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Technology level evaluation methodology based on the technology growth curve

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ABSTRACT

Technology has been the driving force of development for knowledge-based economies. As competition in technology innovation among nations becomes more intense, there is a growing need for improved judgment, evaluation and prediction of scientific technology capacity in order to enhance national competitiveness. Until now, a country's technology level has been evaluated on a relative basis by comparing it with that of the country with the world's best technology. However, this kind of static methodology makes the interpretation of results unclear and makes time series analysis difficult. One of the most important limitations of this methodology is that it cannot be used to establish a strategy to improve the technology level. This paper examines the methodological problems of technology level evaluation and develops a dynamic methodology by applying the technology growth curve model. We also analyze the real technology level by using a new model application and review the relevance of this method. Finally, we discuss how to use the results in order to create a dynamic technology strategy.

1. Introduction

Science and technology have been the foundations of knowledge-based economic societies. As competition in technology innovation among nations becomes more intense in the theoretical and social paradigm called the national innovation system, there is a growing need for improved judgment, evaluation and prediction of scientific technology capacity in order to enhance national competitiveness [1,2].

The International Institute of Management Development and the World Economic Forum annually release a national competitiveness index that measures the national capacity to improve economic growth and the standard of living.[1] This index includes science technology competitiveness. In addition, major industrialized countries undertake technology capacity evaluation as part of establishing strategies for mid-term technology development and predicting trends in technology. Examples are the 'National Core Technology Report' (the United States 2005), the 'Study on Research and Development Levels' (Japan 2000), and the 'Study on 20-year Technology Predictions for the Future' (China 2008).

In Korea, research institutes under each government ministry carry out technology level evaluation, as shown in (Table 1). The purpose of the technology evaluation is to use fundamental information and to identify future potential technology so as to create strategies for technology development and investment in national R&D. The most valuable results of the evaluation relate to levels of, and gaps in, technology development among countries. The reasons behind technology gaps, their contributing factors and the core technology for improving technology capacity can be evaluated depending on the need for a technology development strategy. However, the content and methodology are not consistent, and the framework was designed in accordance with the

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[1] The International Institute of Management Development and the World Economic Forum annually release the 'World Competitiveness Scoreboard' and the 'Global Competitiveness Index', respectively.

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Table 1
Korean cases of technology level evaluation.[a]

	KISTEP	IITA	ITEP
Title	Future potential technology (2005)	Research report on IT level (2008)	Analysis of industrial technology level (2006)
Purpose	Analysis of the current status for effective R&D establishment	Preliminary research for technology planning	Identification of future potential industrial technology
Evaluation subject	21 core technologies of the nation	239 core technologies	1650 core industrial technologies (final count is 874)
Subject nations	Korea, U.S., Europe, Japan, China	Korea, U.S., Japan, China	Korea, U.S., Europe, Japan, China
Methodology	Poll of organizations, groups and corporations	AHP model Gordon model	How to allocate budget Equal-weight method

[a] KISTEP is an institute for evaluating and planning science and technology on a national level under the Ministry of Educational Science and Technology. The IITA was an institute for planning and promoting of Information technology under the Ministry of Information and Communication. The ITEP was an institute for performing and evaluating of R&D under the Ministry of Commerce, Industry and Energy. The IITA and ITPE were combined into the ITEP in 2008.

institutes' perspectives and purposes. However, the methodologies used for the technology level evaluations had one feature in common: the technology gaps and technology levels of individual countries were compared with those of the country with the world's best technology. This is a static method by which technology gaps (in percentages) and technology levels (in years) of individual nations are evaluated in comparison with the technology level of a reference nation prevailing at a particular point in time, which is set at 100. However, the reference standard of 100 is not an absolute value. Rather, it is a relative value that changes over time. Hence, it is impossible to compare technology levels through time series analysis, and this causes difficulties when trying to establish a strategy for improving technology levels.

In this paper, we examine the limits of the existing methodology and propose a dynamic methodology for technology level evaluation by using a technology growth curve. Furthermore, we identify the meaning and limits of dynamic analysis, including the technology life cycle and the pace of development implied by the technology growth curve. And this paper includes the result of evaluation based on this new methodology. We also discuss how to establish a strategy for technology development using dynamic methodology for technology level evaluation as a future research project.

2. Research approach and literature review

2.1. The need for a dynamic technology level evaluation

The technology level refers to the ability to use technological knowledge efficiently and to the extent to which technological knowledge is accumulated, invested in, produced and innovated. The science technology level refers to the current level of technology accumulation or accomplishment based on past science technology activity. Therefore, technology level evaluation refers to statically evaluating the extent of technology performance and capacity at an evaluation point [3,4].

The technology level evaluation is designed to establish a strategy for technology development in the form of technology planning, creating an R&D portfolio and getting a picture of potential technology. Korea is aggressively engaged in the evaluation of its science technology level. Korea needs to measure the technology level of its major core technology and to devise steps to improve its technology level in order to facilitate the development of science technology under the framework act on science and technology.[2]

The technology level is fundamentally dynamic. In other words, the level of science technology is always changing [5]. However, the theoretical concept behind the conventional methodology is one dimensional, and the method is based on static evaluation. The limitations of this methodology are illustrated by the following two factors. First, there is restraint on the relative expression of the technology level. Looking at existing cases of Korea's technology level evaluation, the level of the technology under consideration has been restrictively evaluated at the evaluation point. In other words, it is a relative evaluation and shows the technology level of Korea and other nations in relation to the standard of 100, which is the evaluation of the world's leading technology country. This makes time series analysis and comparisons impossible. In addition, it is impossible to establish mid- and long-term strategies for technology by using the results of this type of evaluation. Second, what is meant by the number of years for the technology gap? For example, does a gap of one year mean that Korea's technology level will match that of the country with the world's best technology level in one year's time? What about the technology level of the current world's best? What will be the standard after one year has passed? What about the technology gap? How should one interpret a widening gap despite technological improvement? Thus, interpreting the technology gap is problematic [6–8].

Absolute evaluations of technology levels should be made in order to produce results that can be used to create strategies for technology development. The technology level of the world's best needs to be determined based on the theoretical upper limits of technology. Also, the time it takes for each nation to reach the theoretical upper limit needs to be determined. Analysis of not only the current technology level but also the technology path and the pace of development for the future from a predictive point should be made [9].

[2] KISTEP has carried out technology level evaluations on science technology since 2001 and has taken charge of national technology planning, which includes making technology foresight, road map and assessment.