# Industrial Technology Competitive Analysis and Its Implications

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## 1. Introduction

Amidst the chaos of the 4th Industrial Revolution, the leaders of the pack are emerging. On the foundation of the digital revolution, the world is entering the era of an industrial big bang, in which the boundary between the actual and the digital world is crumbling into pieces. Major countries have recognized the 4th Industrial Revolution as the innovative agent not only of national development but also of the development of the economy and society, and have announced national development strategies to break through the Age of Austerity; these include the 'industrial internet' (United States), 'Industrie 4.0' (Germany), 'JAPAN is BACK' (Japan), and 'Made in China 2025 Strategy' (China). Furthermore, a few innovative enterprises which achieved early dominance in the platform ecosystem are leading the global economic order, with the R&D investment of the top 1,000 global corporations exceeding USD 700 billion for the first time in the history of mankind in 2017.

While Korea also invests a substantial amount into R&D, quantitative expansion of investment has failed to facilitate growth, and thus the country is in a growth recession. As of 2016, Korea's R&D spending to GDP ratio ranked second-highest in the world, a 1.5 fold increase (2.83% in 2006 → 4.24% in 2016) from 2006. However, the growth rate and technological competency of Korea is stagnant, or even has decreased, and the path from quantitative expansion of investment to growth has been blocked. Also, in recent years, Korea's R&D investment has entered a recession due to weakened growth potential and an increase in demand for welfare. The government's R&D growth rate, which exceeded 10% on average in the 2000s, gradually decreased after 2008, and has been maintained at around 1% since 2016 based on the R&D efficiency policy.

Establishing plans to respond to the increasing uncertainties and changes in the social, political and economic sector is crucial to maintaining industrial and national competitiveness. To this end, the lifespan of IT, science and technology, and the impacts of the rapid pace of their development on the industry and industrial technology should be identified in advance to prepare the response strategy. Predicting the environment of future industrial technology is also becoming important, as the speed of change is accelerated through globalization and ICT such as social media, increasing the level of uncertainty of

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the future.

In this light, an analysis and enhancement of the political usability of policy paradigms for global innovative nation and the changes in the future industry environment is needed. An in-depth review on the factors which influence the current industry—such as the economic, social and political environment—should take place, based on which the analysis paradigm of the industrial technology R&D competitiveness should be designed. It is urgent to establish short-term, medium-term and long-term growth strategies in order to lead and achieve preemptive responses to the global competition caused by the rapid changes in the industrial environment such as the 4th Industrial Revolution.

This study aims to suggest a methodology for such a competitiveness analysis, verify its potential for application in the future and derive implications by implementing the method in the actual industrial technology sector.

## 2. Industrial Technology Competitiveness Analysis

### *2.1 Overview*

Industrial Technology Competitiveness Analysis refers to the analysis of the environment of industrial technology in the market using quantitative and qualitative methodologies. Qualitative analysis includes analysis on private and government investment while quantitative analysis includes Value-chain Analysis, Industrial Structure Analysis and Patent Analysis.

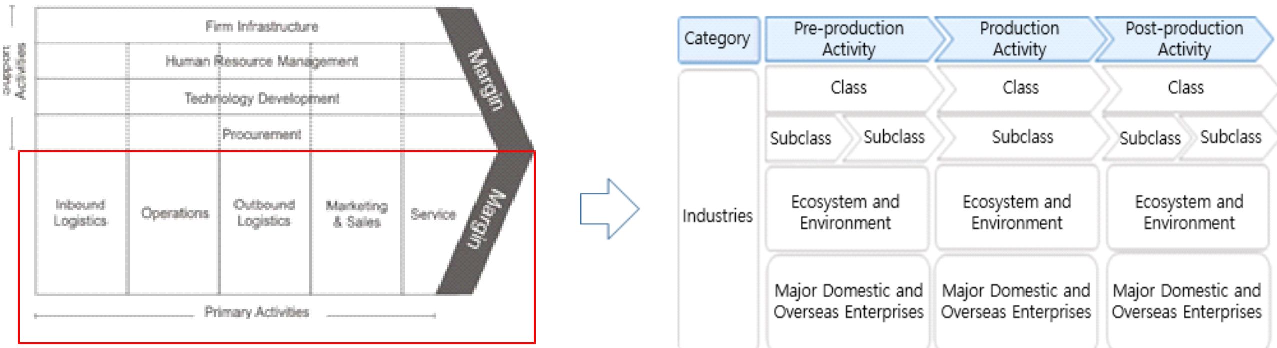
The final outcome of a competitiveness analysis is not expressed in a single numerical value, but consists of multiple results from the aforementioned various methods of analysis. These results are ultimately used as basic data in establishing the visions and strategies of industries. Table 1 shows an example of the application of competitiveness analysis on'Industrial Technology R&BD Strategy' and 'Industrial Technology Roadmap.'

