylized results which summarize on entry and exit to the market. Common findings have been that (i) the survival rates of new establishments are low, (ii) firm survival tends to increase with firm age and firm size and (iii) firm growth tends to decrease with firm age and firm size. Audretsch and Mahmood (1995) employ a hazard duration model for U.S. manufacturing firms and plants stressing on some other factors about survival. As a consequence they state that "scale economies", "initial start-up size" and "selection of technology"; influence the ability of newly established firms to survive over time. They found, as expected, that the exit rate tends to be higher in industries where economies of scale play an important part. This fact can be explained with the power required to survive in highly competitive industries. The ones which can't produce as much as required to profit, leaves the market. Dunne and Hughes (1994) and Mata and Portugal (1994) have the similar findings about the factor of "scale of economy". Other researchers also have added additional factors for further consideration. These include the "lack of specific target market", "poor location", "ineffective advertising" and "sales promotion", "inability to compete in trading area" and "poor financial controls" (Kwansa and Parsa, 1990). Put in a slightly different way, the causes include internal administrative, internal strategic, external administrative and external strategic factors (Boyle and Desai, 1991). In another study, those who closed their businesses were asked about the particularly difficult and unpleasant parts of their role, and the "owners cited many problems to avoid, including financial issues such as cash flow and tax problems" (Stokes and Blackburn, 2002)

There are also many other studies to better understand business success versus failure. However, as Gaskill, Van Auken, and Manning (1993) stated: *"there are many questions still to be resolved and warrant additional exploration . . . previous studies do not provide a comprehensive or unified explanation for small firm failure … comparisons are needed between successful and failed small business owners."* According to Cochran (1981), research on business failure for subgroups of the small business sector would prove useful, and that research on business failure for specific industries in regions might be more useful than studies that are national in scope. Hall in 1995 and Nucci in 1999 restate the fact that “some sectors would have appeared to be more volatile than the others: for example, a firm involved in construction is more likely to close than one involved in manufacture”. They also state that there is a certain need to group “failure cases” by industries and countries. This stated fact shows that, each industry has specific patterns of failures and success, therefore at the initial step, selection of right and convenient industries and relevant technologies play a crucial role.

In addition to the findings in literature, some other observations of Turkish business start-ups have helped to define some critical factors affecting the failure of new startup businesses. Traditionally, investment decisions in Turkey are made based upon intuition and past experience, or using a trial and error method which is time and money consuming. Previous failing investments in Turkey show that they were undertaken with inadequate and invalid analyses. Mostly, investors prefer to invest on the areas that are in some way familiar with them. Worldwide trends such as technology trends and knowledge-based sectors are not usually considered as investment choices due their high cost of entrance. Another challenging issue is about local availability of sectors. The unavailability of a unique database of industrial structure and equipment is also considered as a serious problem. Region’s resource capability should be analyzed and incentive management must be restructured according to these findings. These observations had an invaluable effect on the development of solutions stated in this thesis.

1.3 Thesis Statement and Summary of Frameworks

Making decisions on a new technology and investment is a complicated process for entrepreneurs. Therefore; in order to avoid irrational investments and manage these complicated processes, there is a certain need of systematic approaches that can be used as decision support tools. A typical investment process includes several sub steps. As the steps go forward, the actual costs increase. Each investment selection creates opportunity cost as being consequence of leaving better alternatives. Therefore to avoid unnecessary costs, initial steps, which is called as pre-feasibility, should be focused with more cautious. Especially the investment decision support tools and the preliminary reports are quite beneficial to avoid such costs which are occurring during the detailed feasibility. As stated in the problem definition part, failures have specific characteristics vary by industries. This fact shows that proper selection of the industry and technology is quite crucial for the survival of the investment. Especially selection of accurate areas of technology; creates a great opportunity to construct a better future of companies. This research thesis was inspired by the perceived lack of appropriate solutions to the accurate technology selection problem. In this regard this thesis proposes four different frameworks to qualify the technology selection process.

Stated problems, proposed frameworks and the contribution of each proposed framework has been summarized in Figure 1.1. They all utilize the "patent information" to supply decision support to the entrepreneurs. All the frameworks are developed on the assumption that patent information is the one best indicator of technology changes. The justifications indicating the reasons why patent information is employed is given in Chapter 2.

The developed frameworks include: Construction of "Patent Alert System" (PAS); utilization of Analytical Hierarchy Process (AHP) for trendy technology selection; classification of technologies using fuzzy classifiers; and finally a novel product development framework.

The developed PAS; enables users to set or configure alert(s) for the trend changes in any technology area by using the associated patent data. The second framework; facilitate the selection of trendy technology using patent statistics. The third one utilizes fuzzy classifiers to categorize technology as: dated, classic and trendy. And the final framework employs 5W1H and TRIZ procedure to the selected patents to create novel products. All these frameworks are exemplified by the real cases. In summary, the proposed technology selection frameworks provide several tools and offers some contributions to the current implementations.

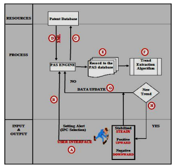
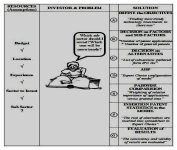
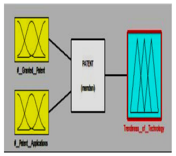
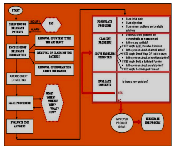
Problem	Framework Title	Thumbnail of Framework	Employed Methodologies	Case Study	Contribution
There is a certain need of a “patent watch system” which enables technology watchers to be aware of any trend changes at the time that trend occurs	Patent Alert System		***XML & Trend Analysis***	√ A visual basic program is available to run proposed framework	This framework presents a visual and responsible patent watch system. The proposed system also has a new trend extraction algorithm.
How to select the trendiest technology to invest in a specific sector using patent statistics?	Trendy Technology Selection Using AHP		***Analytic Hierarchy Process (AHP) & Patent Information***	√ A textile company’s technology selection problem has been solved	This framework is the first AHP model which utilizes patent information.
How can technology be classified using patent statistics?	Technology Classification Using Fuzzy Classifiers		Fuzzy & Patent Information	√ The textile technologies has been classified using TPO’s patent data	This framework is the first fuzzy model which classifies the technology using patent information.
Can a better new product development framework be developed using 5W1H procedure and TRIZ?	A Novel Product Development Framework		***Patent Alert System & 5W1H Procedure & TRIZ***	√ A new banking utility has been developed using the proposed framework	This framework presents a novel product development framework which utilizes TRIZ and 5W1H Procedure

Figure 1.1. The summary of developed framework

1.4 Roadmap for Readers

A roadmap is prepared for readers to follow the thesis easier. The prepared roadmap is presented in Figure 1.2. Thesis starts with the introduction part which is stated in this chapter. Following the introduction; Chapter 2 provides an overview of patent information. Chapter 2 also introduces what the patent information is and how it is used in literature and more crucially this chapter presents the justifications of the related use of patent information through the thesis. Therefore it is suggested for all readers to read this chapter. Chapter 3 details the Patent Alert System (PAS) framework, consisting of inspiring reasons to develop PAS and finally gives the information on the developed software for the implementation of the developed framework. An extensive literature review on investment appraisal techniques and the framework related to "trendy technology selection using AHP" are provided in Chapter 4. Chapter 5 presents "the fuzzy classification of technologies" along with a sample case prepared for textile technologies. In Chapter 6, readers are able to find a "New Product Development Framework" which is developed using 5W1H procedure and TRIZ. Frameworks developed in this chapter also exemplified with the development of a "bank credit system". Readers may read Chapter 3, 4, 5 and 6 separately. However the sequence for the implementation starts with Chapter 5 where trendy technologies are found and continues with the customization of the selection in Chapter 4, and then Chapter 3 is implemented to watch the technology changes in the selected technology and finally Chapter 6 utilizes the alerted patents for new product development.

The outcomes of this research, associated conclusions and recommendations for further studies are summarized in Chapter 7. Relevant information and data are given in the Appendices.

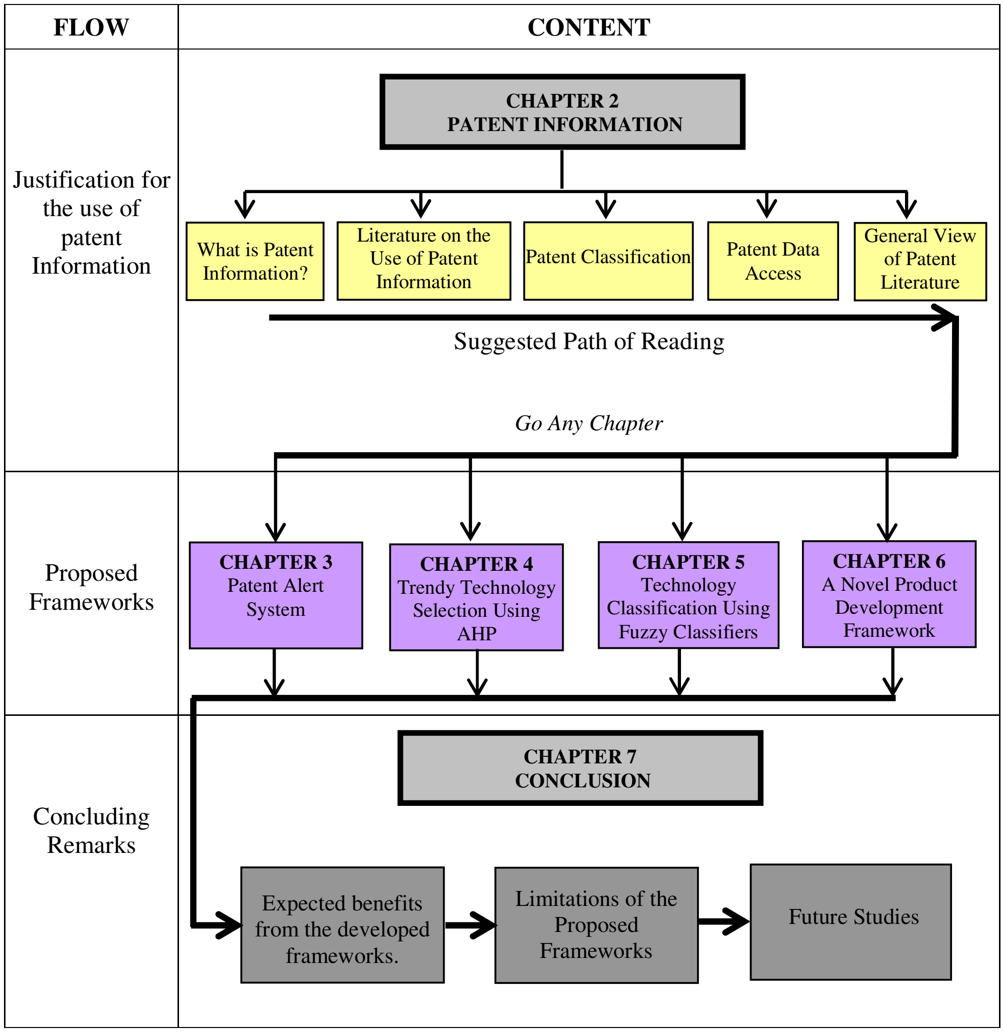


Figure 1.2. The roadmap of the thesis for the readers

1.5 Software Used in the Thesis

Through thesis several methodologies and software are employed to obtain solutions. In Chapter 3, Visual Basic 6.0 platform was used to develop software for running the PAS framework. For the application of AHP presented in Chapter 4, Expert Choice 11 is utilized. In Chapter 5, Matlab 8.0 and its fuzzy tool box and SPSS's "C-mean cluster" module has been used. The reasons for the use of these soft wares through several alternatives will be given in related chapters.

1.6 Conclusion

With this thesis; the conceptual gap in the literature and the lack of appropriate theoretical frameworks of technology selection is filled by the research reported in this thesis. Through thesis original theoretical frameworks of technology and investment selection are presented. The reliability and validity of the developed frameworks is tested by the case studies presented and it is understood that these frameworks can appropriately used to select technologies and investments. The original theoretical frameworks and methods are simple enough to be used by any entrepreneurs who have at least a formal level education in the relevant technology areas. Frameworks are also robust enough to be used in a wide range of industry area for the selection technology.

CHAPTER 2

PATENT INFORMATION

"There are two major problems using patents for economic analysis: classification intrinsic variability. The first is primarily a technical problem. How does one allocate patent data organized by firms or by substantive patent classes into economically relevant industry or product groupings?"

Griliches, 1990

2.1 Introduction

In the literature there have been numerous studies which are conducted on the patent data/information for different purposes. While some studies purely enclose technical or legal analysis, most of them are related with business issues linked to matters of technology or market. All of these studies compose a spanning literature on patents. Patents literature covers studies on philosophy, history, economics, law, and political science. Throughout this chapter, this wide spanning literature on patents and more specifically the use of patents as technology watch instruments is reviewed. The chapter begins with definition and the classification of patent information and then expends to describe a general view on the patent literature. The chapter then examines the patent classification systems and finally issues the free online patent information sources and their specific properties.

2.2 Patent Information

In today's highly competitive environment, technology has become the most important weapon of enterprises. Acquiring competitive advantages can only be succeeded through management of innovation and technology. Different source of data and their processed form - information- can be employed to manage these important processes. Thus, intelligent selection of the information source along with valid framework is essential to reduce the failure risk of wrong technology selection. Using a valid framework is not easy and requires expertise in some fields of technology management like: technology identification, technology assessment, technology watch, technology forecasting and technology mapping. The gathered and processed data through a framework can be used to formulate a technology vision and strategy.

Patents are the documents which protect an inventor's invention by a particularly given monopoly, so that others can't duplicate and commercialize it. Patent documents enclose an archive with millions of papers. These papers witness the progress of technologies through the history. Therefore patent documents are one of the most valuable and rich technology information resources.

World Intellectual Property Organization (WIPO) defines patent information as the "all related information arose from a patent system" (www.wipo.int/edocs/mdocs/sme/en/wipo_ip_bis_ge_03/wipo_ip_bis_ge_03_13-main1.pdf). European Patent Office (EPO) defines it as the technical information which can be found in patent documents, plus any legal information about them (http://www.epo.org/patents/patent-information/about.html). The information included in a patent system has different extensions. In literature, there is also infancy on the classification of patent information. However patent information practically can be grouped as: direct and indirect information. Direct patent information is the information which can be easily accessed just by reading a patent. On the other hand indirect patent information is the information which is extracted from patent documents by the use of further analysis. The Table 2.1 shows what type of data can be included in direct and indirect information.

Table 2.1 Examples of direct/indirect patent information

Direct Information	Indirect Information
Patent Title	Number of Patents Owned by the Same Country Citizens
Patent Number	Number of Patents Owned by the Same Applicant
Patent Filing	Number of Patents Owned in a Specific IPC Section
Patent Issue Dates	Number of Citations per Patent
Inventor Name	Number of Patents per Companies in a Specific Industry
Applicant Name	Number of Patent Applications per Innovation Expenses
Assignee Name	The Quality of a Patent
IPC Classification	The Number of Claims per Patent
Description of the Invention	The Number of Pages per Patent
Priority Date/ Country	The Number of a Specific Word Repeated in Patents
Patent Abstract	The Number of Patents Applied by the Same Applicant
Patent Citations / References	Research and Development Trends
Patent Claims	Industry Trends
Drawings	R&D Activity Cycle Times

These patent classes can be renamed using different phrases as the Gibbs (2007) does in his non-literature article. Gibbs classifies the patent information as: explicit and implicit data. Explicit information refers to indirect patent information and implicit does it for direct information.

Indirect patent information examples can be extended with many other statistical outputs. It should be noticed that indirect patent information can also take several forms like tables, graphs, charts and maps.

There are several good reasons which make the use of patent information such attractive. Direct patent information is structured information and does not have variability due to its formatted and unified content. It is also easy to obtain and can be collected via free online access. The unified and hierarchical classification of patents in accordance to industries also creates a serious advantage. The most important advantage of patent information can be obtained by the right use of data. Table 2.2 shows the list of possible benefits of the patent information prepared by WIPO.

Table 2.2 Possible benefits of patent information

(Source: www.wipo.int/edocs/mdocs/sme/en/wipo_ip_bis_ge_03/wipo_ip_bis_ge_03_13-main1.pdf)

	What can we get?	**What can do with these?**	**Where we get?**
Technological Information	• Technology development trend • Core technology • Basic Patent • Technology relation • Technology distribution status	• Selection of research theme • Decide R & D direction • Forecast new product	• Description • Abstracts • Classification
Administrative Information	• Business Technology Trend • Product development trend • Research management trend • Market share status • Company relationship • Estimate market size • Agency activity status	• R&D management benchmarking • Establish R&D strategy • Establish patent management strategy • Technology trade strategy • Human resource handling	• Assignee • Inventor • Period of patent rights • Patent family • Cited patents
Rights Information	• Patent Claims • Patent registration • Possibility of Infringement • Legal status • Licensing, buying, selling	• Decide whether a patent applies or not. • Handling claim	• Claims • Core technology contents of patent • File wrapper • Examination process

2.3 A General View of Patent Literature

The extended interest on patents makes it an obligatory to categorize the patent literature. In literature there is still infancy on classification of patent studies.

