



## Determining the Effect of Technology Monitoring on Moving towards Knowledge-based Economy

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### ABSTRACT

*In the competitive environment of these days, technologies have become ever more important. This fact has encouraged the economic firms to do further studies and spend tremendously to do technology monitoring. One of the obligations of technology monitoring units is the identification of emerging technologies and monitoring the evolution of existing technologies of the world. The method of this study is descriptive. All the activities within this study follow the same method and consist of different trends. This research is an interpretation of what exists and pays particular attention to existing relations, prevailing beliefs, or current processes. The aim of this research is to explore the effect of technology monitoring on directing toward knowledge-based economy. The methods of data collection consist of interview, observation, and study. This research has a new approach due to its particular attention to technology monitoring units in generating intellectual assets and innovation. The result of this research shows that variables of the speed of generating knowledge, competition at international level, responding to changes in demands, creating contexts for generating knowledge, strategy, and missions of firms, directly affect the development of knowledge-based economy.*

**KEYWORDS:** technology, monitoring, technology monitoring, knowledge-based economy

### 1. Introduction

In the current competitive environment in which fast changes in technology is one of the main features, one of the important concerns of firms is to get behind and surprised by their competitors. i. e. their competitors might introduce a technology to the market that would reduce their share or even change the existing paradigms that govern their field of activity. In order to address this great challenge, firms attempt to not only efficiently manage their own technologies, but also get informing of the latest progress in technology relevant to their field of activity by implementing data collection processes. Therefore, the idea of technology monitoring has developed in the world. Technology monitoring emphasizes on searching and collecting the relevant information for decision-making. Technology monitoring provides a framework to focus on activities that require surveillance. It can also observe the evolution of technology and identify opportunities and threats for each innovation. It is worthwhile to mention that technology monitoring in a complementary element for knowledge management since surveillance (monitoring) focuses on external environment and management focuses on internal environment.

Nowadays, due to the complexity of the world, technology monitoring has turned into a necessity and all organizations and companies that need to survive in this competitive world and remain profitable, should include technology monitoring as part of the main processes of their organization (Thomke and Kuemmerle, 2000). The main shortcoming of most countries is that they do not recognize the necessity of monitoring units. Countries that have established the foundation of their activities on knowledge should get informed of the technologic advancement of other countries to be able to move forward according to changes and reforms.

### 2. Literature Review

Japanese have introduced the discussion on technology monitoring for the first time. In 1868, they put down in their Constitution that they should use the knowledge of technology from all over the world to improve their emperorship. There have been multitudes of definitions for technology monitoring and they consider it as a set of activities that consists of data collection, analysis, expectation, and implementation of technological information from the outside environment in order to ensure the constant progress of their firm. Surveillance should be performed on each innovation to create opportunities or threats. In some cases, technology monitoring has been interpreted as methodology of technology intelligence. In some other cases, it has been interpreted as

a predictor of technology or even as an evaluator of technology (Porter et al., 1991; Ashton et al., 1997; Twiss, 1992; EIRMA, 1999; AIRI, 2002). In the current competitive environment and the information revolution era, technology has become ever more important. This has encouraged the economic firms to study and spend more on technology monitoring.

Technology monitoring is a term that is not yet used widely in management literature and according to studies performed on this subject; it has three aspects of intelligence, prediction, and evaluation. (Anna Nosella, 2008)

- Technology intelligence: the concept of technology intelligence was first developed at the beginning of World War II and generally indicates the process of data collection and use regarding the trend in technology and its related potentials. (Ashton et al., 1997)
- Technology prediction: the aim of it is to identify and predict the changes in technology and it seems that it pays less attention to collection and processing of information compared to technology intelligence (Schuette, 1994). Technology prediction has been considered as a mediator between organization strategy and research and development and has different ways of achieving long-term goals of organization technology. Technology prediction can provide an outline of future for us that can direct our activities to shape future situation. Technology prediction helps managers recognize how technology grows throughout time and how the competitor technology emerges, grows, spreads, and replaces the old technology. In technology planning, protection of organization senior manager of plans is very important and the long-term plans of the senior manager should protect and guide research and development activities in line with the goals of the company and determine to invest on which fields of technology. Without considering this fact, the way to go forward would not be clear and therefore we must avoid what Fruman has call "leap in the dark". (Ansari ,2006)
- Technology evaluation: it should deal with analysis and evaluation of desirable and undesirable effects, opportunities, and risks of technologies including both the new and the established ones. The TA motto is that a new technology must be better than the old technology; otherwise, there would be no need for it. "Being better" considers both the scientific aspect of a technology and its socioeconomic and ecologic aspects. (Yarahmadi , 2009)

**The process of technology monitoring is performed continuously as follows:**

**Step 1:** identification of important monitoring factors that includes two types of technologic and commercial information demands. Thus, we can identify important monitoring factors (CMFs) as external factors that greatly influence the competitive environment. Each company and even each section of a company might have its special CMFs according to its strategic plans. In order to design technology-monitoring process, each firm should define its particular CMFs according to its special context.