**Table 1.** Cases of Application of Industrial Technology Competitiveness Analysis

| [Industrial Technology R&BD Strategy] | [Industrial Technology Roadmap] |
|---|---|
| Ⅰ. Concepts and Characteristics<br>Ⅱ. Current Industrial Issues and Key Trends<br>1. Current Industrial Issues and Other Major Issues<br>2. Global Trend<br>Ⅲ. Industry Competitiveness Analysis<br>1. Investment Analysis<br>2. Business Value-chain Analysis<br>3. Industrial Competitiveness: 5-Forces Model, Patent Analysis<br>4. SWOT Analysis<br>Ⅳ. Vision and Strategy | Ⅰ. Changes in Megatrends<br>1. Definition and Scope of Industry<br>2. Changes in Megatrends<br>Ⅱ. Global Industrial Ecosystem Analysis<br>1. Industry Trends and Prospects<br>2. Industrial Structure Analysis: Value-chain Analysis, 5-Forces Model<br>Ⅲ. Industry Development Strategy<br>1. SWOT Analysis<br>2. Industry Objectives and Strategy |

* Source: Ministry of Trade, Industry and Energy (2018), Korea Institute for Advancement of Technology (2017)

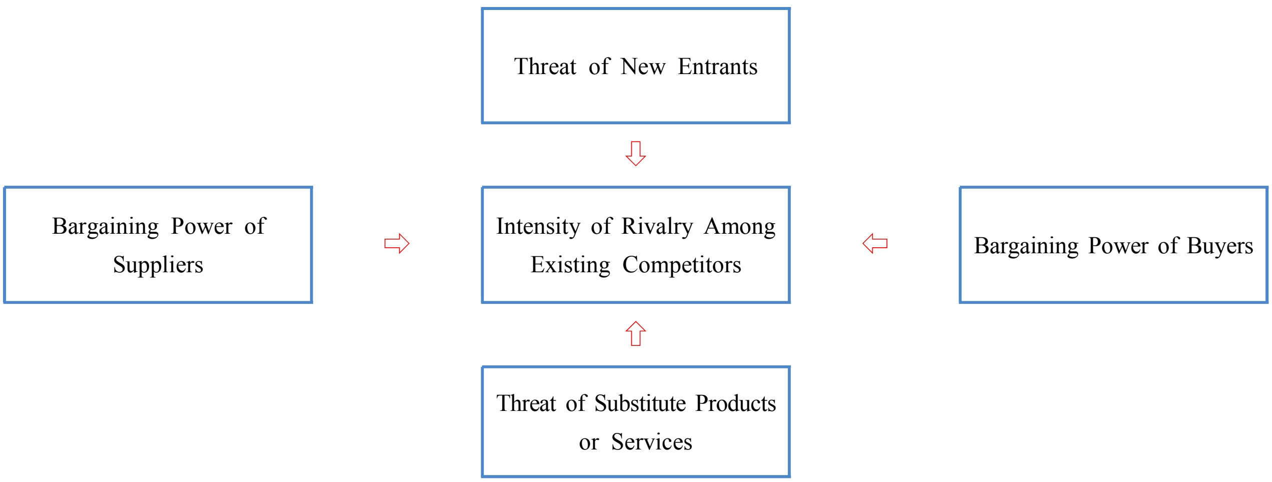
**Figure 1.** Value Chain Analysis




* Source: M.Porter, 1985

<Michael Porter’s Value-chain Model> <Value-chain Model of this Study>

**Figure 2.** 5-Forces Model




* Source: M.Porter, 1979

*2.2 Value-chain Analysis and 5-Forces Model Analysis*

This study aims to provide an explanation of both Value-chain Analysis and 5-Forces Model Analysis (two quantitative methods of competitiveness analysis) and provide the results of the two analyses. Both methodologies were developed by Michael Porter, an American economist, and are the most widely used methodologies in analyzing the competitiveness of industry.

Value-Chain Analysis was originally developed to categorize strategic unit activities of enterprises in order to understand the strengths and weaknesses of a company and analyze the source of incurred costs and existing and potential sources of differentiation with competitors (Porter, 1985), but nowadays it is widely used not only in corporate-level analysis, but also in understanding the ecosystem of a sector or industry. This study also took a more expansive approach by replacing primary activities with industrial activities.

The 5-Forces Model (Porter, 1979), a method of industrial structure analysis, lists five major factors which influence the industrial environment (5-Forces), as following: threat of new entrants, bargaining power of buyers, bargaining power of suppliers, threat of substitutes and industry rivalry. By analyzing the five forces while considering the internal capacity of an industry, it is possible to effectively determine which threats to respond to and which to avoid. In this study, this method was used to analyze the current condition and the future of certain fields of industry.