As a well intentioned work, “World Patent Information” (WPI) journal lists the improvements in the literature on each of its issues. The literature is divided into categories through the list given by WPI journal. These categories are presented in Figure 2.1. The intellectual property (IP) literature has been divided into two main categories as: books and journals. Journal articles include seven subcategories where one is “Patents”. Journal articles about patents are divided into four main categories: Relating to life sciences and pharmaceuticals, relating to software policy and strategic issues and other patent topics.

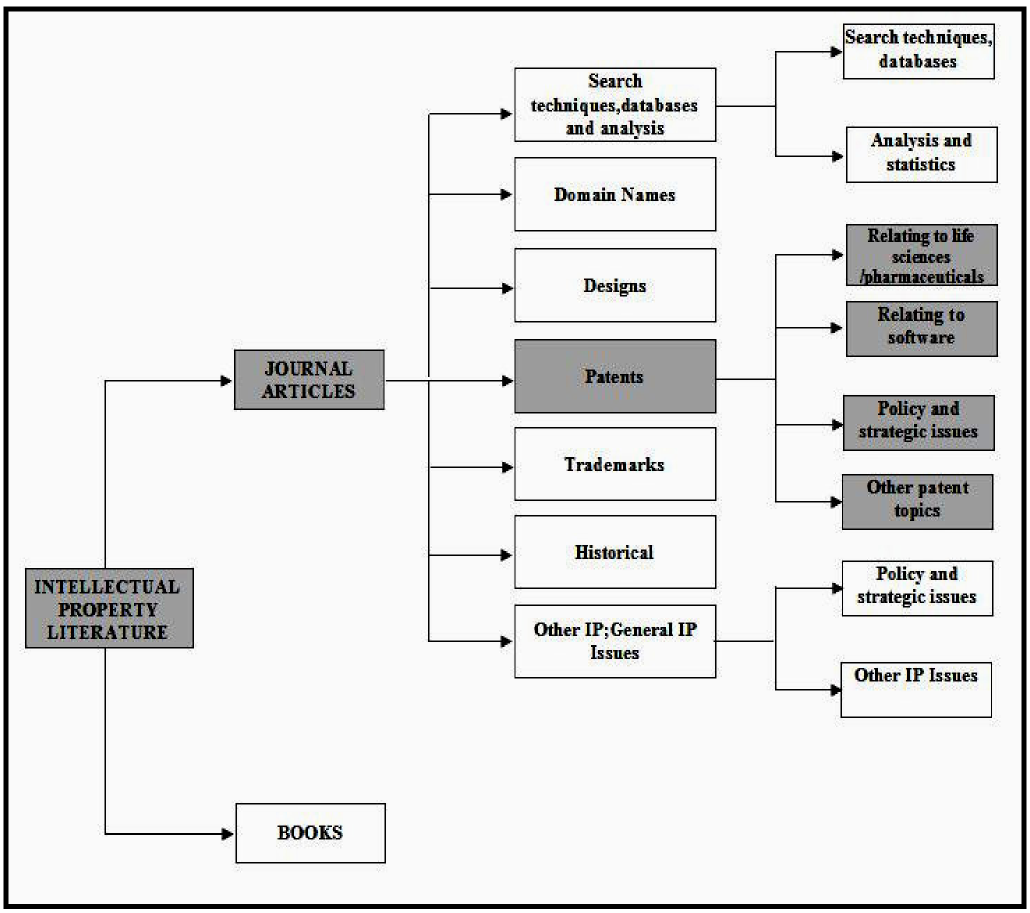


Figure 2.1 Classification of patent literature

2.4 Literature on the Use of Patent Information

The rapid changes in the technology have transformed the structure of competition in business world. With the change in technology, more opportunities are created to invest. A deeper understanding of technological change has been an essential need to avoid unnecessary investment and beyond to find promising investments. Thus understanding technology, forecasting and tracking technology has become extremely important for managing technology.

Since patents are the documents which are one of the best economic instruments for inventors to keep control of their novelties (Mazzoleni and Nelson, 1998) patents have been treated as the most important output indicators of innovative activities (Frietsch and Grupp, 2006). They have become the focus of many tools and techniques to measure innovation and change (Belderbos, 2001; Pilkington, 2004; Hanel, 2006). Some certain advantages of patent data like: containing standardized and structured data relating to new technological developments as well as being freely available, made it a trendy source of information.

Many methods have been developed to recognize progresses of technologies, and one of them is to analyze patent information (Kim et. al, 2007). Patent data represents a valuable source of information that can be used to plot the evolution of technologies over time (Pilkington, et al., 2002). Therefore, patent information and patent statistical analysis have been widely used for examining present technological status and for forecasting future trends (Wu and Lui, 2004). Mogee (1991) applied his patent analysis results to the technology analysis and planning of a corporation. Berkowitz (1993) analyzed how to make proper patent strategies to achieve and maintain competitive advantages under the process of technology development, while Hufker and Alpert (1994) discussed the various situations for applications of patent strategy from a managerial perspective. Ernst (1997) used patent information for technological forecasting. Campbell (1983), Breitzman and Mogee (2002), Jung (2003) also analyzed the patents to show technological details and relations, reveal business trends, inspire novel industrial solutions, or help make investment policy.

Recently, Corrocher et al. (2007), show in their work that high opportunity in ICT (information and communication technology) applications, results high growth of patenting activities. Dou and Bai (2004) present how the recent “Avian Influenza” disease affected investments and patenting activities around the world. Scheu et al (2006) also indicate the expectation of increase in the number of nanotechnology patents as the consequence of large public and private investments in new technologies at the nanoscale. All these studies and many other similar ones (ie: Bengisu and Nekhili (2006), Waguespack (2005)), have proposed a correlation between patenting activities and technology.

On the contrary; there are some concerns about the ability of patent information to indicate current research and development (R&D) activities. Ashton and Sen (1988) claim that although patent information is the unique source on the determination of technology there are some limitations on the use of patent information. They categorize these limitations in two ways. First one is about time duration between application and granting process. They propose that during the granting process most of the novel product or process changes have been already implemented. Therefore the whole picture of technology can not be taken for a certain time. Second reason is about the products or processes which can/did not patented for some reasons. There may be several reasons why an innovation was not patented. The innovations may not be technical, new or perhaps inventive to be patented or the patentable ones may not be patented for economic reasons (McQueen and Olsson, 2003). There are also some cases (Takalo and Kanniainen, 2000) where the companies are not sure about the concrete use of their innovation. Therefore, some companies may decide to keep their options open for the future and may ask for patent protection later. Also some companies prefer to keep innovations as trade secrets. Arundel and Kabla (1998) presents a supportive finding about low propensity rates (percentage of innovations for which a patent application is made). According to their findings, in Europe only 35.9% of the products and 24.8% of the processes is patented.

Although these debates continue to exist, it should be noticed that current researches have shown that the best way to measure innovations is to use patent application data. Several scholars rely on patent count data and use them as the measure of innovation and technology (i.e. Sorenson and Stuart 2001, Rosenkopf and Nerkar 2001, Acs, Anselin and Varga 2002, Katila 2002)

2.5 Patent Classification

Literature searches show that there is numerous numbers of papers on patent activities. Each paper in literature has different scopes. Some of the studies are based on country statistics (Kronz and Grevink, 1980; Kronz and Grevink, 1986; Jialian, 1994; Rajeswari, 1996; Kutlaca, 1998; Marinova, 2001; Wanise et al., 2003; Álvarez and Antolín, 2007, Rezapour et al., 2007) and some others focus on industries or some certain technologies (Hemphill, 2007, Allred and Park, 2007, Levitas et al 2006, Storto, 2006, Reitzig, 2003). All of these researches benefit from several different patent classification schemes. Each classification scheme uniformly classifies the patents according to the technologies employed in the inventions. The classification schemes differ according to purpose of use or according to institution which grants the patent.

One of the well known and most used classification schemes is "International Patent Classification" (IPC). IPC system is a hierarchical system in which the whole area of technology is divided into parts as sections, classes, subclasses and groups. Each of these parts corresponds to an industry and a technology in the relevant industry. IPC includes eight sections designated by one of the capital letters A–H. Eight sections are subdivided into 118 classes; the classes are subdivided into 624 subclasses, then subclasses are subdivided into over 67,000 groups. The full list of these sections, classes and subclasses is presented in **APPENDIX A.**

The first edition of the IPC was established pursuant to the provisions of the European Convention on the International Classification of Patents for Invention of 1954 (http://www.wipo.int/classifications/ipc/en/). IPC entered into force by the sign of the Strasbourg Agreement and then published on September 1, 1968. The Classification has been periodically revised in order to improve the system and to take account of technical development. The first two editions of the IPC were in force from September 1968 to June 1974 and July 1974 to December 1979, respectively. Thereafter, new editions have entered into force at 5-yearly intervals; the third on 1 January 1980, the fourth on 1 January 1985 and so on (Adams, 2000). On 1 January 2000 the seventh edition and most recently, in January 2006, the eight edition has been introduced. There have been some structural changes with the reform. Wongel, (2005) summarizes these changes as follows:

- Split into core and advanced level.
- Creation of a Master Classification Database (MCD).
- More frequent revision: every three months instead of every five years.
- Reclassification of the back file.

The IPC has now existed for 33 years and is the only truly worldwide classification system for technical information (Stembridge, 1999). Apart from the IPC, several major patent offices still use national classifications. Various attempts have been made to provide concordances between them, with (Adams, 2000) varying levels of success.

United States Patent Office (USPTO) implements a different classification system which organized very differently. The USPTO classification system is divided into two categories: a class and a subclass. Representation of the class and subclass varies by the type of patent. The US Classification System is also extraordinarily large consisting of some 400 classes, and 136.000 subclasses. USPTO also reclassifies patents regularly and continuously updates the classification system.

2.6 Patent Data Access

The increasing use of the Internet has also included the establishment of several Web Sites for patent information retrieval. The utilities created by these online databases made it available to access patent data at any time and at any anywhere. Anyone who can access to the Internet has been able to search for a patent and read the full text of published patent documents. The list and web addresses of these web sites are given in Table 2.3. Some of these web sites provide service just for a specific area like serving for chemistry patents or machinery patents. Some information providers also require payment for the service. Corporations such as IBM provide the site and generate profits for the supplier of patents that they promote. There are also other private companies that provide commercial databases. Derwent, Dialog, STN, Questel Orbit, Micropatent, WIPS, etc are some examples of these commercial services. Commercial services offer patent information with more details based on some particular analysis required by the end users.

Many of national patent offices such as the TPO (Turkish Patent Institute), USPTO and the Canadian Patent Office provide information as a public service. The full-text and full-page image database of the United States Patent and Trademark Office (USPTO) is one of the earliest and free online patent information services. Another major on-line free patent database is esp@cenet, which has some 30 million patent documents. The free services work well for simple searches, based on key words, such as a known patent number, name of the inventor(s) or applicant(s), a key word in the title, etc., but are not a suitable tool for executing more complex investigations and legally motivated searches. As access to these kinds of databases is not restricted across national borders, so users worldwide can very easily access patent documents from a computer connected to the Internet.

Table 2.3 List of online patent databases

Name/ Properties of Database	Web URL
U.S. Patent Office	www.uspto.gov
Turkish Patent Office	http://online.tpe.gov.tr
Lexis-Nexis	www.lexis-nexis.com
Dialog Corp.	www.dialog.com/info/products
FIZ Karlsruhe: This German corporation provides access to many databases in Europe and worldwide.	www.fiz-karlsruhe.de
IBM Patent Server	www.patents.ibm.com
Chemical Abstracts: This will enable one to determine which databases are available for use in Chemical Searching.	www.cas.org
Corporate Intelligence: This database will also allow for Trademark Searching.	www.corporateintelligence.com
Derwent	www.derwent.co.uk
Micro Patent	www.micropat.com
Questel-Orbit	www.questel-orbit.com
RAPRA Abstracts: This database is prepared by the Rubber & Plastics Research Association, and is quite thorough and specific to this field	abstracts.rapra.net

2.7 Conclusion

In this chapter a general review on patent information has given. The remarkable spread of patent applications and expanding patent literature are the significant evidences of the importance of patent information. Of course there exist some dilemmas for the technology owners and developing countries. These dilemmas can be questioned as follow and can be issued in the future works.

- Why should a firm declare technological advances to the public? Since patent documents are accessible from anywhere in the world, can the innovation be protected against the producers in those countries which do not have patent protection laws?
- Since the product life cycles are shortened; product may die, before a patent is granted (granting process takes 12-24 months) and then why should a firm pay for a patent application for a dying product?
- Since patent laws are created for the owners of the technology should the developing countries obey the patent legislation?

The last question has been answered by the PhD. thesis written by Moser (2003). She has stated the fact that the countries without patent laws are innovating more then the others. In this thesis this claim is not supported nor it is not ignored, this thesis does more and claims that technologies have fashions and trends, therefore the ones which can foresight these trends may create a better future for its company and patent information is the one best source for it.

CHAPTER 3

PATENT ALERT SYSTEM

"... enlist the aid of every organization out there to alert the general public of everything going on."

Tom Tancredo

3.1. Introduction

This chapter presents a web-based *"technology watch system"* called: *"Patent Alert System" (PAS).* It enables users to set or configure alert(s) for the trend changes in research area as well as the possible trend changes in the technology of the requested sector by using the associated patent data. PAS retrieves the free publicly-accessible databases on the Web and records the counts of newly issued/applied patents for the selected IPC (International Patent Classification) section. Patent count data is captured and updated periodically with the XML (Extended Markup Language) technology.

An online trend-extraction algorithm is developed to search the trend changes within the captured patent data. The algorithm initially fits a constant line for the counts of patents and then calculates the deviation between the fitted and real value. If the cumulative deviation is more than the predetermined threshold value, then a new line is searched by using the regression analysis. If no trend change is found, the algorithm halts until the database is updated. As soon as a new data captured by the system, the trend-search restarts. This loop is repeated in each update. Trends found in the patent data express the time evolution of patent and technology with the symbols such as *upward (+), downward (-)* and *steady (stabilized)*. They are used to generate "alerts" which are then forwarded on-line to the people who requests/sets the alerts. A visual basic program is prepared to run the proposed system (PAS).

The rest of this chapter is organized as follows. The relevant literature and an introduction to PAS are presented in Section 3.2. Description of the PAS and the steps included in -PAS- will be described in Section 3.3. In Section 3.4, trend extraction algorithm and an example for the given algorithm is presented. The conclusions and contributions obtained with this chapter are discussed in Section 3.5

3.2 Literature and Development of Patent Alert System

The data used in most of the patent studies only cover those patents that are issued in a certain time period, in a specific sector or within a geographical location. McAleer et al. (2007) state that these types of analysis are likes "taking snapshot images of patenting activities". Some examples of these types of studies can be seen in Pavitt (1988), Pateland and Pavitt (1995), Griliches (1986), Marinova (2001). Thousands of new patent documents issued in every working day worldwide, use of computerized analysis incorporating quantitative indicators is necessary to understand the implications of this technical output (Narin, 1994). This dynamic nature of patenting has forced to use of fresh and updated data in any kind of patent analysis. The recent availability of Internet-based abstract services and patent databases, allowing easy access to documents in electronic form has made the application of bibliometric techniques for technology forecasting quite practical (Morris et al., 2002). This opportunity can be turned into a great advantage using new web technologies. These new web technologies have enabled to access a certain data automatically, capture it and manipulate it as desired. One of the most known of these technologies is XML (Extended Markup Language). XML is a technology that is reshaping data exchange throughout the world and bringing with it new possibilities for searching and handling data (Pilch and Shalloe, 2005).

It has been recognized that there is still a strong need to develop a system which:

- use fresh patent data that is continuously updated
- monitor patenting activities
- search the trend changes in the patent data
- alert users (managers, investors) immediately upon significant changes

The opportunities created by the advances in web technology along with above goals have created an idea of developing a *trend-based Patent Alert System (PAS) for technology watch.* The evolution of the development and its contribution is summarized in Figure 3.1.