**Step 2:** research and obtaining the necessary information. After identification of CMFs, the data collection sources must be determined and then the process of data collection must be specified. These sources can be collected from bibliography of databases through the titles of articles in specialized journals, accessible article news through search engines, record, and presentation of information on web pages, congress, seminars, or conferences. Data sources can be either official or unofficial.

**Step 3:** analysis of collected data. For decision-making, data collection alone is not sufficient. Data must be analyzed and must be evaluated to become comprehensible. Presenting a large volume of unanalyzed data will not help much in the process of decision-making.

**Step 4:** presenting reports. One of the most important sections of technology monitoring process is reporting. In such reports, the collected and analyzed data can be used for decision-making. In addition, these reports can include the information demands, CMF of each demand, data source for each CMF, tools that are used for systemic data collection for each CMF, collected data, results of analysis and evaluation of data and suggestions for the right approach to changes.

**Step 5:** Internal distribution of results. Access to information must be easy and flexible. Providing a database of all useful information that arises from technology monitoring is considered an appropriate solution. This database must have the same format for all reports and accessibility to information through marketing information systems such as the classic search engines. (Lotfollahzade, 2010)

Today, knowledge is the foundation for new investments. Growth and moving forward of future economy is through accumulation of knowledge. (BoettkeEcon/Spring 12 April 2004) It is attempted to introduce knowledge-based economy as the predominant tool. Schumpeter was the first person who paid attention to knowledge-based economy. (Schumpeter, 1911) He interprets the concept of knowledge-based economy in the context of analysis of the quality of input factors in production process. Knowledge-based economy pays attention to both the human assets as well as knowledge in knowledge-based economy. (Nelson, 1982; Pavitt, 1984). The term "knowledge-based economy" arises from a more complete understanding of the role of knowledge and technology in economic growth. Knowledge (as a "human asset") is expressed in technology and always has an important role in economic development.

**Table 1 - Definition of technology monitoring**

Authors	Term	Definition
Porter et al., 1991	Technology monitoring	"examining the appropriate environment for pertinent information" ... to get "... historical information on technology's development, current information of the state of art today, and/or information pointing directly to future prospects"
ERDA, 1969	Technology monitoring	"Identification and assessment of technology advances critical to the company's competitive position"
ARI, 2002	Technology monitoring	"research management process directed towards the identification and assessment of technological advances (liberal/opportunities), critical for the competitive positioning of the firm"
Ashkan et al., 1997	Technology intelligence	"business sensitive information on external scientific or technological trends, opportunities or developments that have the potential to affect a company's competitive situation"
Lichtenhaler, 2003	Technology intelligence	"to a task" which is "independent from the way that it is performed" and whose goal is "to exploit potential opportunities and to defend against potential threats, through prompt delivery of relevant information about technological trends in the environment of the company"
Vandim, 2003	Technology forecasting	"a number of practical, proven techniques commonly grouped under the designation technology forecasting are available to ... project with reasonable accuracy the nature, rate, magnitude and implications of future advances in technology"
Bright, 1978	Technology forecasting	"... [a] quantified prediction of the timing and of the character of the degree of change in technical parameters"
Tarus, 1992	Technology forecasting	"... the means whereby a systematic approach can be applied to obtain a better view of the future, one that is sufficiently sound to give an adequate foundation for decision making"
ESTO, 2001a,b	Technology forecasting	"continuous monitoring of technological developments leading to an early identification of promising future applications and an assessment/validation of their potential"
Lowridge, 1986	Technology assessment	"can be described as the anticipation of impacts and feedback in order to reduce the human and social costs of learning how to handle technology in safety by trial and error"

The analysis done by OECD has increasingly dealt with the understanding of the dynamic features of knowledge-based economy and its relation to traditional economy in "new growth hypothesis". OECD deals with organization and leadership of an "information society" using growing knowledge and its transference through communication and emerging computer networks. (OECD, 1996)

