Expanding Corporate Use of Artificial Intelligence

| **Summary** |

Despite interest in artificial intelligence (AI) as a transformative driver of economic growth, few Korean companies use AI.

Companies currently using AI are increasing their AI investments and expenditures. Companies employ AI in a wide range of functions and fields including automated operations, predictive analytics, product and service development, and sales and inventory management.*

Challenges

Challenges to the application and use of AI exist in multiple, closely-connected domains. Challenges include human capital scarcity, inadequate funding, the difficulty of acquiring technology, and both the internal and external business environments confronting companies.

Major challenges in the technology acquisition and planning stages include: difficulty securing a skilled workforce, difficulty obtaining funding, and a lack of in-house infrastructure.

Internally, the most serious and frequently-occurring problems are lack of organizational competence and the high cost of investment in AI compared with a relatively low return on investment (ROI).

Externally, the main problems are market uncertainty and burdensome regulations concerning personal data.

Policy Proposals

Comprehensive and effective policy is needed to alleviate the many complicated challenges confronting corporate uptake and use of AI.

To address the shortage of AI experts, an urgent and concerted effort is needed to cultivate and increase the number of personnel that hold a Master of Science (MS) degree or higher, particularly in the fields of software and model development.

Two things must be done to improve the internal corporate environment:

- Simplify and streamline funding procedures for corporate uptake and application of AI

- Increase funding for R&D projects and projects that utilize AI

Externally, broad reform is necessary to improve the operating environment beyond the corporate walls. Companies must be able to attract more investment for AI and acquire critical technology and infrastructure. Regulatory reform concerning personal information laws is also necessary.

*Survey by the Korea Institute for Industrial Economics and Trade (KIET).

◼ Korea's Place in the Global AI Race

● Artificial intelligence (AI) is a general-purpose technology with the potential for broad application in multiple areas of industry, including national defense, security, medical science, and healthcare[1]

● Despite the enormous potential of AI to drive economic growth and lead the digital transformation of industry, AI is employed by only a small minority of Korean companies.

● Global investment in AI has increased consistently year-over-year, from three billion British Pounds (GBP) in 2015, to 19 billion GBP in 2019. (approximately 4.6 trillion KRW in 2015 to KRW 30 trillion in 2019.)[2]

– Countries at the forefront of AI development include the United States, China, the United Kingdom, and Japan. Each country has designated the cultivation of its domestic AI industry as a key national policy. Additionally, each country is competing intensely to achieve AI hegemony. (see Table 1)

Table 1. AI Policies of Major Countries

	Policy Name	Date Announced	Policy Objectives
China	New Generation Artificial Intelligence Development Plan	Jul. 2017	Secure AI competitiveness through government-led data, large-scale investment, personnel training, and creation of industry-specific platforms
UK	AI Sector Deal	Apr. 2018	Attract global AI corporations, cultivate AI personnel, create an AI-conducive industrial environment to improve industrial productivity
US	American AI Initiative	Feb. 2019	Strengthen the private sector's competitiveness through government investment in AI-related R&D and personnel
Japan	AI Strategy 2019	Mar. 2019	Cultivate AI personnel and accelerate AI technological innovation to improve industrial competitiveness and address social problems

Source: Section of ROK policy briefing on AI summarized by author.

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1) This report defines intelligence as "the ability to perceive, analyze and ascertain the environment of a particular theme and respond appropriately to it" and AI as "an area of computer engineering or engineering that engages in the task of making a machine intelligent."
2) Tech Nation (2020), *Report 2020*.

▣ Korea's Prospects

● Korea's AI market is growing rapidly. The government has announced multiple plans for investment in and cultivation of the AI sector to develop AI as an economic growth engine.

- Korea's AI market grew by 40 percent from 2018 to 2019, from KRW 1.07 trillion to KRW 1.5 trillion. By 2025, Korea's AI market size is projected to reach KRW 10.5 trillion.[3]

- The Korean government has announced a number of recent policies to promote AI technologies with a focus on industrial development. (see Table 2)

Table 2. ROK Major AI Policies

Policy Name	Date Announced	Policy Objectives
AI R&D Strategy	May 2018	Attract AI technical personnel, create AI technology infrastructure
Direction of Innovation, Growth and Strategic Investment	Aug. 2018	Strategic investment and personnel cultivation in three key areas: Data, AI, and a hydrogen economy
Plan for the Revitalization of Data and the AI Economy	Jan. 2019	Create a world-class, innovative AI environment. Expedite merging of data and AI
Strategy for Expanding and Accelerating Innovative Growth	Aug. 2019	Industry-wide acceleration of innovation with a focus on key platforms (data, networking, AI) and leading industries.
National AI Strategy	Dec. 2019	A national AI vision to turn Korea into an AI powerhouse

Source: Section of ROK policy briefing on AI summarized by author.

▣ Trends in AI Use

● According to Statistics Korea's *Survey of Business Activity,* (2017 and 2019), Korean companies have broadly expanded their use of AI. However, this expansion is limited to a very small percentage of companies (see Table 3).

- The percentage of companies using AI is on an upward trend. In 2017, 1.4 percent of Korean companies used AI. By 2019, this percentage increased to 3.1 percent. However, AI use rates remain low, with only 409 out of 13,255 companies using AI in 2019.

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3) Korea Credit Information Services (2020), *Trends in AI Technology/Market with a Focus on Core Technologies, Market Size, and Industrial Risks*

- The percentage of companies using AI is expected to increase in most economic sectors.

- By sector, info-communications, finance and insurance had relatively high AI usage rates. In 2019, AI was used by 15.4 percent of info-communications companies and 10.3 percent of finance and insurance companies. Manufacturing and wholesale/retail had relatively low rates of AI use, at 1.8 percent in both sectors.