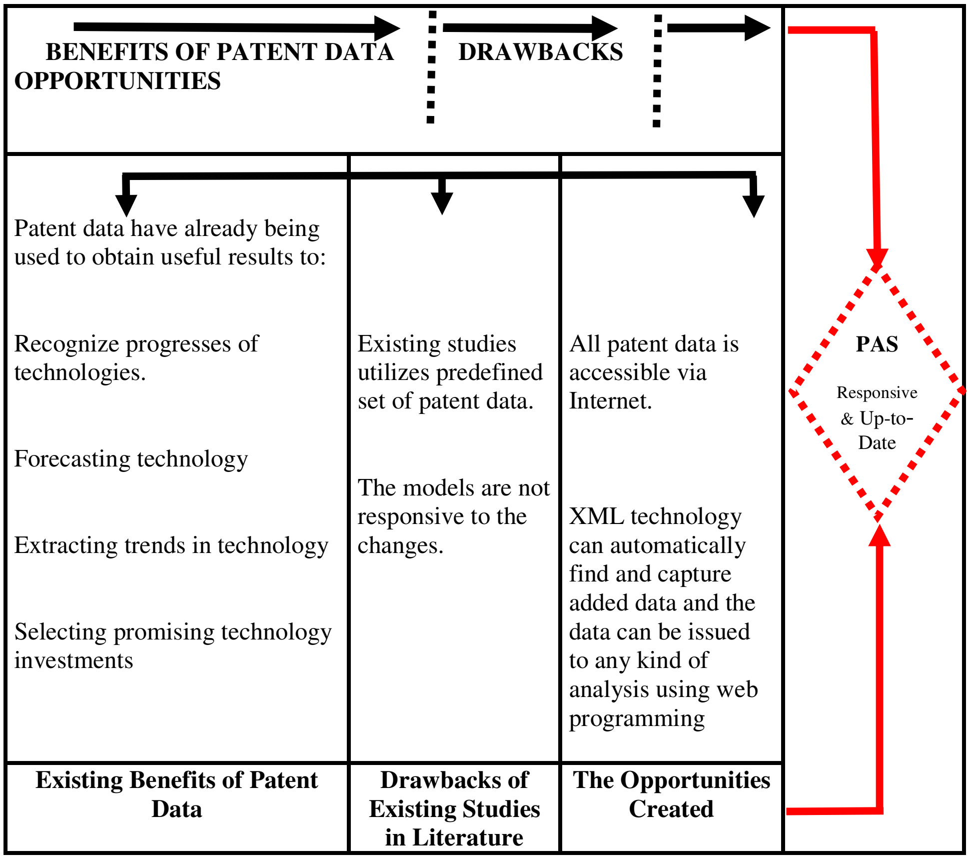


Figure 3.1. The evolution of the PAS

Patent Alert System (PAS) is a responsive alert system which uses the fresh patent data to search trend changes in patenting activities. PAS behaves like an alarm clock and an analogy can be established between an alarm clock and the PAS. Initially the users should set the alert for *a trend change* in the patents of an IPC (International Patent Classification) section and class-subclass. It is like setting an alarm clock to a specific time to respond. Continuous check and update of retrieved patent data using XML can be matched with the continuous flow of the time in the alarm clock. Similarly; forwarding an alert to relevant decision makers is identical to ringing of alarm in the alarm clock. These analogies are summarized in Table 3.1.

Table 3.1. The analogy between alert clock and PAS

Alarm Clock	Patent Alert System (PAS)
Setting the alert to awake in a certain time	Setting alert for any kind of trend changes in a selected section/class of patents.
Continuous flow of time	Continuous check and update of retrieved patent data using XML.
Software used to track the correct time to ring the alert.	Application of online extraction algorithm to find trend changes.
Ringing Alert	Forwarding alert to relevant decision maker.
Ringing Tone	Expressing the time evolution of patent and technology with the symbols such as increasing, decreasing, steady.

PAS is a technology watching system which uses trends as the indicators of the change in technology, and acts like an alert system. The users, who want to keep track and monitor the trend changes in patenting activities, can set the alert. It makes use of the XML (Extended Markup Language) to capture and update the patent data from the publicly accessible patent databases. The captured data is tested for the trend changes in technologies requested in the alert. An online trend-extraction algorithm is developed to search the trend changes within the captured patent data. The algorithm fits a constant line for the counts of patents and then calculates the deviation between the fitted and real value. If the cumulative deviation is much more then the predetermined threshold value, then a new line is searched by using the regression analysis. This loop is repeated in each update. Trends found in the patent data expresses the time evolution of patent and technology with the symbols such as *upward, downward* and *steady*. They are used to generate “alerts” which are then forwarded on-line to the people who requests/sets the alerts.

The trend-based patent alert system developed in this chapter can be used by several decision makers with the different objectives. Some of them are outlined as follows;

- to evaluate the value of existing technologies
- to decide upon whether owned technology is trendy or not?
- to find promising technology-related investment areas
- to avoid unnecessary investment.
- to be informed from trendy research topics
- to establish a long-term strategic plan including technology planning

3.3 Description of the System

The overall information flow of the PAS has been illustrated in Figure 3.2. The first step in the flow of the alert system is the configuration (setting) of alert by the user. The relevant IPC section, class and the subclass of the patents to be watched are selected by the alert initiator (the user) through the use of interface (Figure 3.2-A). The requested alert is then transmitted to PAS engine (Figure 3.2-B). PAS retrieves the relevant database by using XML (Figure 3.2-C) and the patent count data for the selected IPC section, class and the subclass is captured (Figure 3.2-D) correspondingly. The next step is the recording of the captured data to the own database of the PAS (Figure 3.2-E). An online trend-extraction algorithm is employed to search and find the trend changes in the captured patent data (Figure 3.2-F). If a trend change is found, the user is immediately alerted by following indicators (Figure 3.2-H); “stabilized (steady)” “positive (upward)” or “negative (downward)”. If there is no trend extracted then the loop is repeated in each update (Figure 3.2-G).

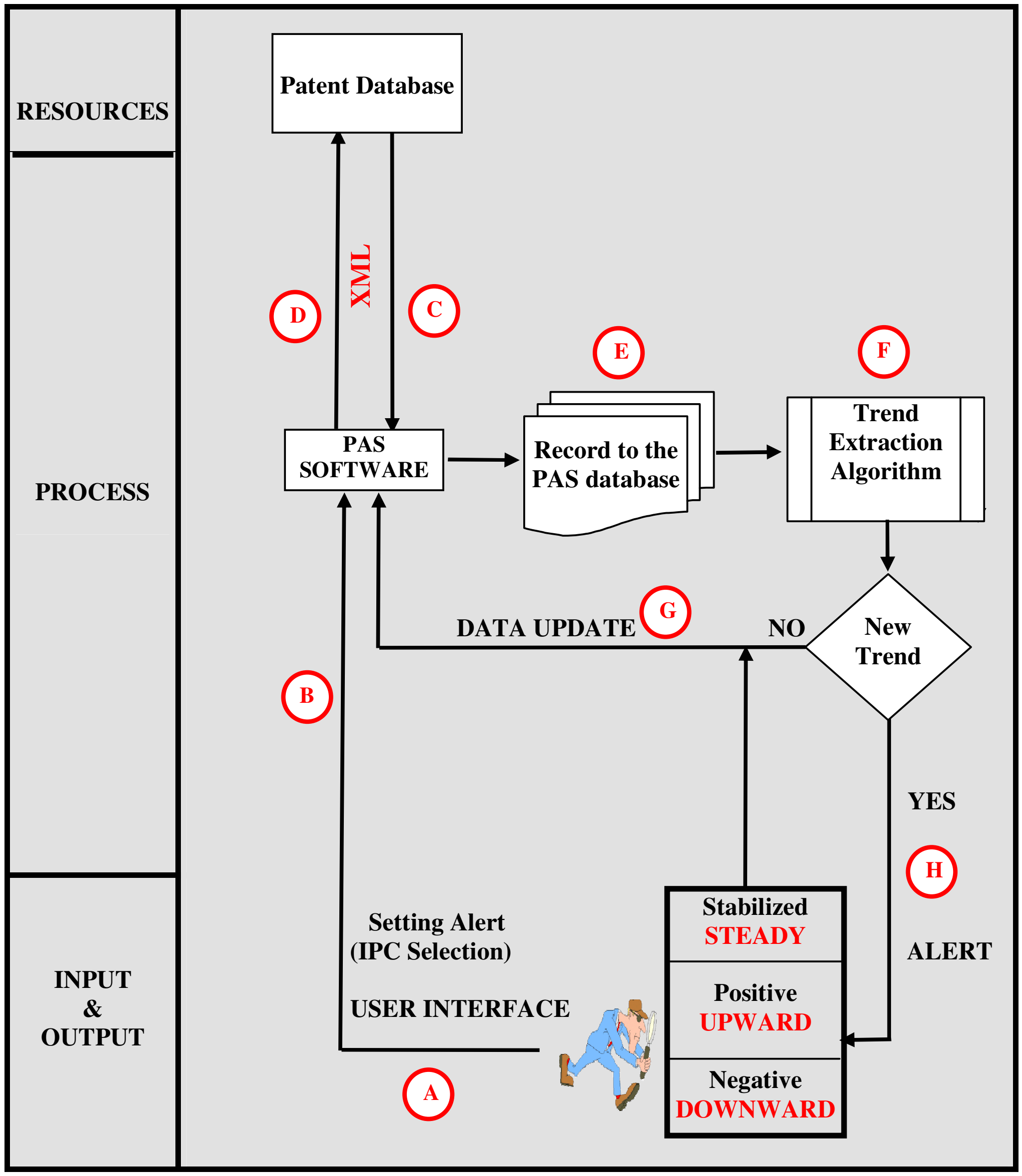


Figure 3.2 Overall flow of information in PAS

3.3.1 Alert Configuration

The patent studies may benefit from existing classification scheme of World Intellectual Organization (WIPO). WIPO introduced the "International Patent Classification" (IPC) system by Strasbourg Agreement in 1971. IPC system is a hierarchical system in which the whole area of technology is divided into a range of sections, classes, subclasses and groups the patents according to their scopes (http://www.wipo.int/classifications/ipc/en/). The IPC has now existed for 33 years and is the only truly worldwide classification system for technical information (Stembridge, 1999).

IPC system has been periodically revised to respond changes in the technology environment. Recently, the eighth edition of the IPC has entered into force by January 1, 2006**.** Last update covers eight sections denoted by the letters from A to H. Each section refers a technology area and covers subclasses to define *technology niches* more precisely. Since publicly accessible databases cluster the patents by using IPC codes, PAS also retrieves the data for configured alerts by the relevant IPC codes. Figure 3.3 presents the user interface of PAS which is prepared for alert configuration of the users. Configuration an alert includes the following steps:

1. *Assignment of a unique alert number*
2. *Giving a unique alert name*
3. *Selection of the IPC section to be monitored*
4. *Selection of the IPC class of the selected IPC section*
5. *Selection of the IPC subclass of the selected IPC class*
6. *The selection of search space (use of issued patent data or use of applied patent data)*
7. *Selection of responsiveness sensitivity*
8. *Selection of the database*
9. *Selection of the alert forwarding method*
10. *Saving the alert*

It should be noted that the configuration of the alert determines the quality and type of the benefits which can be obtained from the PAS. For example, it is a known fact that there is a certain *time gap* between the application and completion of patenting process. Therefore, if one chooses “applied patent data” as the search space; it may be more informative about the future as compared to the use of “issued patent data”. Although it is left to preference, not all of the patent databases include and publish the patent applications (such as database of USPTO) (Frietsch and Grupp, 2006). Therefore, in such circumstances the alerts are disabled for “applied patent data”.

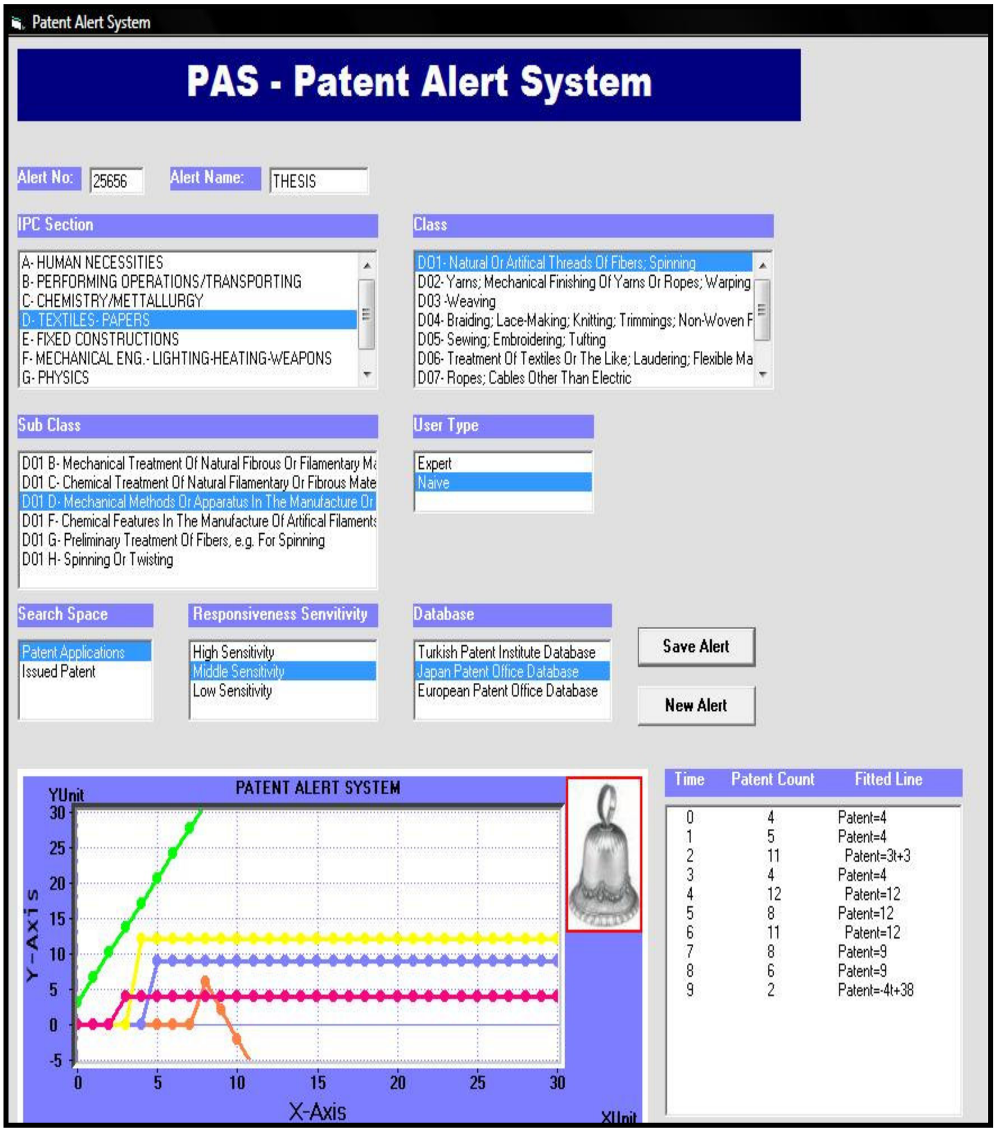


Figure 3.3 User interface of PAS for setting alert

3.3.2 Data Capturing

Patents are seen as a rich, but often insufficiently utilized source of technical information. Much effort have been undertaken to popularize and promote the use of patent information. A central element of these activities was the launch of freely-accessible databases on the Internet (Schwander, 2000; Dulken, 1999). These freely-accessible databases made it much easier to chapter on patents. However, the opportunity of "freely accessible databases on the Internet" has not absolutely solved the problem of analyzing continuously changing patent data. A new era has been initialized in the patent analysis with the three very specific developments defined by Pilch and Shalloe (2005):

- The IPC reform
- XML
- MIMOSA retrieval software with its new internet functionalities

IPC reform launched on 1st January 2006; has been a revolution for the classification of patents. IPC enabled easy modification for the possible changes in future and the adaptation of existing data to the electronic environment. The second development was the use of XML. XML has been developed as a web technology which enables the capture of structured data in the electronic environment. Development of MIMOSA software is another advance which made it easier to access databases over the internet and to load the required data (Pilch and Shalloe 2005).

PAS (Patent Alert System) presented in this chapter used XML to capture the data from the patent databases in Internet. Having connected to the relevant patent databases by predefined queries and filters, the patent count received in the selected IPC code is recorded to the own database of the PAS which is located in the server. The PAS enables users to select database to be used in *trend analysis*. Database (search space) options are also shown in the interface of the PAS (Figure 3.3). In this way, the trend changes can be watched across the countries by setting different type of alerts. Data provided by patents properly processed offer a valuable source of information useful to keep track of the evolution of the technological strategy of firms and to make comparisons (Storto, 2006). This utility (of the PAS) for comparative technology watch creates opportunities to make comparative analysis among the countries. The users may benefit from this comparison to draw conclusion about the technological differences in between the countries.

An example for the relative trend analysis between two countries is given in Figure 3.4. As it can be seen from Figure 3.4, the PAS enables to monitor and compare the alerts which are configured by the users previously. This is one of the most outstanding properties of the PAS developed in this chapter. As illustrated at the bottom right of the snapshot (Figure 3.4), the alert-10 and the alert-15 are evaluated which were configured by the users for Japan and US patents, respectively. The alerts for both Japan and US patents ascertained in the compared pairs of periods are shown in the summary table of the screen. Here, "U" denotes a new upward trend while "D" stands for a new downward trend. It should also be noted that the only comparable alerts (i.e. periods to be compared should be equal) can be compared with each other within the PAS system.

