



# Development of post-evaluation model for future and emerging technology item reflecting environmental changes



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## ABSTRACT

This study suggests a post-evaluation model for future and emerging technologies identified by previous foresight activities to determine whether their potential has been maintained, extended, or minimized due to rapid technological and social changes in the research and development environment occurring after the technology item was selected. Moreover, the proposed model is based on specialist insight, and can measure whether the selected technology is still promising and socially and technically feasible at the current time domestically and worldwide based on a technology growth curve. The results of the case study suggest which technology items have been implemented or unimplemented due to particular accelerators or obstacles, which items are still promising, and the technology level of the items. The proposed model focuses on the technology items themselves, whereas previous evaluation activities have focused only on the process and impacts of foresight projects. Moreover, this post-evaluation model can be applied to various emerging technology items that are continuously selected and reported around the world, allowing for the monitoring of changes in the brightness and realization status of previously selected items. Thus, the model can provide feedback for the future selection process to improve the reliability of emerging technology selections and suggest the information for decision-making with related to a particular emerging technology item.

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## 1. Introduction

Government divisions, public research centers, private professional institutions, and individual companies around the world are increasingly focused on identifying future and emerging technologies or conducting technology foresight projects (see Table 1). Once the preliminary rounds of investigation are completed, activities can be focused on making strategic progress with regard to implementation. Indeed, practical pursuits, such as the establishment of roadmaps for national or corporate implementation, budget allocation, and portfolio setting, have increased in order to build on research efforts related to future and emerging technologies.

In addition, emerging technology presentations held by governments or professional forecasting institutions are considered key in leading the research and development direction of private companies and public institutions. Companies and institutions that want to enter new markets and expand their research and development will select certain emerging

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**Table 1**

Major examples of technology foresight and identification of emerging technologies.

Country	Responsible agents	Project or recent products	Period
United Kingdom	Department for Business, Innovation and Skills (DBIS) Government Office for Science–Horizon Scanning Center (HSC)	The UK Technology Foresight Programme Foresight projects: “Technology and Innovation Futures: UK Growth Opportunities for the 2020s–2012 Refresh” Horizon scanning reports	1994–1999 1999–2002 Every other year Intermittent
Japan	National Institute of Science and Technology Policy (NISTEP)	“Science and Technology Foresight”	Every five years
United States	Office of the Director of National Intelligence–National Intelligence Council (NIC) MIT Technology Review TechCast	“Global Trends 2030: Alternative Worlds” “10 Breakthrough Technologies” “Forecasting the Technology Revolution: Results and Learnings from the TechCast Project”	About every five years Every year (private sector)
Korea	Gartner Korea Institute of Science and Technology Evaluation and Planning (KISTEP) Korea Institute of Science and Technology Information (KISTI)	“Top 10 Strategic Technology Trends” “Technology Foresight” “10 Promising Technologies”	Every five years

technologies based on their promise, feasibility, marketability, sustainability, and relevance to their technological competences.

It is important to ensure the reliability of the approach used to select future and emerging technologies, as this process has a significant impact on national R&D strategy as well as on firms' R&D strategy. Thus, there is increasing interest in the evaluation process used to select which future and emerging technologies to adopt. These evaluations are often made with limited information, although many countries put significant effort into examining future and emerging technologies (Grupp & Linstone, 1999). A recent study suggested that the findings of technology foresight projects and the list of emerging technologies have not been fully utilized because of low applicability of the long-term foresight results. (Van der Steen & van Twist, 2012).

European countries, such as the United Kingdom, Germany, and Hungary, which conduct various technology foresight activities have examined the processes used in foresight programs and their influence; however, these projects were short-lived (Poteralska & Sacio-Szymańska, 2013; Yoda, 2011). Those European evaluation efforts have focused largely on assessing projects themselves and their impact on society rather than on selecting future technologies and identifying their potential for implementation.

Because future and emerging technologies are derived from a variety of environmental and trend information disclosed until the time of selection, it is necessary to evaluate the emerging technology retrospectively. Thus, there is a need for a dynamic post-evaluation model that can examine changes in the potential of the future and emerging technology from the time of selection through the technical, social, economic, and environmental activities carried out post selection. Such a model could identify the validity of the technology at the present time. Future and emerging technologies are often considered state-of-the-art at the time of selection. Thus, there is significant uncertainty for firms and researchers adopting such technologies immediately. In such a case, firms and researchers may want to re-evaluate the technologies to determine whether their investments are warranted after a few years from the time of selection.

When considering the entire life cycle of the foresight activity (Andersen & Andersen, 2014), the post-evaluation of foresight activity and its results can contribute to improving the potential value and the applicability of foresight. Reflecting the changes in the social and technological environment and deriving the direction of improvement of the foresight process can introduce more extensive information to the foresight activity. Monitoring the dynamics of emerging technologies can improve the applicability of foresight results.

Therefore, this study suggests a post-evaluation model for future and emerging technologies based on specialist insight that can be used to determine whether a technology is still promising, whether it has been realized, and its growth level at the current time in light of all environmental changes, such as technological innovation, globalization, and convergence after the selection.

## 2. Previous studies

The evaluation can be divided into the process and the outcome. The process evaluation should consider organization and management (e.g., participation of scientists for the pertinent field, proper supporting systems, and agreement with the decision maker) and propriety and efficiency of applicable data and methodology (e.g., applicability of appropriate

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