**Table 2 - Definition of knowledge-based economy**

Author	Definition
Luc Soete 1998	Knowledge-based economy is a type of economy in which production, distribution and use of knowledge are the main factors for growth, producing wealth and creating jobs in all industries.
Boettke Econ Spring 2004	Today, knowledge is the foundation of new investment. Growth and moving forward of future economy is through accumulation of knowledge. It is attempted to introduce knowledge-based economy as the predominant tool.
Nelson 1982; Pavitt 1984	Knowledge-based economy pays attention to both human assets and knowledge in knowledge-based economy.
OECD 2003	Knowledge-based economy considers knowledge as a general tool at international level and its spread is not limited and is non-competitive. However, this does not mean that no competition happens to obtain that. Instead, it means that its use by one person will not limit its supply and consequently will not limit others' ability to use it.

**3. Methodology**

This research is descriptive from the methodological point of view. All activities of this research follow the same method or strategy that is easily recognizable. It consists of different aspects that each is appropriate to address a particular issue. The aim of this research is to describe different parts of a condition or series of conditions. This research describes and interprets what exists and pays attention to existing conditions and relations, prevalent beliefs, current processes or developing trends. The focus of this research is firstly on the current time, though it relates past events to existing conditions and gives some suggestions for the future. The method of this research is an integration of quantitative, adaptive, and qualitative. In the quantitative method, randomized sampling and structured Interviews were performed. In the adaptive study, the knowledge-based economy indices are evaluated and in the qualitative study, sampling techniques and tools like exploring samples, studying documents, questionnaires, interviews, and observations were adopted.

In order to determine the content validity we used the validity coefficient. In addition, the degree of relevance of questions in the questionnaire after the calculation of the mean of given grades was determined. The reliability of the whole questions was determined by eliminating individual questions. The result was that each questions of the questionnaire had proper correlation coefficient with the whole questionnaire. The correlation coefficient between questions 1-37 with the question number 38 was 0.827, which is statically significant (p > 0.0001).

In this research in order to determine the reliability of tools, the Chronbach's alpha was used. The questionnaires of 30 people were used as primary sample and the resulting Chronbach's alpha was 0.832.

The statistical population of this research is a technology-based company with 462 employees and using the Cochran's formula, the sample size was calculated to consist of 210 people and the questionnaires were distributed randomly.

The questionnaire had three sections. The first section was a brief explanation of the questionnaire and the way to complete it. The second section included some personal information and consisted of three questions regarding the age, educational level, and work history of respondents. The third section consisted question regarding innovation, knowledge and technology environment of the organization. The questions of the third section were close-ended. The questionnaire consisted of 38 questions of 7 dimensions as follows: structural factors,

questions 1-9; knowledge variables questions 10-22; competitiveness, questions 23-26; knowledge adopting contexts, questions 27-32; demand related factors, questions 33-36 and knowledge-based economy, questions 37-38.

#### 4. Data analysis

Since the collected data do not have a normal distribution pattern and that the variables of the study are independent, the non-parametric Kruskal-Wallis test was used for hypothesis test and data analysis. Each of the hypotheses is explored as follows:

##### **Hypothesis 1: the faster the speed of knowledge production, the easier the establishment of knowledge in economy**

Eight questions from the questionnaire are related to knowledge and innovation development.

The confidence level of the test is 95% and since the sig of all variables is less than 5%. The H1 hypothesis and thus the following claim are not rejected: the speed of knowledge production, which is one of the main obligations of Technology monitoring units, plays a role in developing the knowledge-based economy. It is concluded that countries must pay more attention to technology monitoring, Application, and spread of its achievements and play a more active role in knowledge production because in this manner they can move toward knowledge-based economy. The results of this study show that a country that pays more attention to its monitoring units has stronger foundations in knowledge-based economy and can comprehend the existing knowledge of the world much faster.

##### **Hypothesis 2: increase in competitiveness at international level, more access to markets and speed in knowledge exchange will improve knowledge level in the field of economy largely.**

Four questions from the questionnaire deal with commercial environment and competition at international level.

The test has been performed at 95% confidence interval and since the sig of all variables is less than 5%, the H1 hypothesis and thus the following claim are not rejected: increase in competitiveness at international level and more access to markets affects knowledge-based economy.

Competitiveness in industry and trade sections is the cornerstone in economic growth of countries. Competitiveness allows countries to pioneers in trading, to improve their economic foundation and to achieve their appropriate position at international level and enhance their credit and prestige. Technology monitoring units are considered as a competitive advantage for organizations. One of the duties of these units is to prepare organization to enter the international competition field. This means that through technology monitoring and updated knowledge of the world they can take appropriate steps to succeed in international competition.