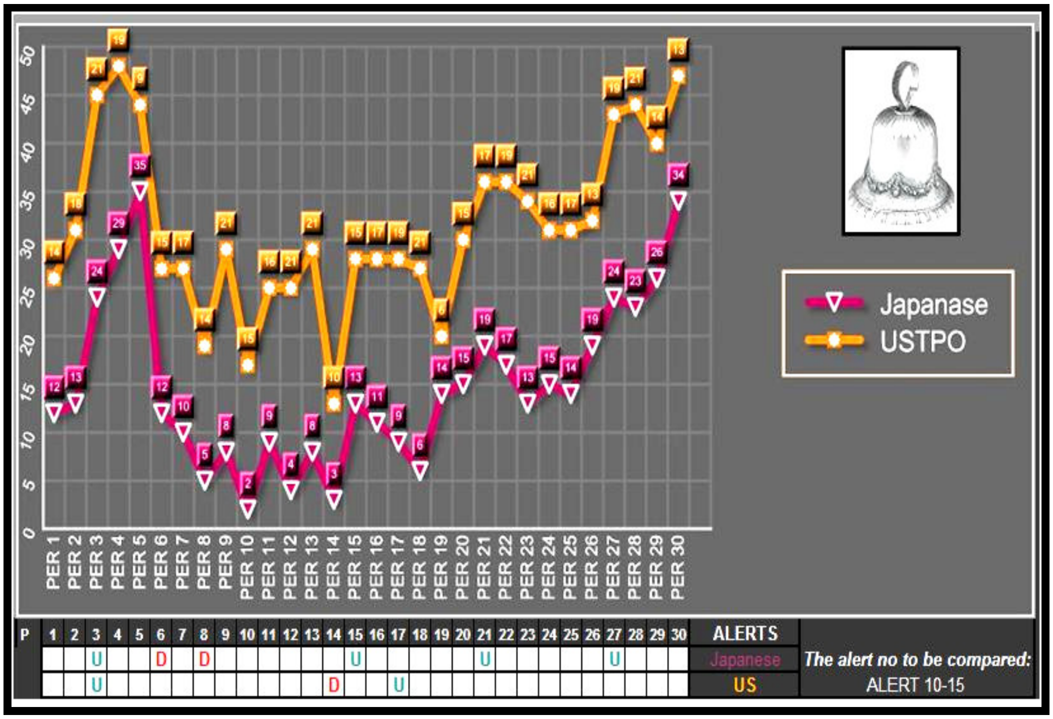


Figure 3.4 Screen of PAS for the comparison of alert 10 and 15

3. 4 Trend Extraction Algorithm

Technology foresight, *using the tools of knowledge and information management, based on primary and secondary sources,* is extremely useful in arriving at an understanding of the state of the art of a given sector, with the goal of generating value-added information about technological and market trends and thus feeding the cycle of the creation of new wisdom (Canongia et al., 2004).

Since patent publications are listed in databases, these publications can be used for statistical purposes to provide a general view of worldwide technical activity.

The analysis on the patent information can be performed by means of several different methods. Analysis on the issued or applied *patent counts* can be used with the scope of decision-making and can create value-added information, while they are expected to bring a light into certain understanding of the past and can be used for estimating the future. In this chapter, trend analysis has been used to create alerts which react upon the change in the direction of the patenting activities monitored constantly. A trend is known as the general tendency or the direction in a collection of data. Trend analysis is a useful approach to extract information from numerical data and represent it symbolically, in a qualitative or semi-qualitative way and its objective is to convert on-line numerical data into knowledge usable for operator support (Charbonnier et al., 2005).

A trend extraction algorithm is developed in this chapter to search the trend changes within the monitored technology. The algorithm initially fits a constant line for the counts of patents and then calculates the deviation between the fitted and real value (of patent counts). If the cumulative deviation is more than the predetermined threshold value (responsiveness parameter discussed in the following section), then a new line is searched by using the regression analysis. If no trend change is found, the algorithm halts until the database is updated. As soon as a new data captured by the system, the trend-search restarts. The trends found in the patent data express the time evolution of patent and technology with the symbols; *upward (+), downward (-)* and *steady (stabilized)* as illustrated in Figure 3.2. They are used to generate "alerts" which are then forwarded on-line to the people who requests/sets the alerts. A step by step explanation of the methodology developed for extracting the trend changes from counts of patents/applications is given below. The pseudo code of the algorithm is given in Table 3.2. The summary of the written Visual Basic program is also presented in Table 3.3.

Table 3.2 The pseudo code for trend extraction algorithm

STEP 1 – Initialization of trend change extraction algorithm: The first value of the patent count captured for the "alert" configured by the user is assigned as the initial hypothetic line

P(t) = R(t=0) (As initial step);

Where;

t: Indicates the period number (it depends on the update frequency of the patent databases requested by the users) and starts with zero and increments one in each update.
P(t): Hypothetic line which sets the patent count.
R(t): Real patent count captured in time t

STEP 2 – In each data update, the deviation (dev(t)) and is cumulative deviation (cumdev) calculated between the hypothetic line and the real value (captured) obtained.

dev(t) = P(t) – R(t)
Else cumdev(t)= cumdev(t-1)+ dev (t)

STEP 3 – If the cumdev(t) is more than the previously determined threshold value (th), then a new linear model is fitted by using "linear regression".
Else; update the patent data under consideration and go to STEP 2.

If absolute cumdev(t)> th then linear regression is run and a new line is fitted as and cumdev(t)is set to zero.
P(t)= a(t)± b

STEP 4 – If there is a change in the model, this trend change is forwarded to user as an alert using one of the following indicators:

Downward Trend: If a < 0 ➔ negative (-)
Upward Trend : If a > 0 ➔ positive (+)
Steady Trend : If a = 0 ➔ stabilized

Table 3.3 The algorithm used in PAS

```
BEGIN;
z = 0;
th= m;
cumdev(t=0)=0

   UPDATE {RETRIVE FROM DATABASE}
            R (t=z)= RETRIVED_DATA,
                  If z=0 then P(t)= R(t=0),
                        z=z+1,
                        go to UPDATE;
                  Else go to GENLOOP

    GENLOOP
               dev(t=z) = R(t=z)- P(t)
         cumdev(t=z) = cumdev(t=z-1)+ dev (t=z)

               If absolute of cumdev(t=z)> m then go REGMOD
                    Else
                    z=z+1 and go to UPDATE

    REGMOD
            P(t)= a(t)+ b {Regression by least squares of error
method}
            cumdev(t=z)=0 and go to ALERT

    ALERT   If a<0 then forward a "downward (-)" alert
                    a>0 then forward an "upward (+)" alert
                    a=0 then forward a "steady" alert
               and go to UPDATE
END IF ALERT IS OFF.
```

3.4.1 Specification of Threshold Value (*Th*) for the Trend Extraction Algorithm

As discussed above, the trend extraction algorithm uses a *threshold value* (denoted by *th in the trend extraction algorithm*) for initializing the trend search within the patent counts being considered. Threshold value is actually a *responsiveness parameter* of the trend extraction algorithm which is one of the central parts of the Patent Alert System (PAS) presented in this chapter. The searching of new linear models is started when *the deviation between the fitted and real value of patent counts* exceeds the threshold value.

The responsiveness level (sensitivity) of the system is determined or adjusted by the users configuring the alerts through the use of *user interface* shown in Figure 3.3. Three options for the responsiveness sensitivity are provided/suggested by the system; high, middle and low sensitivity. If *"high sensitivity"* option is selected by the user; "1" is assigned to the threshold value. This means that any deviation in patent count will lead a new trend search. If *"middle sensitivity"* or *"low sensitivity"* options are selected by the users; the threshold parameters are assigned based on *"average number of patents issued in the indicated patent section/class or sub-class"*. The average number of patents issued in the indicated patent section is explored by the query created particularly for the Patent Alert System (PAS). The query discovers the average number of issued patents in previous week (one week prior to the alert configuration) and assigns it as the threshold value if *"low sensitivity"* option is preferred by the user. Half of the *"average number of patents issued in the indicated patent section"* is assigned as the threshold value in case of the *"middle sensitivity"* option. As the value of threshold parameter (*th*) decreases, the sensitivity of the PAS is improved and therefore frequency of the alerts generated and forwarded to the users increases correspondingly. However, it should be underlined here that the *"high sensitivity"* option sometimes may generate repeating alerts and this might not be desirable for the ones who just want to be informed about *significant trend changes*. Therefore, the selection of the best possible threshold value for the trend extraction algorithm is vital for drawing robust conclusions from the PAS. The PAS developed and presented in this chapter suggests currently three options. Alternatively, the adjustment of the threshold parameter might be left to the users, of course, if they have the required experience and professionalism. The work for finding an optimal value of for the threshold parameter using a fuzzy approach as well as the determination of the percentage of the false alerts created by the system is under development.

3.4.2 An Example

An example is given here to demonstrate the execution of the trend extraction algorithm as well. Let's assume that an alert has been configured while a threshold value of 5 is assigned and the following values are captured from database.

PATENT COUNT DATA OF THE FIRST PERIOD *(say 1st day):*

For IPC section X and class Y and subclass Z *(please note that these are just hypothetically given names assumed for this example)* the first captured value (patent count) is **13** then;

R(t=0)= 13

P(t)= 13

dev(t=0)= R(t=0)-P(t=0)= 0

cumdev(t=0)= dev (t=0) = 0 < 5 (th)

PATENT COUNT DATA OF THE SECOND PERIOD (Say 2nd Day):

In the second update; if R(t=1) = 15

dev (t=1)= R(t=1) - P(t=1) = 15 - 13= 2

cumdev(t=1)= cumdev(t=0)+ dev (t=1)= 0+ 2= 2 < 5 (th)

PATENT COUNT DATA OF THE THIRD PERIOD (Say 3rd Day):

In the third update; if R(t=2) = 19

dev (t=2)= R(t=2) – P(t=2)= 19 – 13= 6 > 5 (th)

This trend change of extracted by the model is an “alert” and it is forwarded to the owner of the alert in a following manner;

↑

A NEW UPWARD (+) TREND HAS BEEN FOUND
FOR THE IPC SECTION X AND CLASS Y AND SUBCLASS Z PATENTS

Therefore, a new P(t) is required and a new line is fitted by the method of least squares.

New P(t)= 3 (t) + 12,66
and cumdev (t=2) is set to “0”.

<u>PATENT COUNT DATA OF THE FOURTH PERIOD (Say 4th Day):</u>

In the fourth update if R (t=3) = 26
dev (t=3)= R(t=3) - P(t=3) = 26 – P(3*3+12.66)= 27-21.66=4.34
cumdev(t=3)= cumdev (t=2) + dev (t=3)= 0+ 4.34= 4.34 < 5 (th)

<u>PATENT COUNT DATA OF THE FIFTH PERIOD (Say 5th Day):</u>

In the fifth update if R (t=4) = 10
dev (t=4) = R(t=4) - P(t=4) = 10 – P(3*4+12.66)= 10-24.66= -14.66
Absolute cumdev(t=4)= cumdev (t=3) + dev (t=4)= abs(4.34-14.66)= 10.32 > 5 (th)
This change of model creates an “alert” which is forwarded to the owner of the alert in a following manner;

**A NEW DOWNWARD (-) TREND HAS BEEN FOUND
FOR THE IPC SECTION X AND CLASS Y AND SUBCLASS Z
PATENTS**

Therefore, a new P(t) is required and a new line is fitted by the method of least squares.

New P(t)= -16x+90
and cumdev (t=4) is set to "0".

3.5 Concluding Remarks and the Future Work

In recent years, there has been an exponential growth in the number of patents and consequently in the number of papers about the patent analysis. Patents analysis have been trendy today (Simmons, 2005) due to the benefits obtained to understand and to plot the development of technologies over time. The new approach, PAS, presented in this chapter uses trend analysis to find direction of changes in patenting activities, technology and research. The developed model, PAS, creates also an online visual decision support for the managers. PAS is a quick to respond and a self-motivated alert system with the following contributions offered:

* Contrary to the existing trend analysis conducted on patent data, PAS always use fresh and continuously patent data to analyze.

* PAS searches the direction of the changes in patent counts using a novel "trend extraction algorithm" which is able to detect trends in a set of continuously changing online data.

* PAS detects the trend changes in patent data and forward them as alerts to be used as a decision aid for technology and investment planning.

* PAS presents a visual support for the users which is more useful than conventional ways such as textual, tabular, and list for quick and easy knowledge discovery documents (Ganapathy et al., 2004).

It should be noticed that, the lines detected by the “trend extraction algorithm” does not aim to set up a model which fully explains the variation in patenting activities. A more advanced and sophisticated model may be required to enlighten the variation in patenting activities. PAS, as extended before, gives the direction of the changes in patenting activities.

The information (extracted trends) created by the direction of the changes can be used with several scopes listed as in the follows:

- to evaluate the value of existing technologies
- to decide upon whether owned technology is trendy or not?
- to find promising technology-related investment areas
- to avoid unnecessary investment.
- to be informed from trendy research topics
- to establish a long-term strategic plan including technology planning.

Trends are visual symbols, which create qualitative or semi-qualitative information to the users. PAS’s another utility is the comparison of two different alerts in a visualized manner. This utility creates the opportunity to make benchmarking on cycles of technologies among the different industries and countries.

CHAPTER 4

TRENDY TECHNOLOGY SELECTION

"*Nothing has changed in the last 30 days, other than the market itself to dispel the tremendous amount of earnings growth that is taking place in technology. It's just up to the investor to decide to what degree do they want to participate.*"

William J. O'Neil

4.1 Introduction

Some of the capital investments in our country are sacrificed due to some reasons such as; wrong selection and implementation before the expectations of the firms and the economy in advance had been met. Selection of randomly determined, copyist and obsolete business ideas result in inefficient use of national resources. It is very important to determine the direction of investments and technologies in order to avoid selection of obsolete and dated business ideas by the investors.

Patents and patents statistics are also one of the crucial instruments used on the determination of the direction of investments, technologies and to find the business ideas which will be obsolete (or already been obsolete) in near future. Patent applications and the granted patents are widely employed documents in watching technological activities, research and development (R&D) work and investments. In this chapter, the Analytic Hierarchy Process (AHP) method is employed to find a promising business idea which is trendy. In addition the proposed method is exemplified for solving a textile company's investment selection problem.

4.2 Literature Summary

There are several techniques in literature which are used to appraise investments. Irani (1997) groups these techniques within four categories as: economic, strategic, analytical, and integrated. These techniques and the corresponding references are summarized in Table 4.1

Economic appraisal techniques require cash values and benefits as tangible costs and benefits; however they mostly do not take into account intangible factors like preferences, competitiveness of the industry and market trends. Analytical appraisal techniques are highly structured but employ factors in a subjective way. They are usually based on relative information and do not consider much of measurable scales. Integrated approaches combine both subjectivity and the formal structure. They integrate financial and non-financial factors together, through the acknowledgment and assignment of weighting factors to the intangible implications of the project.

Many of the companies located in Turkey quantifies the full implications of their investments, from a cost, benefit and risk perspective and brings a predictive value investments or they employ traditional appraisal techniques. These techniques are inadequate to have the right conclusions on investments since they are just based on financial aspects and can only suggest an investment from limited alternatives. Furthermore, many of these costs associated techniques are inadequate to be implemented for new technologies. Therefore they are often overlooked (Hochstrasser, 1992). In this chapter a framework is prepared which combines an analytic approach (AHP) with a valuable source of objective information (patent information).

Table 4.1 Appraisal techniques and references (Adapted from Irani et al, 1997)

Appraisal Technique	**Classification**	**Reference sources**
Payback Return on investment (ROI) Cost-benefit Analysis (CBA)	Economic Approach (ratio-based)	Huang and Sakurai (1990);Dugdale (1991) Pavone (1983); Suresh and Meredith (1985) Kaplan (1984); Kakati and Dhar (1991)
Net Present Value (NPV) Internal Rate of Return (IRR)	Economic Approach (discounting techniques)	Kaplan (1984); Kakati and Dhar (1991) Kaplan (1984); Hares and Royle (1994)
Option Pricing Theory	Economic Approach (future value techniques)	Furlong and Keeley (1989) Ronn and Verma (1989)
Technical Importance/Research and Development Competitive advantage Critical success factors Application Portfolio Approach SWOT Analysis	Strategic Approach	Meredith and Suresh (1986); Swamidass and Waller (1991); Naik and Chakravarty (1992); Parker et al. (1988); Hochstrasser (1992) Rockart (1979); Hochstrasser and Griffiths (1991) Ward (1990) Davies, (1997); Kurttila et al. (2000)
Non Numeric Scoring models Analytic Hierarchy Process (AHP) Computer based techniques Fuzzy Approach	Analytic Approaches (portfolio)	Suresh and Meredith (1985) Nelson (1986) Saaty (1988) Burstein (1986); Primrose and Leonard (1987) Mamdani, (1994); Monoh et al., (1995)
Risk Analysis Value Analysis	Analytic Approaches (other)	Swamidass and Waller (1991) Remenyi and Heafield (1995) Meredith and Suresh (1986); Money et al. (1988)
Multi-Attribute Utility Theory Scenario planning and screening Information economics Balanced scorecard	Integrated Approaches	Sloggy (1984) Garrett (1986) Kennedy and Sugden (1986) Parker et al. (1988) Kaplan and Norton (1996)

4.3 Developing a Framework for Sub-Sector Selection

The modern economic inquiry into technological knowledge stems from a number of theoretical developments led by Romer (1986, 1990), Lucas (1988), Aghion and Howitt (1988) and Grossman and Helpman (1991). Ideas, inventions, research and scientific discoveries are at the heart of modern growth theory. The difficulty comes in capturing these dynamic processes empirically, in a systematic and consistent manner. However, "in this desert of data, patent statistics loom up as a mirage of wonderful plentitude and objectivity" (Griliches, 1990 p. 1661). Therefore patent statistics have been widely employed to have conclusions on technological development. They are used in different aspects and had all useful results. In this work, an investor which plans to invest on technology is considered and a decision support framework is generated. The framework proposed in this study is given in Figure 4.1. The investor searcher mentioned here is assumed to have all the resources like capital, available location, experience etc. The study aims to assist to decision maker to select the best suitable and trendy sub-sector to invest. Patent statistics are taken as the trend indicator of the technology in the corresponding sub-sectors. Therefore on the way going through the objectives, it is important to determine which statistics and on what weights should be included in a decision model.