## 3. Result of Industrial Technology Competitiveness Analysis

### *3.1 Subject and Method of Analysis*

In this study, an Industrial Technology Competitive Analysis was conducted on 20 industrial technologies as defined in the 'Industrial Technology R&BD Strategy[1)]' of the Ministry of Trade, Industry and Energy.

**Table 2.** Definitions of the Topics of Analysis

| Field | Industry | Definition |
|---|---|---|
| Transportation | Highly Convenient Long Distance Electric Vehicle | Electrically Propelled Vehicle (xEV) is a vehicle which uses electrical energy supplied from a secondary battery or fuel cell as the source of power for driving |
| | Highly Reliable Autonomous Vehicle | Vehicle which allows safe driving through autonomous control and minimization of driver control through automatic autonomous control based on self-recognition of surrounding environment and route planning |
| | High Performance Drone | Drone refers to an aerial vehicle or its system which performs designated tasks without a pilot aboard the vehicle |
| | Environment-friendly Smart Shipbuilding & Offshore Plant | Vessels, offshore plants and equipment with environment-friendly and smart technology. Vessels, offshore plants and equipment with environment-friendly technologies to reduce energy consumption and atmospheric·marine pollution and ICT for autonomous·unmanned navigation·operation, remote diagnosis and maintenance |
| Bio-Health | Digital Health Care | Industry of convergence between ICT and health care, which provides advanced patient-customized medical service and health management products·services to improve public health using ICT such as big data or AI |
| | Customized Bio Medicine | Industry which provides ideal outcomes through a comprehensive diagnosis of genetic attributes and biochemical reaction mechanisms based on genetic information and blood |
| | Smart Medical Appliance | Industry which produces customized smart medical appliances and services, providing preventive and customized treatments based on measurement, diagnosis and treatment using miniaturized, intelligent and responsive devices |
| Smart Electronics | Convenient and Safe Smart Home | New service industry which converges ICT with the residential environment to improve quality of life.<br>Home appliance·home-net + Convergence of IoT·AI·big data ➡ establishment of people-centered residential environment |

1) Master plan for the Plan for Innovation of Industrial Technology (Five-year plan) in accordance with the Industrial Technology Innovation Act, which serves as the basic strategy for R&D task planning. While the Strategy includes the energy sector, this excluded from analysis for this study.