##### **Hypothesis 3: the faster response to demand changes, the more paved the way of forming knowledge-based economy.**

Four questions from the questionnaire are related to environmental demands and response to them.

The test has been performed at 95% confidence interval and since the sig of all variables is less than 5%, the H1 hypothesis and thus the following claim are not rejected: fast response to demand changes affects the trend of developing knowledge-based economy.

Monitoring units are responsible for assessment of fast changes of demands. One of the duties of these units is to Observe the changes in society demands and response to these changes is one of the requirements of knowledge-based economy.

##### **Hypothesis 4: the more available the contexts for adopting information and knowledge, the easier the movement toward knowledge-based economy.**

Six questions from the questionnaire are related to the contexts for adopting knowledge.

The test has been performed at 95% confidence interval and since the sig of all variables is less than 5%, the H1 hypothesis and thus the following claim are not rejected: the presence of necessary contexts for adopting knowledge and technology affects the development of knowledge-based economy.

One of the requirements of knowledge-based economy is to prepare the necessary contexts for adopting knowledge. Technology monitoring units can prepare these contexts through their process mechanisms.

##### **Hypothesis 5: the strategy of technology-based firms enhances the possibility of achieving knowledge-based economy.**

Three questions from the questionnaire are related to strategies of commercial firms.

The test has been performed at 95% confidence interval and since the sig of all variables is less than 5%, the H1 hypothesis and thus the following claim are not rejected: appropriate strategies of organization affects the movement toward knowledge-based economy.

In the current competitive environment, survival and growth of firms requires competitive advantage. The approach that can create competition advantage for organizations is a strategy. Since the technology, monitoring units can create competition advantage for organizations; the organization strategy must be knowledge-based in order for the monitoring units to be able to create the above-mentioned competition advantage. The strategy of technology-based firms will pave the way to develop knowledge-based economy.

##### **Hypothesis 6: the clearer the mission of organizations, the easier the establishment of knowledge in economy.**

Four questions the questionnaire are related to the structural factors of an organization.

The test has been performed at 95% confidence interval and since the sig of all variables is less than 5%, the H1 hypothesis and thus the following claim are not rejected: organizing the appropriate mission for organizations affects the development of knowledge-based economy.

Mission specifies the existential basis of an organization. The existential basis of today's organizations is to respond to the demands of a society with all its particular features. Technology monitoring units provide the necessary conditions for an organization to be able to accomplish its missions.

#### 5. Factor analysis of variables

Confirmatory factor analysis was used for classification of variables. The first parameter is "completely effective", the second parameter is "effective", and the third parameter is "probably effective".

In the resulting table of the factor analysis, variables that are completely effective on research and their absence would distort the development of knowledge-based economy were placed in the column of parameter 1 in the inverted matrix. These variables are as follows:

- Appropriate performance of duties by employees
- Moving toward success, large scale goals and organization missions
- Appropriately organizing the missions of the organization
- Tradition change
- Appropriately organizing strategies of the organizations proportional to current conditions of the society
- Allocation of enough time to employees for assessment of ideas
- Protecting the employees and their ideas
- Speed in science production
- Information regarding commercial environment and competitors
- Competitiveness at international level
- Activity of research and development unit
- Response to change in demands
- Knowledge-based economy

##### **Variables that are categorized in the second parameter group are effective on research. These variables are as follows:**

- The commitment of employees in performing their duty

- Type of organization strategy
- Seeking new ideas
- Appropriate response to employees ideas
- Awareness of employees of new knowledge
- Appropriate infrastructure
- Employee training
- Employees response to customers' demands

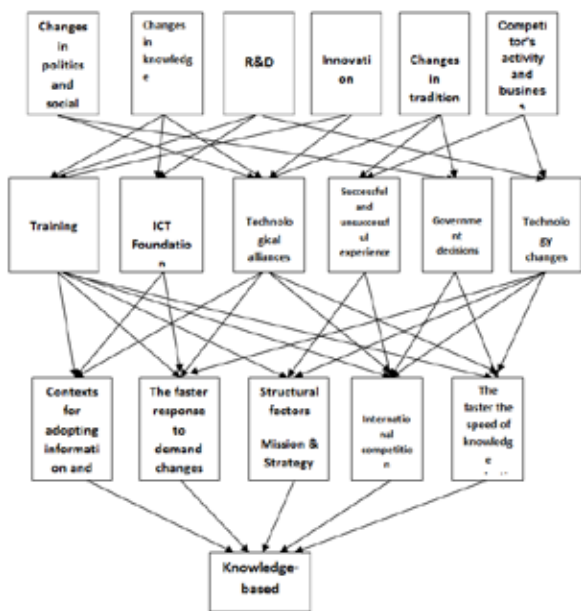
**The effect of variables of group 3 on dependent variable is not precisely known. These variables are as follows:**