AHP, which was developed by Saaty (1990), has been an effective tool in structuring and modeling multi-objective problems. AHP is one of the most extensively used Multi-Criteria Decision-Making (MCDM) methods. AHP has been applied in a variety of contexts; from the simple everyday problem of selecting a school to the complex problems of designing alternative future outcomes of a developing country; evaluating a political candidacy; allocating energy resources; and so on (Cheng et al., 1999). Ranking, scoring and AHP methods do not apply to problems having resource feasibility, optimization requirements or project interdependence property constraints (Lee and Kim, 2001). In spite of this limitation, practitioners have used the AHP method with real problems, because of its simplicity and user-friendliness. Therefore it is the one of the best, easy and convenient way to apply Analytical Hierarchy Process (AHP) in the proposed framework. Several commercial software packages are available to assist in conducting an AHP analysis, such as Expert Choice, Criterium and HIPRE3+. Expert Choice is used in the case study due since it has been already used in several studies and therefore it is known as credible and reliable AHP software

For additional information on AHP theory and practical applications of AHP, readers are referred to Saaty (1990; 1996), Hastak (1998), and Hastak and Halpin (1998).

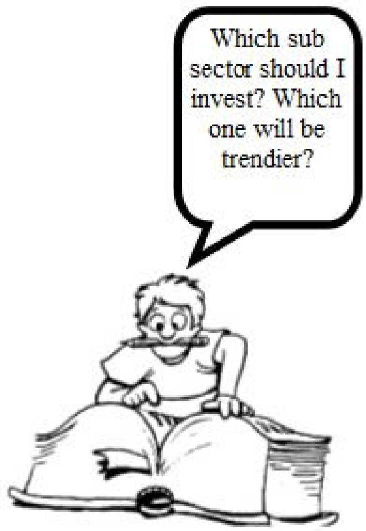
<table>
<tr><th>RESOURCES (Assumptions)</th><th>INVESTOR & PROBLEM</th><th></th><th>SOLUTION</th></tr>
<tr><td rowspan="7">Budget
√
Location
√
Experience
√
Sector to Invest
√
Sub Sector
?</td><td rowspan="7">
</td><td>A</td><td>DEFINE the OBJECTIVES
"Finding most trendy technology investments in short-run"</td></tr>
<tr><td>B</td><td>DECISION on FACTORS and SUB-FACTORS
*Number of patent applications
* Number of granted patents</td></tr>
<tr><td>C</td><td>DECISION on ALTERNATIVES
"List of subsections gathered form IPC list"</td></tr>
<tr><td>D</td><td>AHP
"Expert Choice configuration of model"</td></tr>
<tr><td>E</td><td>PAIRWISE COMPARISION
"Weighting of relative importance of applications versus granted ones"</td></tr>
<tr><td>F</td><td>INSERTION PATENT STATISTICS to the MODEL
"The real of alternatives are inserted into spreadsheet in Expert Choice"</td></tr>
<tr><td>G</td><td>EVALUATION of RESULTS
"The consistency and validity of results are evaluated"</td></tr>
</table>

Figure 4.1 The developed framework for AHP selection

As presented in the Figure 4.1 the decision makers all have the same objective: *"Finding most trendy technology investments in short-run"*. Factors are determined by the experts. Experts decide on which countries' patent statistics (applications/ granted) are heavily effected on the trend of the technology. Then the experts weight the factors using the comparison scale presented in Table 4.2

Table 4.2. Pairwise comparison scale (adapted from Saaty, 1990)

Intensity of importance on an absolute scale	**Definition**	**Explanation**
1	Equal importance	Two indicators contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment moderately favor one indicator over another
5	Essential or strong importance	Experience and judgment strongly favor one indicator over another
7	Very strong importance	An indicator is strongly favored and its dominance demonstrated in practice
9	Extreme Importance	The evidence favoring one indicator over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed

The comparison of any two criteria C_i (Number of patent applications) and C_j (Number of granted patents) with respect to the goal is made using the questions of the type: of the two criteria C_i and C_j which is more important and how much. Larger number assigned to the pair-wise comparisons means larger differences between criteria levels. The entries a_{ij} (difference vector) is governed by the following rules (Chang et al. (2007)):

$a_{ij} > 0$, $a_{ji} = 1/a_{ij}$, $a_{ii} = 1$ for all i.

4.4 The Case Study for a Textile Company

The framework proposed in this work is exemplified in a textile company located in Gaziantep, Turkey. The company has been serving in sack manufacturing industry for 20 years. They have been searching for a new investment in textile sector. They have adequate land and financial power to invest on any textile sub-sector. The investment options are created using the IPC section D titles. These options are listed in Table 4.3.

Table 4.3 The IPC codes for textile patents

IPC Code	Contents
DO1	Natural or artificial threads or fibres; Spinning
D02	Yarns; Mechanical finishing of yarns or ropes; Warping or beaming
D03	Weaving
D04	Braiding; Lace-making; Knitting; Trimmings; Non-woven fabrics
D05	Sewing; Embroidering; Tufting
D06	Treatment of textiles or the like; Laundering; Flexible materials not otherwise provided for
D07	Ropes; Cables other than electrical

The factors are selected as the patent statistics of Greece Patent Office (OBI), European Patent Office (EPO) and Turkish Patent Office (TPO). The fundamental reason of these factors' selection is about the market conditions. The company considers Greece since they have credits and contacts in Greece. They select Europe since they have already known that the dominant textile technology is constructed in Europe. The hierarchy view of the model is presented in Figure 4.2.

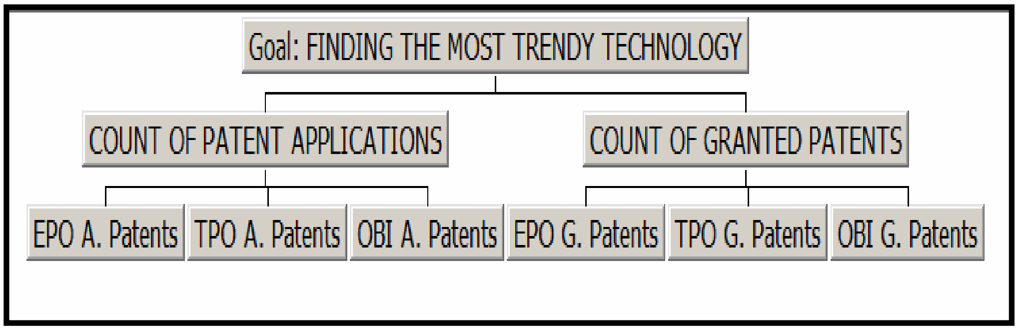


Figure 4.2 The hierarchy view of the AHP model

As a next step, experts in the indicated company have weighted the factors using "Expert Choice" software. Consequently, the related statistics of last two years have been inserted into spreadsheet. The screen capture of the spreadsheet of weights are shown in Figure 4.3 As it presented, Section D06 has greatest weight which has the value of 1. The smallest weight is for Section D03 which is 0,102.

Ideal mode	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE	PAIRWISE
Alternative	COUNT OF PATENT APPLICATIONS (EPO A. Patents (L: ,701)	COUNT OF PATENT APPLICATIONS (TPO A. Patents (L: ,106)	COUNT OF PATENT APPLICATIONS (OBI A. Patents (L: ,193)	COUNT OF GRANTED PATENTS EPO G. Patents (L: ,540)	COUNT OF GRANTED PATENTS TPO G. Patents (L: ,163)	COUNT OF GRANTED PATENTS OBI G. Patents (L: ,297)
EPO						
D01	,305	,310	,267	,257	,373	,331
D02	,071	,086	,267	,257	,110	,638
D03	,167	,161	,691	,103	,194	,102
D04	,315	,086	,091	,561	,373	,196
D05	,889	,155	,554	1,000	,853	,638
D06	1,000	1,000	1,000	,985	1,000	1,000
D07	,105	,310	,081	,107	,212	,173

Figure 4.3. The spreadsheet of weighted factors

The eigenvector method yields a natural measure of consistency. Saaty(1990) defined the consistency index CI as:

$$CI = (\lambda_{max} - n) / (n-1)$$

where λ_{max} is the maximum eigenvalue, and n is the number of factors in the judgment matrix. Accordingly, Saaty (1990) defined the consistency ratio (CR) as

CR= CI/RI

For each size of matrix n, random matrices were generated and their mean CI value, called the random index (RI) where RI represents the average consistency index over numerous random entries of same order reciprocal matrices. The consistency ratio CR is a measure of how a given matrix compares to a purely random matrix in terms of their consistency indices. A value of the consistency ratio CR $\leq$ 0.1 is considered acceptable. The consistency of the model given here presented in Table 4.4.

Table 4.4 Inconsistency table for factors/subfactors

Factors vs Factors/Alternatives	**Inconsistency**
Count of patent applications vs Count of granted patents	0
EPO applied patents vs OBI applied patents vs TPO applied	0,01
EPO granted patents vs OBI granted patents vs TPO granted	0,01
Count of patent applications vs EPO applied patents	0,01
Count of patent applications vs OBI applied patents	0,01
Count of patent applications vs TPO applied patents	0,01
Count of granted patents vs EPO granted patents	0,01
Count of granted patents vs OBI granted patents	0,01
Count of granted patents vs TPO granted patents	0,01
OVERALL CONSISTANCY	***0,01***

Expert Choice software is adopted here to perform sensitivity analysis. Sensitivity analysis can be performed by the criterion weight with respect to determining how it influences an alternative hierarchy. According to the results for the Dynamic Sensitivity for nodes below Goal, the alternative hierarchy is of the following order: D06, D05, D01, D04, D03, D02, and D07. Dynamic sensitivity of the model variables are shown in Figure 4.4.

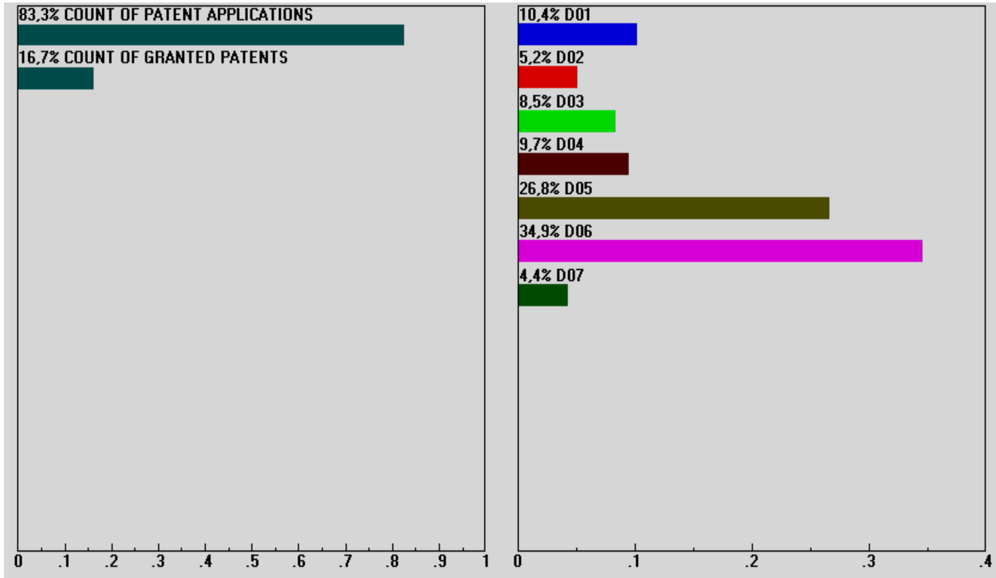


Figure 4. 4. Dynamic sensitivity of the AHP model

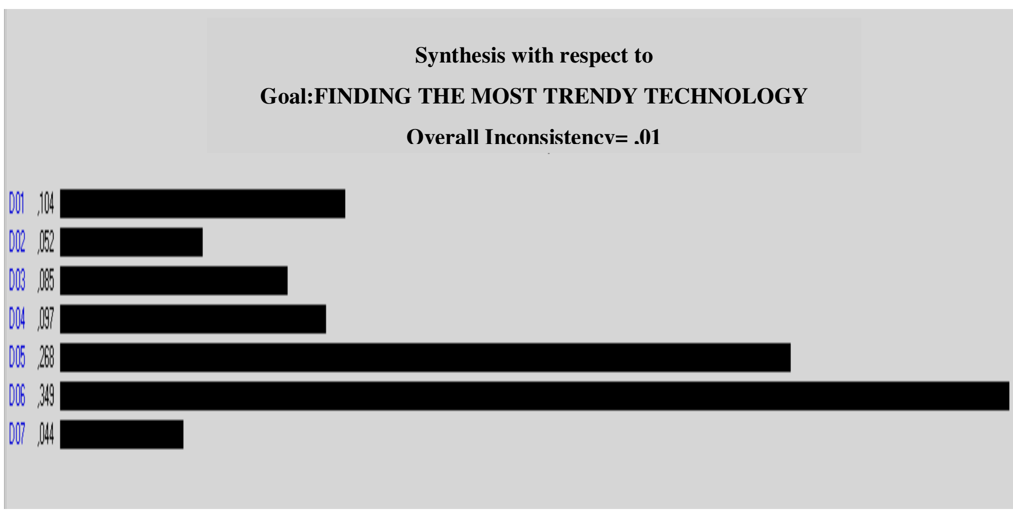


Figure 4.5. Synthesis result of the AHP model

4.5 Conclusion

AHP can combine quantitative and qualitative factors to handle different groups of factors and to combine the opinions of many experts. The proposed AHP-based algorithm significantly contributes to the technology selection problem. The trendy selection realized by considering the technical activities in the target markets. It is like Paris's effect on the creation of wearing fashion. Therefore the determination of countries is significantly important for the validity and reliability of the model. The proposed model can be extended with additional factors. Also, for future work, the alternatives can be defined more precisely including the subsections of IPC list. Another way of running model can be realized by using output alerts of Patent Alert System which is described in Chapter 3.

CHAPTER 5

TECHNOLOGY CLASSIFICATION

"The difference between science and the fuzzy subjects is that science requires reasoning while those other subjects merely require scholarship."

Robert A. Heinlein

5.1 Introduction

Fundamental structural changes in many economies and advance of technologies have changed the classical capital investment trends. Traditional sectors lost its profitability and new business trends have raised. Consequently, watching these dramatic trend changes has been an essential need to determine and act on hidden business opportunities. The entrepreneurs who are seeking for business ideas have utilized several data sources to watch those trends in the market. Patent statistics, as being one best known indicator of technological growth, has also been very functional source of trend watch. This chapter as well uses patent statistics and focuses on classification of technology trends as "dated", "classic" and "trendy". "Dated technologies" mentioned here, refers the technologies which have not been the issue of a granted patent or a patent application in the recent years. Similarly "Classic technologies" refer the ones which have been issued in patent documents on average. Finally the "Trendy Technologies" refer to the technologies which have been issued in patents with an increasing rate.

Fuzzy approach is employed to classify technology trends into categories based on estimated membership in each class. Membership function is obtained using "patent count data" retrieved from TPO's (Turkish Patent Office) online database. IPC (International Patent Classification) system -which the whole area of technology is divided into a range of sections, classes, subclasses and groups according to their scopes-, has been used for the evaluation of trends in the corresponding technology groups. The sample case is designed for textile patent applications received and granted by Turkish Patent Institute (TPO).

5.2 Literature Summary

Selection of promising investment alternatives create opportunities for the entrepreneurs to survive and to develop. This claim has been proved several times in last few decades. The ones which have invested in the accurate areas of technology during the last few decades became the developed countries and the -biggest- firms (Taşkın et al, 2004). However; it hasn't been easy as it is expected. Selection of technologies has been one of the most challenging decision making areas which the management of a company encounters (Saen, 2006). Therefore; there have been certain efforts to qualify the "technology selection decision". It is possible to find several different approaches used in literature. Classification of technologies is one of the methods widely used however the intension is not to utilize technology selection considering them as investment opportunities. Classification of technologies is such important for understanding the requirements and criteria for the specific technology selection. As Weiss (1990) stated; many real world decision-making problems are indeed classification problems. One of the earliest studies on technology classification is prepared by Steele (1989), he has roughly classified technologies into three dimensions:

1. Product/service technologies = "product technologies"
2. Manufacturing/service-delivery technologies = "production technologies"
3. Information/operations technologies for management control = "information technologies"

Muller (2007) classifies technologies with respect to the rate of "know-how" required to manage technologies. He defines hard technology as the technology which requires tangible engineering and scientific know-how, such as software and electronics engineering, and mathematics, physics, chemistry and biology. Similarly, he defines soft technology as the technology which requires less tangible know-how which is based on a mixture of sciences and human arts. There are also some other classification studies which were prepared specific to industries. Most of these studies classify technologies heuristically (ie: Roussos et al., 2003, Slimaneet al., 2003, Taylor and Viraraghavan, 1999, Luo et al. 2005).

5.3 Fuzzy Classification

Classification is to learn a model that maps a data item into a predefined categorical class. It has been discussed in fields such as statistics, machine learning, and expert systems. It is known as the supervised learning because the number and the types of classes are predefined. There are several classification approaches in literature. One of the most known and widely used classification approaches is the fuzzy rule-based classification. Fuzzy classification approach enables the use of linguistic based rules. It also enables some applications to be classified where the discrete classification cannot be easily done. The allowance of overlapping in the memberships is also another advantage for the situations where the boundaries are not certain. It is also the case for technology classification. The boundaries are not certain. A dated technology of today may be a trendy technology in near future. Therefore the framework mentioned in this part utilizes fuzzy classification.