| | | |
|---|---|---|
| | Human-friendly Service Robot | Service robots refer to all robots except for base fixed robots used in manufacturing |
| | Customized Interactive Wearable Device | Provides physical and cognitive augmentation using wearable devices and related service platforms, and creates new industries which provide better quality of life through interaction between the reality and virtual information |
| Smart Manufacturing | Flexible Intelligent Information Display | Flexible boards which exceed the level of performance of existing glass boards or vacuum technology-based LCD and OLED, providing new video display functions through ultra-high definition, non-vacuum process and convergence with other technologies |
| | Intelligent Semiconductor | Industry of semiconductors for smart services including calculation, control, transmission, conversion, and storage in IT convergence products (smart cars, IoT, wearable smart devices, etc.) and materials, components and equipment used in the production of such. |
| | High-tech Manufacturing Process·Machinery | Industry which provides customized equipment and systems through the convergence of production and manufacturing equipment and innovative technologies (robot, AI, big data, IoT) to supply components·products for strategic industries |
| | Smart Industrial Machinery | Smart industrial machinery refers to an engineering solution which supplies the intelligent machineries and systems needed for future construction and farm works, and provides environment control systems and physical flow to precision manufacturing processes and large-scale buildings |
| | 3D Printing | A technique which produces 3D materials by laminating materials using digital design data rather than through cutting and molding |
| Infrastructural Investment | Intelligent Information Service | New knowledge-convergent technology which strengthens the competitiveness of the industry and creates added value for products and services through systematic service internalization based on diverse industrial knowledge |
| | Smart Engineering | Advanced engineering industry which accomplishes comprehensive optimization throughout the entire cycle of engineering of design − construction − operation through the adoption of smart technologies in generic engineering technology, such as design·project management (PM)·plant operation & management (O&M) and the establishment of a digital cooperation environment, based on the application of data-based ideal decision-making technology developed through the convergence and integration of intelligent information technologies of the 4th Industrial Revolution |
| | Design Convergence | Industry which provides comprehensive product·service concept design and user-focused problem-solving technology development |
| | New High-tech Material | Innovative materials which can achieve new performances and functions that can lead the advancement of five new industries and other major industries |
| | Clean Manufacturing | Technology which minimizes environmental load (resources·energy consumption and generation of pollutants) throughout the entire process of material adoption, production, utilization and disposal, and includes clean process, environmental products and services businesses |

* Source: Ministry of Trade, Industry and Energy (2018)

Two analyses were conducted on 20 fields of industry to determine outcomes. First, a planning committee consisting of around 10 experts from the industry, academia and research institutes in each field was formed and operated to conduct Value-chain analysis, and an on-line survey[2] of experts was conducted as the second phase of the analysis. For industrial structure analysis, the planning committee conducted the first phase evaluation based on the points of five factors of competition, which was then supplemented with a peer review by experts.