- Work monitoring by employees themselves
- Freedom in testing the ideas
- Employees protecting each other
- Awareness of social and political situation
- Awareness successful and unsuccessful experiences

The speed of science production, competitiveness at international level, appropriate response to demands, preparing the proper context for adopting knowledge and organization of structural factors of organizations are directive effective on development of knowledge-based economy. The effect of other mentioned variables on development of knowledge is indirect and through factors mentioned above.

**6. Conceptual model of effect of technology monitoring on knowledge-based economy**

The other hypothesis of the study is to present a model for effective variables on knowledge-based economy. The presented model in this study is designed by the software Expert Choice and AHP hierarchical analysis.



**Figure 1- Conceptual model**

**7. Discussion**

This study is about technology monitoring in a technology-centered organization that besides exploring the process of implementing technology monitoring, has also studied the effective factors on developing knowledge-based economy. The analysis of the data has indicated that development of technology monitoring units and appropriate performance of its roles establishes the foundation of developing knowledge-based economy. The major role of technology monitoring units is to monitor the technological progresses. In fact, this role is similar to listening to external signals that happen outside and to monitor the evolution of technology. Likewise, the organizations can move along with environmental changes. With updated information, organizations can be aware of the situation of their competitors at international level and by enhancing knowledge production; they can move forward and leave them behind.

Some of the effective factors on developing knowledge-based economy are as follows: progress at information technology and ICT commu-

nication, speed in knowledge production, enhancing competitiveness at international level, fast response to demand changes, education, study, research and development of innovations, governmental roles, cultural endeavor to change traditions and enhancing online economy. (Policy Forums 1999)

According to results of this study and the paragraph above it could be concluded that establishment of technology monitoring units can provide about 70% of effective factors on development of knowledge-based economy.

**8. Conclusion**

Some of the numerous parameters which are important for moving toward knowledge-based economy are as follows;

- Identification of changes in technology
- Social and political changes
- Quick response to changes in demand
- Enhancing competitiveness at international level
- Speed in knowledge production
- The dimension of the firm
- Structural factors of the organization
- The mission of the firm
- The type of adopted technology
- Field of work and the history of the firm (the experience of the firm)
- The strategy of the firm and the type of activity of competitors and changes in commercial environment, freedom of employees in their work
- The amount of innovation and creation of knowledge by employees

All the above parameters are the duties of the development of technology monitoring units in organizations. Therefore, the establishment and appropriate performance of technology monitoring units pave the way for directing toward knowledge-based economy.

From the result of this research, it can be concluded that the speed in knowledge production, creating the necessary background for adopting knowledge and information, the strategy of firms, the mission of the organization, enhancing competitiveness at international level and quick response to changes in demands are the most important applications of technology monitoring units.

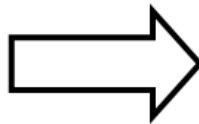
As the result of the research indicates the speed in knowledge, production influences the development of knowledge-based economy. Thus, it is suggested that the organizations enhance the knowledge and innovation environment and organization managers provide courses for their employees to improve innovation of their organizations and organize instructions for development of technology monitoring units and create the necessary information technology contexts.

Innovation capacities in people may develop over a long period. Therefore, the educational managers are advised to focus on these capacities at lower educational levels so that in the future society and organizations people of higher degree and better quality of innovation can be observed.

It is also suggested that the employees should enhance the environment of knowledge and innovation and that the managers of organizations provide courses to enhance the degree of innovation at organizations and organize instructions for development of technology monitoring units. As it can be seen from the figure below, the appropriate performance of technology monitoring units will provide the

effective factors for development of knowledge-based economy.

<b>The results of Establishing technology monitoring unit in organizations</b>
Increase innovation
Knowledge creation
ICT foundation
International competition
Changes in culture
The faster response to demand changes
Changes in organization mission
Awareness of Successful and unsuccessful experience
Awareness of the latest technological advances



<b>Effective Factors in creating knowledge-based economy</b>
ICT Foundation
Faster speed in creating knowledge
Increase in international competition
Faster response in demand changes
Training
R&D
Cultural activity in tradition changes
Increase the online economy

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