Fuzzy set theory was introduced by Zadeh (1965) to present a way of modeling the uncertainty of natural language. Fuzzy logic was developed later from fuzzy set theory primary to reason with uncertain and vague information and secondary to represent knowledge in operationally powerful form (Frantti and Mahören, 2001). Fuzzy sets remove the rigid boundaries by assigning a membership value with a real number from 0 to 1. This membership value correspond the degree to which the member is similar or compatible with the concept represented by the fuzzy set. By applying fuzzy sets, it is possible to represent uncertainty in problems where imprecision exists using linguistic descriptions and not well-defined relationships.

In fuzzy set theory there exists a set A, which is the subset of a universe of events, denoted by U. Structurally; A is a collection of elements of D. The characteristic function of A, m_A: D→{0,1}, provides the complete information about what elements are in A, but it is structurally different from a crisp A where $m_A(x)$ =1 if x is in A, otherwise $m_A(x)$=0. The fuzzy set A defined over a universe of discourse, set D, is no longer a collection of elements of D. Each element of D can be in A "to some degree". The membership function of A, m_A : U→[0,1], provides the complete information about to what degree each element of D is in A. $m_A(x)$ is the "membership degree" of x in A. This degree can range between zero and one.

Ordoobadi and Mulvaney (2001) summarizes and figures out the five main steps of modeling fuzzy expert system as shown in below and in Figure 5.1.

1. Define the input variables for the system and their corresponding ranges of values.
2. Define the output variables for the system and their corresponding ranges of values.
3. Develop fuzzy membership functions for every input and output.
4. Develop a rule base based upon the potential outcomes of the system.
5. Determine how much each action will be carried out by establishing the rule strengths and defuzification.

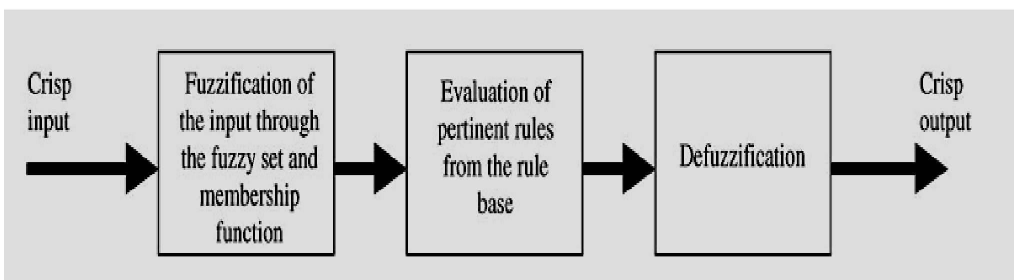


Figure 5.1. General depiction of a fuzzy inference (Ordoobadi and Mulvaney, 2001)

5.4 The Implementation for the Model

As the first step the model input and outputs are figured out. Figure 5.2 presents the model view drawn in Matlab's Fuzzy Tool Box. As it is justified earlier the input variables are: number of (#) patent applications and the number of granted patents. The values of these input variables for Turkish Textile Patents have been derived from the study of Dereli and Durmuşoğlu (2006). These values can be found in the **APPENDIX B**.

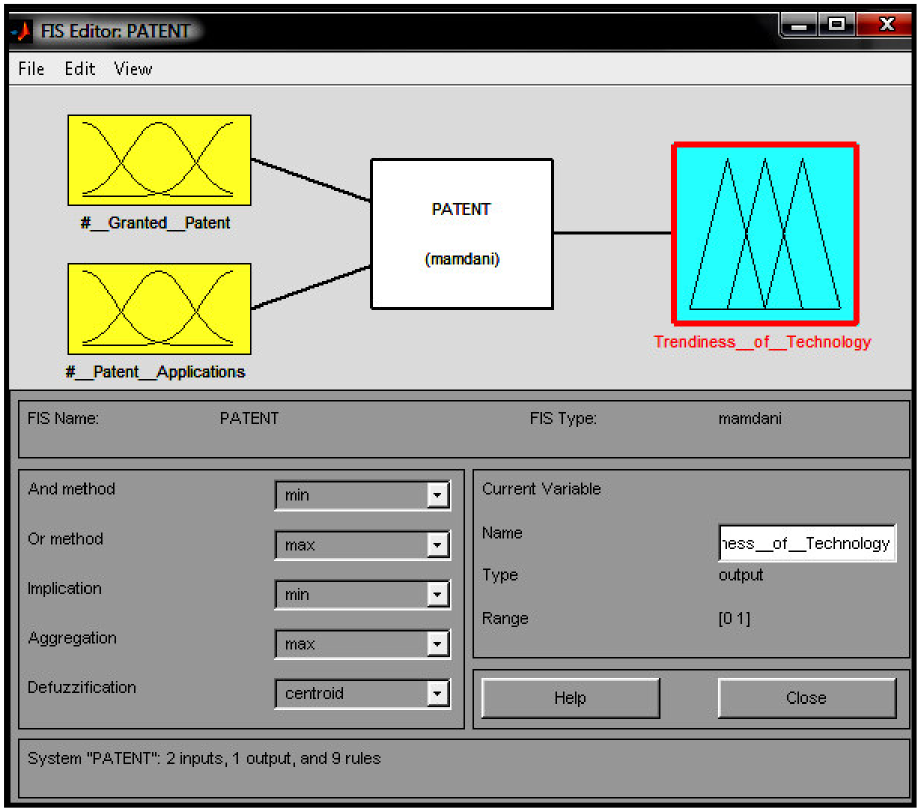


Figure 5.2. FIS editor of the fuzzy model

As a second step, membership functions were determined. Using the usual crisp cluster analysis these difficulties cannot be sufficiently taken into account. With fuzzy clustering it is not necessary to definitely place an object within one cluster, since the membership value of this object can be allocated among different clusters. This “distribution” of the membership among different clusters can be interpreted as the measure of similarity between a particular object and the respective clusters. The most common clustering method, the so called fuzzy c-means method is based on the minimization of the following distance-based objective function (the least-squared errors-functional; Bezdeck, 1980; Bezdeck et al., 1984):

$$F(c) = \sum_{i=1}^{p} \sum_{j=1}^{c} (\mu_{ij})^m d_{ij}^2$$

where:

where:

d_{ij}	is the distance between the ith object and the jth cluster center (usually the Euclidean distance or the diagonal norm),
p	is the number of objects,
$c \in N$	is a desired number of clusters ($2 \leq c \leq n$),
m	is a weighting exponent (the so-called fuzzifier), $m \geq 1$,
μ_{ij}	represents the membership of the ith object to the jth cluster which satisfies the following conditions:

$$\mu_{ij} \in [0, 1] \quad \text{for} \quad 1 \leq i \leq p, \quad 1 \leq j \leq c,$$

$$\sum_{j=1}^{c} \mu_{ij} = 1 \quad \text{for} \quad 1 \leq i \leq p,$$

$$\sum_{i=1}^{p} \mu_{ij} > 0 \quad \text{for} \quad 1 \leq j \leq c.$$

The count of textile patent statistics retrieved from TPO's online database (http://online.tpo.com) entered into Statistical Package for Social Sciences (SPSS) for the determination of ranges and the membership functions. For conversion of numerical values to verbal values "C means clustering" method has been implemented and the statistics are classified as: low, average and high. The corresponding ranges and the membership functions are presented in Table 5.1 and in Table 5.2.

Table 5.1. The result of "C means clustering analysis" for patent applications

# of Patent Applications	"Low"	"Average"	"High"	Range
Middle	2.24	18.41	55.57	2.24-55.57
Symmetric Triangle Created	0- 2.24-4.48	4.48-18.41-32.34	32.34-55.57-78.8	0-78.8
Number of Cases	653	116	14	
Percentage	% 83.4	% 14.8	% 1.79	

Table 5.2. The result of "C means clustering analysis" for granted patents

# of Granted Patents	"Low"	"Average"	"High"	Range
Middle	1.4	10.88	27.24	1.4-27.24
Symmetric Triangle Created	0-1.4-2.8	2.8-10.88-18.96	18.96-27.24-35.52	0-35.52
Number of Cases	656	110	17	
Percentage	% 83.7	% 14	% 2.17	

The k-means clustering is one of the classical, well-studied unsupervised learning algorithms that solve the fundamental clustering problem (MacQueen¸1963). The k-mean clustering follows a simple and easy way to classify a given data set into a certain number of clusters that is usually given as a priori (Zhou and Liu, 2008). In this study number of clusters is given as three (low, average, high). The main steps for k-means clustering are shown in Figure 5.3. The first step is to initialize k centroids, one for each cluster. The next step is to take each point belonging to a given data set and associate it with the nearest centroid. When no point is pending, the k centroids need to be updated as barycentres of the clusters resulting from the previous step. This process can be iterated until the k centroids do not move any more (Zhou and Liu, 2008).

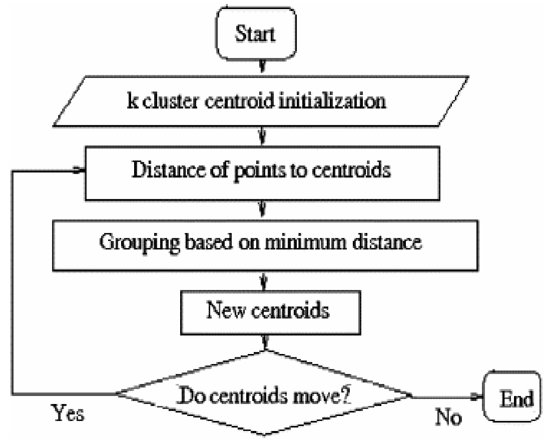


Figure 5.3. The flow of the "C means clustering"

After the membership functions have been entered to Matlab, the rules are written as given in the following:

i. If (#__Granted__Patent is Low) and (#__Patent__Applications is Low) then (Trendiness__of__Technology is Dated) (1)

ii. If (#__Granted__Patent is Average) and (#__Patent__Applications is Average) then (Trendiness__of__Technology is Classic) (1)

iii. If (#__Granted__Patent is High) and (#__Patent__Applications is High) then (Trendiness__of__Technology is Trendy) (1)

iv. If (#__Granted__Patent is Average) and (#__Patent__Applications is Low) then (Trendiness__of__Technology is Dated) (1)

v. If (#__Granted__Patent is High) and (#__Patent__Applications is Low) then (Trendiness__of__Technology is Classic) (1)

vi. If (#__Granted__Patent is Low) and (#__Patent__Applications is Average) then (Trendiness__of__Technology is Classic) (1)

vii. If (#__Granted__Patent is High) and (#__Patent__Applications is Average) then (Trendiness__of__Technology is Classic) (1)

viii. If (#__Granted__Patent is Low) and (#__Patent__Applications is High) then (Trendiness__of__Technology is Classic) (1)

ix. If (#__Granted__Patent is Average) and (#__Patent__Applications is High) then (Trendiness__of__Technology is Trendy) (1)

5.5 Results and Discussion

The Rule Viewer and Surface Viewer of Matlab display a roadmap of the whole fuzzy inference process. They are based on the fuzzy inference diagram. The Figure 5.4 presents the rule viewer and Figure 5.5 presents surface analysis of the model which is presented in this chapter. Anyone using the rule viewer may adjust the realized values of patent statistics to determine the trendyness of the relevant textile technology. As it is presented in the Figure 5.4 and Figure 5.5, if number of granted patents is 12 and patent applications are 43 then the ninth rule applies and result shows that the relevant sector's technology is trendy.

This model can be utilized for any technology class or subclass. Naturally selection of application area and data resource is crucial for selecting a promising technology. Patent statistics of a technology creating country will make more sense to really understand which technologies are trendy and which are not. As stated at the beginning this kind of classification of technologies is novel to literature.

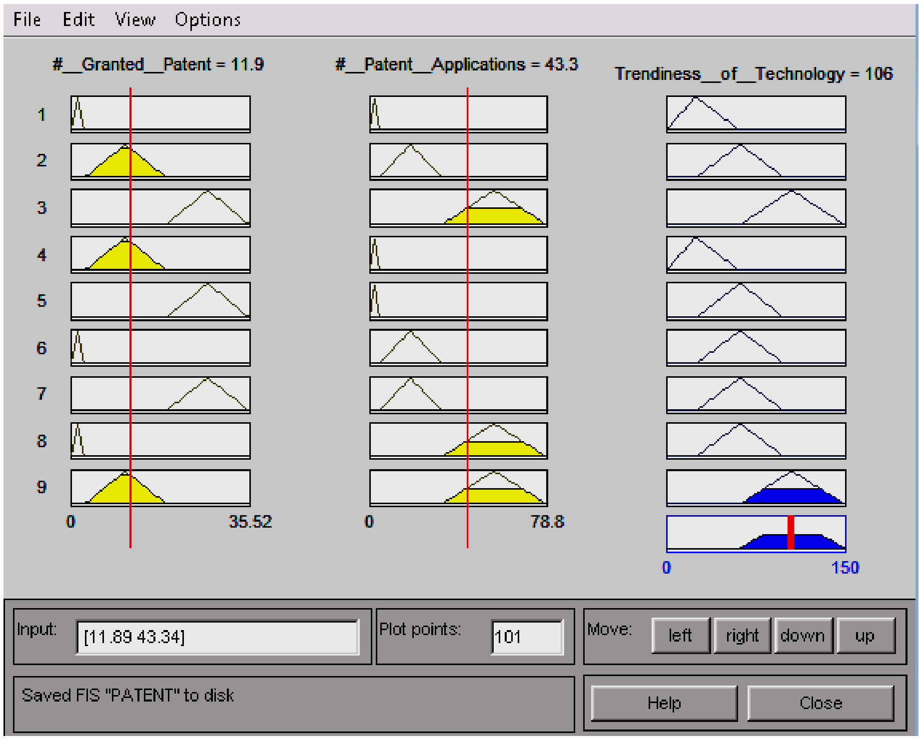


Figure 5.4. The rule viewer of Matlab Fuzzy Box

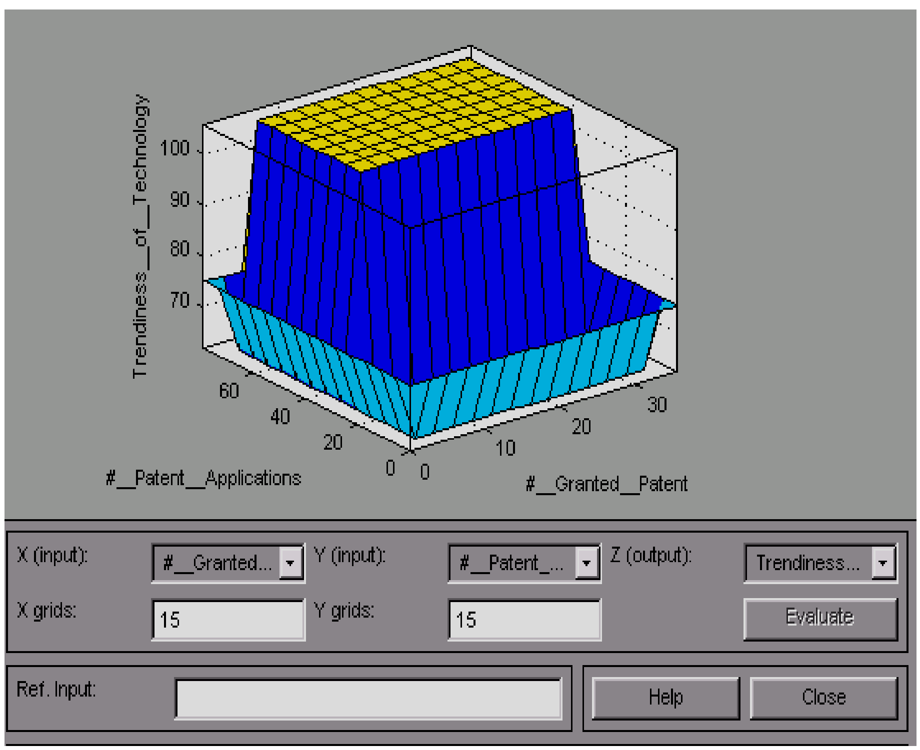


Figure 5.5. Surface analysis for the factors of the model

CHAPTER 6

A NOVEL PRODUCT DEVELOPMENT FRAMEWORK

"The funny thing is, there are frequently very good reasons for good companies to suppress revolutionary innovation. If a technology is disruptive to the health of the company, management is resistant. If a new product would undercut existing product margins or if it conflicts with previous public messages, it threatens to undermine that company's management. To facilitate revolutionary innovation, management has to be willing to take the risk of appearing in bad light and has to decide that if they don't do what is necessary to provide the customer the best capability at the lowest cost, someone else will. The dream that you can bury your head in the sand and continue selling what you already are indefinitely is just that - a dream."