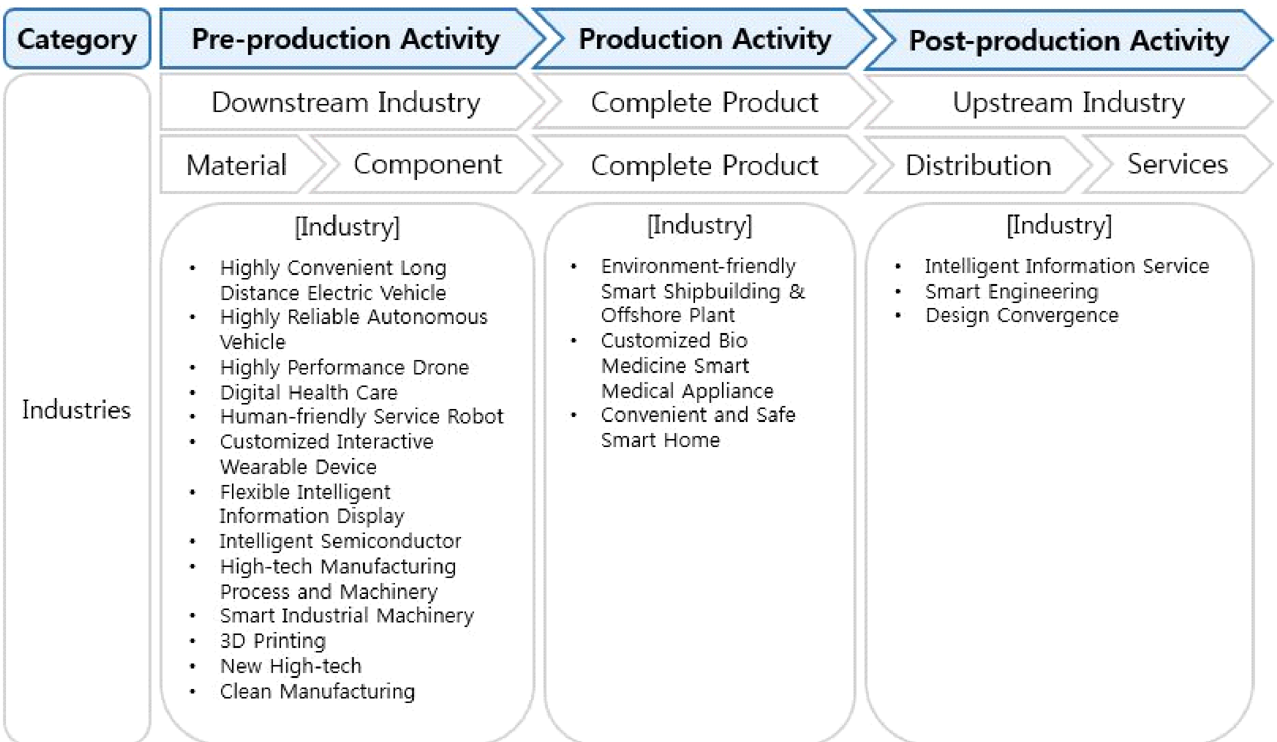
### *3.2 Results of Analysis*

By first conducting a Value-chain analysis on 20 industrial technologies, it was found that the ecosystem of all fields was arranged in the form of a value chain consisting of downstream industry → complete product → upstream industry. Downstream and upstream industries were each segmented into material and component, and distribution and service, while the complete product was not segmented.

The stages of the ecosystem which the 20 industrial technologies place their emphasis vary. By field, transportation, smart electronics and smart manufacturing place an emphasis on downstream industries, while bio-health focuses on complete products, and infrastructural investment focuses on upstream industries.

Downstream industries consist of materials and components industries, and upstream industries consist of distribution and services industries. The results of the detailed analysis by industry is shown in Table 3.

**Figure 3.** Results of Value Chain Analysis




2) An on-line survey was conducted on 11,710 experts in 20 fields at KIAT, and the responses of 530 experts were used to analyze the results.

**Table 3.** Detailed Results of Value Chain Analysis

| Category | | Downstream | | | Complete Product | Upstream | | | Others |
|---|---|---|---|---|---|---|---|---|---|
| | | | Material | Component | | | Distribution | Service | |
| Transportation | Highly Convenient Long Distance Electric Vehicle | 70.8 | 24.8 | 46.0 | 19.8 | 8.3 | 4.6 | 3.7 | 1.0 |
| | Highly Reliable Autonomous Vehicle | 78.1 | 17.5 | 30.6 | 30.8 | 20.0 | 6.9 | 13.1 | 1.1 |
| | High Performance Drone | 28.5 | 10.9 | 17.6 | 41.5 | 24.5 | 7.1 | 17.4 | 5.6 |
| | Environment-friendly Smart Shipbuilding & Offshore Plant | 42.3 | 6.3 | 36.0 | 26.3 | 25.0 | 6.0 | 19.0 | 6.7 |
| Bio-Health | Digital Health Care | 45.7 | 21.1 | 24.6 | 32.5 | 21.8 | 10.7 | 11.1 | 0.0 |
| | Customized Bio Medicine | 35.0 | 29.5 | 5.5 | 38.9 | 23.6 | 9.8 | 13.8 | 2.5 |
| | Smart Medical Appliance | 25.5 | 11.2 | 14.3 | 48.6 | 25.9 | 11.9 | 14.0 | 0.0 |
| Smart Electronics | Convenient and Safe Smart Home | 35.0 | 10.3 | 24.7 | 37.3 | 28.3 | 5.3 | 23.0 | 0.0 |
| | Human-friendly Service Robot | 59.2 | 21.5 | 37.7 | 15.4 | 23.1 | 7.7 | 15.4 | 2.3 |
| | Customized Interactive Wearable Device | 50.6 | 30.3 | 20.3 | 22.2 | 20.9 | 7.5 | 13.4 | 6.3 |
| Smart Manufacturing | Flexible Intelligent Information Display | 49.7 | 21.2 | 28.5 | 27.7 | 8.4 | 4.6 | 3.8 | 6.5 |
| | Intelligent Semiconductor | 62.5 | 20.7 | 41.8 | 23.6 | 11.4 | 6.4 | 5.0 | 2.5 |
| | High-tech Manufacturing Process·Machinery | 49.6 | 19.4 | 30.2 | 39.2 | 10.9 | 4.0 | 6.9 | 0.3 |
| | Smart Industrial Machinery | 46.0 | 15.0 | 31.0 | 31.3 | 19.2 | 9.8 | 9.4 | 3.0 |
| | 3D Printing | 58.5 | 29.6 | 28.9 | 18.9 | 20.3 | 6.4 | 13.9 | 2.1 |
| Infrastructural Investment | Intelligent Information Service | 10.3 | 3.1 | 7.2 | 18.6 | 70.8 | 11.4 | 59.4 | 0.0 |
| | Smart Engineering | 21.0 | 9.4 | 11.6 | 16.9 | 53.4 | 8.1 | 45.3 | 8.1 |
| | Design Convergence | 31.1 | 17.6 | 13.5 | 21.3 | 39.0 | 14.5 | 24.5 | 8.5 |
| | New High-tech Material | 69.1 | 45.2 | 23.9 | 17.6 | 12.4 | 7.0 | 5.4 | 0.7 |
| | Clean Manufacturing | 50.5 | 30.3 | 20.2 | 21.7 | 24.0 | 11.0 | 13.0 | 3.8 |

**Table 4.** Results of Industrial Structure Analysis

| Category | | Threat of New Entrants | Bargaining Power of Suppliers | Bargaining Power of Buyers | Threat of Substitute Products or Services | Intensity of Rivalry Among Existing Competitors |
|---|---|---|---|---|---|---|
| Transportation | Highly Convenient Long Distance Electric Vehicle | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| | Highly Reliable Autonomous Vehicle | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| | High Performance Drone | ⬇ | ⬆ | ⬆ | ⬇ | ⬆ |
| | Environment-friendly Smart Shipbuilding & Offshore Plant | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| Bio-Health | Digital Health Care | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| | Customized Bio Medicine | ⬇ | − | ⬇ | ⬇ | ⬆ |
| | Smart Medical Appliance | ⬇ | ⬇ | ⬆ | ⬇ | ⬆ |
| Smart Electronics | Convenient and Safe Smart Home | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| | Human-friendly Service Robot | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| | Customized Interactive Wearable Device | ⬆ | ⬆ | ⬆ | ⬆ | ⬆ |
| Smart Manufacturing | Flexible Intelligent Information Display | ⬇ | ⬇ | ⬆ | ⬇ | ⬆ |
| | Intelligent Semiconductor | ⬆ | ⬆ | ⬆ | ⬇ | ⬆ |
| | High-tech Manufacturing Process·Machinery | ⬇ | ⬆ | ⬆ | ⬇ | ⬆ |
| | Smart Industrial Machinery | ⬆ | ⬇ | ⬆ | ⬆ | ⬆ |
| | 3D Printing | ⬇ | ⬇ | ⬆ | ⬇ | ⬆ |
| Infrastructural Investment | Intelligent Information Service | ⬇ | ⬇ | ⬆ | ⬇ | ⬆ |
| | Smart Engineering | ⬇ | ⬇ | ⬆ | ⬇ | ⬆ |
| | Design Convergence | ⬆ | ⬇ | ⬆ | ⬇ | ⬆ |
| | New High-tech Material | − | ⬆ | − | ⬇ | ⬆ |
| | Clean Manufacturing | ⬇ | ⬆ | ⬆ | ⬇ | ⬆ |