Wally Rhines

6.1 Introduction

In today's dynamic and turbulent market conditions, companies are not expected to survive with their same/similar products. Therefore; companies are in search for an agile new product development approach in order to respond to the rapid changes in the market without ignoring innovativeness. Beside these considerations, the companies are calling for a cheap, robust and fast available method which can utilize the entire product development process. To overcome the well known obstacles, the existing capabilities should be utilized. There are some certain techniques used as creativity management tools such as AIDA (Analysis of Interactive Decision Areas), ARIZ (Algorithm of Inventive Problem Solving), idea boxes, laddering and etc. These techniques are quite similar with special pros and cons of each. In this chapter, all these techniques are combined within a novel method. The proposed method merges TRIZ with a "Patent Alarm System" (PAS) that tracks "trend changes" in patenting activities. It also introduces a modified idea generation scheme with 5W1H methodology that helps companies to drive inventions/innovations and inspires ideas that escape from "ordinary" and "linear" thinking.

Under the difficulties created by the competition, the ever more rapid materialization of new products, changing consumer interests and globalization, innovation has started to play a crucial part in the growth of industries, including service and manufacturing. Consequently, companies are forced to evaluate the efficiency of their design methods to keep their competitive edge and ensure their survival (Cavallucci and Lutz (2000)). There are various ideation techniques which have been applied in solving industrial problems. Buyukozkan et al. (2004) summarize several number of these tools used for new product development. These tools are also used for problem solving. One of the most known of these techniques is "Theory of Inventive Problem Solving" (TRIZ), which is implemented in several areas including service and manufacturing systems. TRIZ methodology is based upon the classification of relevant problem in technical or physical contradiction terms. For the solution the problem suggested 40 inventive principles or separation principles are used. Although these separation principles and the inventive principles were extracted from mechanical engineering solutions, both the solution systems and the principles have much broader significance Sohlenius (1992).TRIZ helps in concept generation for solving design problems related to manufacturing and service. More than 30 years ago, Shirwaiker (2005) used the concept of mechanical design trade-offs to help acknowledge and manage conflicting performance parameters associated with manufacturing (Stratton and Mann, 2000). A problem of designing a 500-passenger plane that could land on a carrier and also break the sound barrier was put forth. Stratton and Mann (2000) suggest the use of TRIZ to develop a solution for this problem. The design problem is codified in terms of technical contradictions and principles suggested by the contradiction matrix are used for resolving the trade-offs to develop a solution.

Patents are considered one of the best economic instruments for inventors to keep control of their novelties and ensure a return on their investments in research and development (Jaffe and Tragtenberg, 2002) Patents also are most frequently used particularly to keep track of the technical changes over time (Mazzoleni and Nelson, 1998). Patent watching is undoubtedly the most efficient way for the organizations to understand the research and development activities and the trend changes in technologies of global competitors. To be successful in discontinuous innovation, at least patent engineering and theory of inventive problem solving (TRIZ) should be merged in the tool list of creativity engineer (Wang, Wu, 2006). In this study, a new method has been proposed and implemented which merge several methods with the patenting activities. The method introduces a modified idea generation scheme that helps companies to drive inventions/ innovations and inspires ideas that escape from "ordinary" and “linear” thinking.

6.2 Proposed Approach

Patent claims are the list of features which are requested to be protected as inventive steps. They form a protective boundary line around the patents and let others search for vacancies in the relevant technology. In this chapter, a new methodology has been introduced to support companies for capturing new inventive/innovative ideas. The proposed methodology is given in Figure 6.1 (Dereli and Durmuşoğlu, 2007). As illustrated in Figure 6.1, corresponding patents are selected for the new product development process. An alert system called Patent Alarm System (PAS), which is also developed in this work, is employed for the selection of the related patents. PAS is an XML (extended mark-up language) based expert-system which watches continuously the sector related patents (setting the alert) from the patent databases (http://ep.espacenet.com; http://online.tpe.gov.tr., http://www.delphion.com., http://www.dialog.com) and forwards the trend changes (alert) to the users (Dereli and Durmuşoğlu, 2006). PAS is a responsive system and it reacts upon the trend changes in the patenting activities of relevant industry. The flow diagram of PAS is shown in Chapter 3. PAS has been developed for the “Patent Watch” department of the companies. It is currently available in the web (http://www.e-investment.org) but the system is still under test level and expected to be fully functional in few months. After the selection of related patents, an unbiased body is required to remove the title, abstract and information which belong to the owner of patent. The removal process is for avoiding the “creativity team” to be under the influence of some apparent features of the patents. This process will also urge the “creativity team” to make some guesses on the removed sections of the patents. Having completed the removal process; a meeting should be held to manage “innovative idea generation”. These kinds of group activities (innovation, product development, problem solving, etc.) usually require holding of regular meetings. In these regular meetings, the predetermined methodologies are scheduled and applied in a logical order. The selected patents are distributed to the members of creativity team at the first meeting held within the process. Subsequently, a list of questions is distributed to the participants. Afterward, the participants are asked to fill the answers to questions which are prepared using 5W-1H principle (Who-When-Where- Why-What- How). 5W1H suggests that any problem can be analyzed based on 6 aspects, which are “Why”, “What”, “Who”, “When”, “Where” and “How”. The essence of 5W1H is to analyze the problem systematically, including the essence of the object (What), the essence of the subject (Who), the problem-existence ways in time and space (When, Where), the solution of the problem (How) (Changqing et al., 2005)

Used in combination with TRIZ, 5W1H principle can effectively be employed to find the contradictions and harmful effects which are vital for a successful application of the TRIZ methodology. Adapted 5W1H questions for TRIZ are shown in Table 6.1.

Table 6.1. 5W1H questions for modified TRIZ

W1- Who …is affected by the solution offered in the patent? …may be the owner of patent? …is the target audience of the patent? …is affected by the harmful action?
W2- When …will the product appear in the market? (Expectations are asked) …will the product life end and the product disappear?
W3- Where …does the problem occur?
W4- Why …did the owner of the patent applied for granting? …does the problem occur?
W5- What …is new in the patent? …can be the claims of these patents? …are its main weaknesses? …does the problem seem to be? …values underlie the patent? …principles underline the patent?
H1-How …to improve the parts? …to dynamize the parts? …to control and hence automate the function? ...does the harmful action arise? ...is the source connected to the output? …can the problems be observed in a measurable scale?

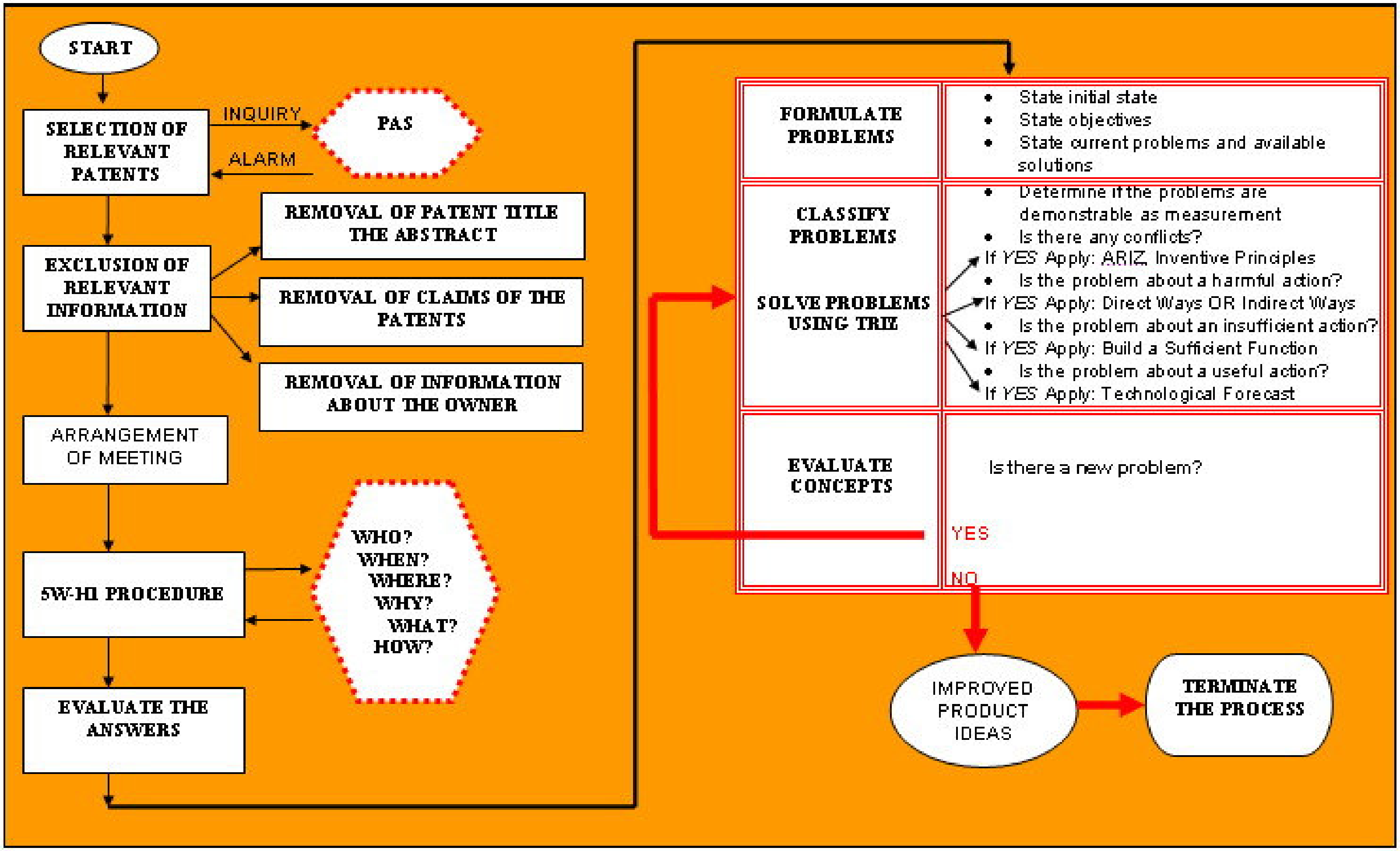


Figure 6.1. Proposed new product development framework

These questions can be improved and modified according to the necessities which are specific to the relevant sector in consideration. Before applying the TRIZ methodology, the collected answers should be evaluated and be prepared for the next meeting scheduled for the "innovative idea generation". Problem definitions of the participants should be categorized in this evaluation and preparatory period. And then they should be put in an order based on their repetition rates. The problems which are ascertained during 5W1H session should also be classified in the preparatory period. In the next meeting, the classification of those problems and their possible (corresponding) solutions should be analyzed by the creativity team. The offerings about the conflicts and the harmful actions should be reconsidered for the proposed solutions. If the problems persist, AIDA (Analysis of Interactive Decision Areas), ARIZ (Algorithm of Inventive Problem Solving), idea boxes, laddering, separation rules, and inventive principles should be utilized for a better solution. The "inventive idea generation" process can be repeated until the problems have been effectively solved. Finally the solutions should be conceptualized and summarized. Following the conceptualization, the process is terminated for further considerations. The improved product can be materialized or an economical/technical feasibility can also be requested for measuring the marketability of the product. It should be noted that patents are existing technologies and improving the existing technologies is called as "reverse engineering". Therefore, inspiring may raise a problem about fully/partially copying the existing products. Copying is not the goal of the reverse engineering and its goal is actually to obtain a design concept from an existing physical product and to generate a digital product-model and then to improve the design (Dereli et al., 2005).

6.3 Case Study

This case study is performed in one of the leading banks of Turkey. Company representatives firstly configured alert to the section G07, which includes the technology on checking devices. Then a trend has been alerted with a new patent which is recently applied by Garanti Bankası. In the selected patent, a new "money transfer" method has been established. According the proposed method a customer can give order to transfer money to anyone using SMS and moreover this recipient can draw the money from any ATM without any need to have an account or ATM card in the Bank. After the retrieval of this patent by PAS; removal process has been completed. Then a first meeting has been arranged and participants answered the 5W1H questions. After the meeting, the answers has been categorized and analyzed. SWOT and fishbone diagrams were prepared. A list for the contradictions and the possible solution offerings were listed. Then creativity team was invited to a new meeting. All findings were distributed to them. Then it was time to start TRIZ. 40 principles were applied until all the problems were removed.

Then a new product idea has been generated. The product proposes the money transfer using satellite receivers. It keeps the advantages of existing product but it does more. Firstly, participants had voted for the cost problems. They think that some customers would avoid using the system because the costs that arise from SMS. Now in the proposed product, there is no additional cost. Creativity team also believes that there may be security problems in using cellular phones. On the loose or stealing, customers can be damaged. But in the satellite case, it is less risky because the users don’t carry satellite receivers on their bodies. And almost all satellite receivers are protected with passwords. The proposed product also enables reporting function upon completion of money transfer.

6.4. Concluding Remarks

There are a variety of techniques used as creativity management tools for new product development process. These techniques are quite similar with special pros and cons of each. This chapter presents a modified TRIZ approach for accelerating the New Product Development (NPD) process. The proposed approach merges the TRIZ methodology with the patent information. An alert system called Patent Alarm System (PAS), which reacts upon the trend changes in the patenting activities, is employed for the selection of the related patents. After some of the patent information (name of owner, claims and the abstract, etc.) is removed, the questions created by 5W1H method have been asked to the responders to obtain inputs for the TRIZ methodology. Following the collection of responses, the resulting ideas are systematically grouped and listed for the next meeting. TRIZ methodology is subsequently applied until all of the contradictions are removed. During the solution search process; the methods like ARIZ, laddering, inventive principles and etc can also be utilized. The proposed methodology has improved the power and level of creativity of the members of "creativity team". It accelerates and enhances the NPD process by accelerating the idea generation phase.

CHAPTER 7

CONCLUSION

"If all economists were laid end to end, they would not reach a conclusion."

George Bernard Shaw

7.1 General Remarks

The problem identification and the objectives to this research study have been briefly described in Chapters 1 and 2, detailed in Chapters 3, 4, 5 and 6. The continual effort to translate these research objectives into an appropriate research approach has been undertaken during the courses of this study and conferences attended. The degree to which the stated objectives have been achieved is presented in this chapter.

This chapter provides an overview of the key discussion issues associated with each developed technology selection frameworks and method. It builds upon the discussions of the analysis, findings and case studies. It also presents the conclusions, contributions and implications that emerge from this research. The following Section 7.2 of this chapter individually addresses the research objectives and outcomes of each framework of the technology/investment selection. The next sections discuss the contributions of this research to the body of knowledge on technology selection and the directions for future research. Finally, Section 7.3 concludes the thesis with a brief summary of findings.

7.2 Research Objectives and Outcomes - Overview

Based on the patent information, four proposed frameworks and method(s) were developed for: (1) Extraction of the trend changes in the technologies (2) Strategic sub sector selection for the technology investments (3) Classification of technologies as dated, classic and trendy and (4) Developing a novel and cheaper product development scheme. The development of the proposed frameworks has involved a number of major tasks, which are summarized below, together with the associated conclusions.

7.2.1 Patent Alert System

The new approach, PAS, presented in this thesis uses trend analysis to find direction of changes in patenting activities, technology and research. The developed model, PAS, creates also an online visual decision support for the managers. PAS is a quick to respond and a self-motivated alert system with the following contributions offered:

* Contrary to the existing trend analysis conducted on patent data, PAS always use fresh and continuously patent data to analyze.

* PAS searches the direction of the changes in patent counts using a novel “trend extraction algorithm” which is able to detect trends in a set of continuously changing online data.

* PAS detects the trend changes in patent data and forward them as alerts to be used as a decision aid for technology and investment planning.

* PAS presents a visual support for the users which is more useful than conventional ways such as textual, tabular, and list for quick and easy knowledge discovery documents

It should be noticed that, the lines detected by the “trend extraction algorithm” does not aim to set up a model which fully explains the variation in patenting activities. A more advanced and sophisticated model may be required to enlighten the variation in patenting activities. PAS, as extended before, gives the direction of the changes in patenting activities. The information (extracted trends) created by the direction of the changes can be used with several scopes listed as in the follows:

- to evaluate the value of existing technologies
- to decide upon whether owned technology is trendy or not?
- to find promising technology-related investment areas
- to avoid unnecessary investment.
- to be informed from trendy research topics
- to establish a long-term strategic plan including technology planning.

7.2.2 Trendy Technology Selection Using AHP

The proposed AHP-based algorithm significantly contributes to the technology selection problem. The trendy selection realized by considering the technical activities in the target markets. It is like Paris's effect on the creation of wearing fashion. Therefore the determination of countries is significantly important for the validity and reliability of the model. The proposed model can be extended with additional factors. Also, for future work, the alternatives can be defined more precisely including the subsections of IPC list. Another way of running model can be realized by using output alerts of Patent Alert System which is described in Chapter 3.

7.2.3 A Novel Product Development Framework

There are a variety of techniques used as creativity management tools for new product development process. These techniques are quite similar with special pros and cons of each. This chapter presents a modified TRIZ approach for accelerating the New Product Development (NPD) process. The proposed approach merges the TRIZ methodology with the patent information. An alert system called Patent Alarm System (PAS), which reacts upon the trend changes in the patenting activities, is employed for the selection of the related patents. After some of the patent information (name of owner, claims and the abstract, etc.) is removed, the questions created by 5W1H method have been asked to the responders to obtain inputs for the TRIZ methodology. Following the collection of responses, the resulting ideas are systematically grouped and listed for the next meeting. TRIZ methodology is subsequently applied until all of the contradictions are removed. During the solution search process; the methods like ARIZ, laddering, inventive principles and etc can also be utilized. The proposed methodology has improved the power and level of creativity of the members of “creativity team”. It accelerates and enhances the NPD process by accelerating the idea generation phase.