* : ⬆(High, 5 Points), −(Normal, 3 Points), ⬇(Low, 1 Point)

Next, the results of the 5-Forces Model analysis showed that ‘Customized Interactive Wearable Device’ scored the highest points, and ‘Customized Bio Medicine’ scored the lowest. Overall, three industries in the field of bio-health showed less intensity of competition, which implies that there is not much that can be done considering that global pharmaceutical companies are monopolizing the market. In addition, the intensity of competition in the field of infrastructural investment did not converge towards a certain direction.

## 4. Conclusion and Implications

The study suggested Value-chain analysis and 5-Forces Model as the method of competitiveness analysis on 20 industrial technologies, and is presumed to have developed meaningful findings reflecting the characteristics of the industry. Based on this, the methodology suggested by the study can be used in the competitiveness analysis of other industries.

Two implications can be derived from the findings of the study. First, from the perspective of the industrial technology ecosystem, the proposed methodology can be used in the establishment of a new industrial technology strategy. That is, an industrial technology competitive analysis will enhance political utilization at three points in time to promote a growth strategy for Korea to become a global technology leader.

From the short-term perspective, the methodology can be used in the establishment of trend analysis and structure analysis (Value-chain analysis, current status of major enterprises, industry competitive analysis, etc.) in various R&D strategies implemented by government ministries. From a medium-term perspective, the methodology can be used by ministries to set the direction of investment in establishing the budget plan for the following year. For example, the results can be used to set the direction of investment of new financial resources from the R&D budget of MOTIE, which has been reduced from 2019 due to closed government projects. Lastly, in the long-term perspective, the results can be used by ministries to establish medium- and long-term R&D strategies. As the Ministry of Trade, Industry and Energy should establish and promote ‘Plan for Innovation of Industrial Technology’ every five years as per Article 5 of the Industrial Technology Innovation Act, the ministry can utilize the results of the analysis in its domestic/overseas environment analysis or R&D diagnosis to establish the plan.

Second, the significance of Global Value Chain (GVC), a concept referring to activities which mobilize products and services from the initial stage of conceptualization to the final stage of utilization, is increasing due to the rapid changes in the business paradigm, based on the development of new technologies such as AICBM[3] and blockchain, and changes in the global environment such as the expansion of protectionist trade policies. Therefore, by expanding the concept of Value-chain analysis of industries provided by the study, political measures for the Global Value Chain can be developed to allow Korea to take advantage of the Global Value Chain Network and enhance the competitiveness of global leader enterprises.

3) AI, IoT, Cloud, Big Data, Mobile

**Table 6.** Plans for the Utilization of the Results of Industrial Technology Competitiveness Analysis

| Category | | Point of Utilization | Content |
|---|---|---|---|
| Industrial Technology Competitiveness Analysis | ⇨ | Short-term (Following year) | (ex) Government Agency Budget Strategy (MOTIE's R&BD Strategy, etc.) |
| | ⇨ | Short·Mid-term (2-3 years) | (ex) Mid-term budget plan establishment of government agencies |
| | ⇨ | Mid·Long-term (Over 5 years) | (ex) Five-year Plan for Innovation of Industrial Technology, Science and Technology Basic Plan, etc. |

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