7.3 Limitations of the Thesis and the Future Work

Although this study contributes to technology/investment selection literature, there are some drawbacks and possible future studies to be continued. As stated in the chapters of the thesis; the proposed frameworks work separately as decision support tools. A future work can be combination of all of the frameworks into a full framework using holistic approach. The technology selection mentioned through thesis equivalently means the selection of business. However the selection of a novel business requires much more. In the developed frameworks, financial and market constraints have not been considered. Therefore the frameworks can be extended using these critical factors such as: timing of investment, state of the rivals, cost and expected benefits of the investment and in this way these frameworks can be converted to technology selection roadmaps.

The findings of this thesis can also be utilized for establishment of national policies. It should be also noted that with this thesis; it is once more recognized that a systematic approach to technology selection is necessary for developing countries like Turkey. These countries can take stock of their resource base and capabilities; identify the technologies available, the modifications necessary, and the strategies for implementation within the sustainable development context (Dereli and Durmuşoğlu, 2006). A time and result specific plan can then be developed for the implementation of the promotion and adoption of new technologies within the identified sectors, with the necessary evaluation mechanisms put in place to determine success or failure. This approach will remove the non-methodical approach to technology implementation so prevalent in developing countries.

The proposed frameworks in this thesis can also be used to solve the “incentive system” problem in Turkey. The current incentive system in Turkey has been topic of hot discussions. Currently, the incentives are paid off on the base of national income of the regions. Since this thesis puts several methodologies to find promising technologies, the incentives can be paid off on the base of technology selected.

7.4. Closure

This research made fundamental contributions in two areas: 1) Use of patent information (statistics, counts) in AHP, Fuzzy and trend extraction models; 2) The use of 5W1H procedure along with TRIZ in a new product development scheme.

In completing this research, a substantial amount of patent information regarding the developed technology selection frameworks was collected and analyzed. This has helped validating the developed frameworks. In addition, this investigation also provides a foundation for future research, in a number of related areas, offering new and exciting directions for the research and practice of managers, entrepreneurs and the government.

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APPENDICES

APPENDIX A

Section A
Human Necessities

Subsection: Agriculture

A01 Agriculture; Forestry; Animal husbandry; Hunting; Trapping; Fishing.

Subsection: Foodstuffs; Tobacco

A21 Baking; Edible doughs.

A22 Butchering; Meat treatment; Processing poultry or fish

A23 Foods or foodstuffs; Their treatment not covered by other classes

A24 Tobacco; Cigars; Cigarettes; Smokers' requisites

Subsection: Personal or Domestic Articles

A41 Wearing apparel

A42 Headwear

A43 Footwear

A44 Haberdashery; Jewellery

A45 Hand or traveling articles

A46 Brushware

A47 Furniture; Domestic articles or appliances; Coffee mills; Spice mills; Suction cleaners in general

Subsection: Health; Amusement

A61 Medical or veterinary science; Hygiene

A62 Life-saving; Fire-fighting

A63 Sports; Games; Amusements

Section B

Performing Operations; Transporting

Subsection: Separating; Mixing

B01 Physical or chemical processes or apparatus in general

B02 Crushing, pulverising, or disintegrating; Preparatory treatment of grain for milling

B03 Separation of solid materials using liquids or using pneumatic tables or jigs; Magnetic or electrostatic separation of solid materials from solid materials or fluids; Separation by high-voltage electric fields

B04 Centrifugal apparatus or machines for carrying-out physical or chemical processes

B05 Spraying or atomising in general; Applying liquids or other fluent materials to surfaces, in general

B06 Generating or transmitting mechanical vibrations in general

B07 Separating solids from solids; Sorting

B08 Cleaning

B09 Disposal of solid waste; Reclamation of contaminated soil

Subsection: Shaping

B21 Mechanical metal working without essentially re- moving material; Punching metal

B22 Casting; Powder metallurgy

B23 Machine tools; Metal working not otherwise provided for

B24 Grinding; Polishing

B25 Hand tools; Portable power driven tools; Handles for hand implements; Workshop equipment; Manipulators

B26 Hand cutting tools; Cutting; Severing

B27 Working or preserving wood or similar material; Nailing or stapling machines in general

B28 Working cement, clay, or stone

B29 Working of plastics; Working of substances in a plastic state in general

B30 Presses

B31 Making of paper articles; Working paper

B32 Layered products

Subsection: Printing

B41 Printing; Lining machines; Typewriters; Stamps

B42 Bookbinding; Albums; Files; Special printed matter

B43 Writing and drawing implements; Bureau accessories

B44 Decorative arts

Subsection: Transporting

B60 Vehicles in general

B61 Railways

B62 Land vehicles for travelling otherwise than on rails

B63 Ships or other waterborne vessels; Related equipment

B64 Aircraft; Aviation; Cosmonautics

B65 Conveying; Packing; Storing; Handling thin or filamentary material

B66 Hoisting; Lifting; Hauling

B67 Opening or closing bottles, jars or similar containers; Liquid handling

B68 Saddlery; Upholstery

Section C

Chemistry; Metallurgy

Subsection: Chemistry

C01 Inorganic chemistry

C02 Treatment of water, waste water, sewage or sludge

C03 Glass; Mineral or slag wool

C04 Cements; Concrete; Artificial stone; Ceramics; Refractories

C05 Fertilisers; Manufacture thereof

C06 Explosives; Matches

C07 Organic chemistry

C08 Organic macromolecular compounds; Their preparation or chemical working up; Compositions based thereon

C09 Dyes; Paints; Polishes; Natural resins; Adhesives; Miscel- laneous compositions; Miscellaneous applications of mate- rials

C10 Petroleum, gas or coke industries; Technical gases con- taining carbon monoxide; Fuels; Lubricants; Peat

C11 Animal or vegetable oils, fats, fatty substances or waxes; Fatty acids there from; Detergents; Candles

C12 Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Ensymology; Mutation or genetic engineering

C13 Sugar industry

C14 Skins; Hides; Pelts; Leather

Subsection: Metallurgy

C21 Metallurgy of iron

C22 Metallurgy; Ferrous or non-ferrous alloys; Treatment of alloys or non-ferrous metals

C23 Coating metallic material; Coating material with metallic material; Chemical surface treatment; Diffusion treatment of metallic material; Coating by vacuum evaporation, by sputtering, by ion implantation or by chemical vapor deposition, in general; Inhibiting corrosion of metallic material or incrustation in general

C25 Electrolytic or electrophoretic processes; Apparatus there- for

C30 Crystal growth

Section D

Textiles; Paper

Subsection: Textiles or flexible materials not otherwise provided for

D01 Natural or artificial threads or fibres; Spinning

D02 Yarns; Mechanical finishing of yarns or ropes; Warping or beaming

D03 Weaving

D04 Braiding; Lace-making; Knitting; Trimmings; Non-woven fabrics

D05 Sewing; Embroidering; Tufting

D06 Treatment of textiles or the like; Laundering; Flexible mate- rials not otherwise provided for

D07 Ropes; Cables other than electric l

Subsection: Paper

D21 Paper-making; Production of cellulose

Section E

Fixed Constructions

E01 Construction of roads, railways or bridges

E02 Hydraulic engineering; Foundations; Soil-shifting

E03 Water supply; Sewerage

E04 Building

E05 Locks; Keys; Window or door fittings; Safes

E06 Doors, windows, shutters or roller blinds, in general; Lad- ders

Subsection: Earth drilling; Mining

E21 Earth drilling; Mining

Section F

Mechanical Engineering; Lighting; Heating; Weapons; Blasting

Subsection: Engines or Pumps

F01 Machines or engines in general; Engine plants in general; Steam engines

F02 Combustion engines; Hot-gas or combustion-product engine plants

F03 Machines or engines for liquids; Wind, spring, weight or miscellaneous motors; Producing mechanical power or a reactive propulsive thrust, not otherwise provided for

F04 Positive-displacement machines for liquids; Pumps for liquids or elastic fluids

Subsection: Engineering in General

F15 Fluid-pressure actuators; Hydraulics or pneumatics in general

F16 Engineering elements or units; General measures for producing and maintaining effective functioning of machines or installations; Thermal insulation in general

F17 Storing or distributing gases or liquids

Subsection: Lighting; Heating

F21 Lighting

F22 Steam generation

F23 Combustion apparatus; Combustion processes

F24 Heating; Ranges; Ventilating

F25 Refrigeration or cooling; Combined heating and refrigeration systems; Heat pump systems; Manufacture or storage of ice; Liquefaction or solidification of gases

F26 Drying

F27 Furnaces; Kilns; Ovens; Retorts

F28 Heat exchange in general

Subsection: Weapons; Blasting

F41 Weapons

F42 Ammunition; Blasting

Section G

Physics

Subsection: Instruments

G01 Measuring; Testing

G02 Optics

G03 Photography; Cinematography; Analogous techniques using waves other than optical waves; Electrography; Holography

G04 Horology

G05 Controlling; Regulating

G06 Computing; Calculating; Counting

G07 Checking devices

G08 Signalling

G09 Education; Cryptography; Display; Advertising; Seals

G10 Musical instruments; Acoustics

G11 Information storage

G12 Instrument details

Subsection: Nucleonics

G21 Nuclear physics; Nuclear engineering.

Section H

Electricity

H01	Basic electric elements
H02	Generation, conversion or distribution of electric power
H03	Basic electronic circuitry
H04	Electric communication technique
H05	Electric techniques not otherwise provided for

APPENDIX B

YEAR	D01D	D01F	D01G	D01H	D02G	D02H	D02J	D03C	D03D	D03J	D04B	D04H	D05B	D05C	D06B	D06C	D06F	D06H	D06L	D06M	D06N	D06P	D06Q	D07B	D21B	D21C	D21F	D21G	D21H
1980	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
1981	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	2	0	0	2	0	0	0	0	0	0	0
1982	1	1	0	0	1	0	0	0	0	0	2	4	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0
1983	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1
1984	1	2	0	0	0	0	0	0	3	0	1	3	1	0	1	0	0	0	2	0	0	1	0	0	0	0	0	0	0
1985	1	1	0	0	0	0	0	1	3	0	1	1	1	0	0	1	0	0	1	0	1	2	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0
1987	2	4	0	0	1	0	0	1	5	0	0	6	0	0	1	1	1	1	0	3	0	0	0	6	0	1	0	0	4
1988	4	4	0	0	1	0	0	0	0	1	2	0	0	0	1	0	5	1	2	3	0	3	0	3	0	0	0	0	1
1989	10	9	0	0	3	0	3	0	2	0	0	2	0	0	3	1	7	0	0	4	0	4	0	1	0	2	0	0	4
1990	3	4	0	2	2	0	2	0	1	0	4	4	0	0	1	0	10	0	0	5	0	8	1	4	1	8	1	0	2
1991	7	7	0	3	2	0	0	0	3	5	8	4	0	0	5	1	9	0	2	5	0	5	1	2	0	1	0	0	3
1992	4	6	1	3	4	0	1	2	2	3	3	7	1	2	3	2	6	1	2	7	0	11	2	0	0	1	2	0	4
1993	1	5	0	1	3	0	0	0	5	3	2	2	2	0	2	1	6	0	1	8	0	14	0	0	0	0	2	0	2
1994	13	15	1	1	7	0	0	0	3	1	9	13	1	2	4	2	6	0	3	8	1	5	0	2	3	1	1	0	8
1995	4	9	1	2	0	0	0	1	4	1	5	3	0	0	3	1	5	0	8	16	2	12	0	1	0	2	1	1	8
1996	7	11	1	11	5	1	4	5	6	0	12	10	3	3	12	3	18	1	10	13	1	17	0	5	0	2	2	0	16
1997	8	10	1	4	8	4	1	4	6	1	6	10	4	0	8	2	24	0	5	15	4	11	1	0	0	2	8	0	12
1998	5	17	12	13	7	3	3	9	12	5	3	24	3	1	3	5	29	1	2	18	4	13	0	2	0	6	13	1	14
1999	5	21	1	3	8	2	3	5	14	7	6	13	8	1	5	7	31	1	9	26	3	18	1	5	0	3	10	0	13
2000	12	21	6	16	9	1	4	1	16	5	12	22	5	1	6	4	45	1	15	26	2	23	0	6	0	9	4	1	15
2001	16	31	10	14	15	2	3	1	26	0	4	10	8	6	11	5	42	5	3	19	4	6	0	4	0	1	1	0	9
2002	5	13	3	10	11	3	1	5	17	3	7	13	8	1	12	6	29	0	2	11	4	8	0	2	0	1	3	1	5
2003	8	4	2	8	6	0	0	3	10	1	8	14	8	5	8	5	21	5	1	6	2	6	3	3	0	0	2	0	4
2004	3	3	2	4	4	3	1	3	9	3	6	1	8	1	9	8	16	0	0	0	4	12	0	2	0	0	0	0	4
2005	2	0	0	7	2	0	4	2	6	2	2	3	9	1	6	2	11	2	1	2	2	3	2	0	0	0	0	0	0
2006	2	1	0	3	1	1	0	2	5	0	4	3	5	1	6	1	22	2	0	1	0	4	0	0	0	0	1	2	0

Table B1. Granted textile patent statistics for 1980-2006

YEAR	D01D	D01F	D01G	D01H	D02G	D02H	D02J	D03C	D03D	D03J	D04B	D04H	D05B	D05C	D06B	D06C	D06F	D06H	D06L	D06M	D06N	D06P	D06Q	D07B	D21B	D21C	D21F	D21G	D21H
1980	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0
1981	0	4	0	0	0	0	0	0	2	0	0	0	0	0	2	2	0	0	4	0	0	4	0	0	0	0	0	0	0
1982	2	2	0	0	2	0	0	0	0	0	4	8	0	2	2	2	0	0	0	0	0	2	0	2	0	0	0	0	0
1983	0	2	0	0	0	0	2	0	2	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	2
1984	2	4	0	0	0	0	0	0	6	0	2	6	2	0	2	0	0	0	4	0	0	2	0	0	0	0	0	0	0
1985	2	2	0	0	0	0	0	2	6	0	2	2	2	0	0	2	0	0	2	0	2	4	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	2	0	2	2	0	0	2	2	0	0	0	0	0	0	0	2	0	0	2	2	0	0	0
1987	4	8	0	0	2	0	0	2	10	0	0	12	0	0	2	2	2	2	0	6	0	0	0	12	0	2	0	0	8
1988	8	8	0	0	2	0	0	0	0	2	4	0	0	0	2	0	10	2	4	6	0	6	0	6	0	0	0	0	2
1989	20	18	0	0	6	0	6	0	4	0	0	4	0	0	6	2	14	0	0	8	0	8	0	2	0	4	0	0	8
1990	6	8	0	4	4	0	4	0	2	0	8	8	0	0	2	0	20	0	0	10	0	16	2	8	2	16	2	0	4
1991	14	14	0	6	4	0	0	0	6	10	16	8	0	0	10	2	18	0	4	10	0	10	2	4	0	2	0	0	6
1992	8	12	2	6	8	0	2	4	4	6	6	14	2	4	6	4	12	2	4	14	0	22	4	0	0	2	4	0	8
1993	2	10	0	2	6	0	0	0	10	6	4	4	4	0	4	2	12	0	2	16	0	28	0	0	0	0	4	0	4
1994	26	30	2	2	14	0	0	0	6	2	18	26	2	4	8	4	12	0	6	16	2	10	0	4	6	2	2	0	16
1995	8	18	2	4	0	0	0	2	8	2	10	6	0	0	6	2	10	0	16	32	4	24	0	2	0	4	2	2	16
1996	14	22	2	22	10	2	8	10	12	0	24	20	6	6	24	6	36	2	20	26	2	34	0	10	0	4	4	0	32
1997	16	20	2	8	16	8	2	8	12	2	12	20	8	0	16	4	48	0	10	30	8	22	2	0	0	4	16	0	24
1998	10	34	24	26	14	6	6	18	24	10	6	48	6	2	6	10	58	2	4	36	8	26	0	4	0	12	26	2	28
1999	10	42	2	6	16	4	6	10	28	14	12	26	16	2	10	14	62	2	18	52	6	36	2	10	0	6	20	0	26
2000	24	42	12	32	18	2	8	2	32	10	24	44	10	2	12	8	91	2	30	52	4	46	0	12	0	18	8	2	30
2001	32	62	20	28	30	4	6	2	52	0	8	20	16	12	22	10	85	10	6	38	8	12	0	8	0	2	2	0	18
2002	10	26	6	20	22	6	2	10	34	6	14	26	16	2	24	12	58	0	4	22	8	16	0	4	0	2	6	2	10
2003	16	8	4	16	12	0	0	6	20	2	16	28	16	10	16	10	42	10	2	12	4	12	6	6	0	0	4	0	8
2004	6	6	4	8	8	6	2	6	18	6	12	2	16	2	18	16	32	0	0	0	8	24	0	4	0	0	0	0	8
2005	4	0	0	14	4	0	8	4	12	4	4	6	18	2	12	4	22	4	2	4	4	6	4	0	0	0	0	0	0
2006	4	2	0	6	2	2	0	4	10	0	8	6	10	2	12	2	44	4	0	2	0	8	0	0	0	0	2	4	0

Table B2. Textile -patent application- statistics for 1980-2006