Table 3. Corporate AI Use Rate by Sector

Unit: No. of companies, %

		2017			2019		
		No. of Companies	No. of Companies Using AI	AI Use Rate	No. of Companies	No. of Companies Using AI	AI Use Rate
Total		12,578	174	1.4%	13,255	409	3.1%
Sector	Manufacturing	6,113	48	0.8%	6,330	114	1.8%
	Wholesale/Retail	1,398	13	0.9%	1,480	26	1.8%
	Info-communications	1,047	71	6.8%	1,124	173	15.4%
	Finance and Insurance	327	20	6.1%	370	38	10.3%
	Science and Technology Services	543	7	1.3%	586	20	3.4%
	Other Industries	3,150	15	0.5%	3,365	38	1.1%

Source: Authorial summary of Statistics Korea's *Survey of Business Activity* (2017, 2019).
Note: Table includes Korean corporations with at least 50 regular employees and at least KRW 300 million in capital.

◉ Industrial Survey of AI Use by Economic Sector

● The Korea Institute for Industrial Economics and Trade (KIET) conducted a survey with the goal of helping domestic industries initiate and increase AI use. Details of the real-life application and use of AI by Korean companies were studied and compared across economic sectors.

- The survey was conducted on the AI application and use rates of 745 companies in the following sectors: manufacturing, wholesale/retail, info-communications, finance and insurance, and science and technology services. (For further survey-related details, please see the Appendix)

● The survey sample was selected based on AI-using companies by industrial sector as they appeared in three years' worth of data from the *Survey of Business Activity* (2017, 2018, 2019).

◼ AI Use Increasing Among Companies Already Using AI

● According to the survey results, companies already using AI are increasing investments in AI-related technology, increasing AI-related expenditures, and expanding their use of AI (see Table 4).

Table 4. Corporate AI-related Technology Investment, Expenditure, and Use

Unit: KRW 10,000, %

	2018	2019
Average Amount Invested in AI Technology	459,366	846,235
Average Expenditure for Purchase and Use of AI Services	88,166	507,924
Percentage of Companies that Invested at Least KRW 100 million in AI Technologies	48.2%	56.3%
Percentage of Companies that Purchased at Least KRW 100 million in AI Services	23.3%	31.4%
Percentage of Company Divisions or Departments that Use AI Services	26.1%	36.3%

Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: 245 out of 745 companies surveyed responded that they use AI.

- From 2018 to 2019, average AI-related investments increased by 84.2 percent, while average AI-related expenditures increased by 476 percent.

- From 2018 to 2019, the percentage of companies that have at least KRW 100 million in AI-related investments increased from 48.2 percent to 56.3 percent. The percentage of companies that have at least KRW 100 million in AI-related expenses increased from 23.3 percent to 31.4 percent.

- From 2018 to 2019, the percentage of company divisions or departments that use AI services increased from 26.1 percent to 36.3 percent.

◼ Diverse Applications and Functions of AI Technology

● Companies already using AI apply the technology in diverse ways. AI uses include automated operations, prediction analysis (predictive analytics), and resource categorization (see Table 5).

- Companies use AI most frequently for automated operations (39.8 percent), prediction analysis (37.6 percent), and resource categorization (32.1 percent).

- Other AI-uses include technology research, commercialization, video-based processing, and quality control.

- The manufacturing and info-communications sectors cited automated operations as the most frequently-used function, while science and technology services named prediction analysis as the most frequently-used function.

Table 5. Key Uses of AI Technology by Economic Sector

Unit: no., %

		No. of Cases	Automated Operations	Prediction Analysis	Resource Categorization	Other
Total		221	39.8%	37.6%	32.1%	13.6%
Sector	Manufacturing	45	40.0%	28.9%	33.3%	17.8%
	Wholesale/Retail	5	40.0%	0.0%	40.0%	20.0%
	Info-communications	115	40.9%	32.2%	28.7%	13.0%
	Finance and Insurance	7	85.7%	42.9%	14.3%	0.0%
	Science and Technology Services	49	30.6%	61.2%	40.8%	12.2%

Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 221 companies (Excludes the 24 of 245 AI-utilizing companies that did not respond or responded "do not know").

■ AI Use by Corporate Functional Area

● Companies that already use AI most often apply AI in the functional area of product and service development (see Table 6).

Table 6. AI Use by Sector and Functional Area

Unit: no., %

		No. of Cases	Product and Service Development	Sales and Inventory Management	Business Management	Sales Management	Personnel Management	Other
Total		218	75.2%	5.5%	5.0%	3.7%	1.8%	10.1%
Sector	Manufacturing	43	74.4%	4.7%	0.0%	0.0%	9.3%	11.6%
	Wholesale/Retail	5	40.0%	40.0%	0.0%	0.0%	0.0%	20.0%
	Info-communications	122	86.9%	4.9%	4.9%	2.5%	0.0%	3.3%
	Finance and Insurance	7	0.0%	0.0%	42.9%	57.1%	0.0%	0.0%
	Science and Technology Services	41	58.5%	4.9%	4.9%	2.4%	0.0%	29.3%

Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 218 companies. (Excludes the 27 of 245 AI-utilizing companies that did not respond or responded "do not know")

▣ Personnel Requirements of Companies Using AI

● Workers at companies that are already using AI tend to be experts with a Master's degree or higher. Companies prefer workers with several years of higher education over those with only short-term training provided by the company (see Table 7).

Table 7. Data Science Personal and their Educational Attainment

Unit: no., no. of people, %

		No. of Cases	Avg. No. of Personnel Exclusively Dedicated to Data Science	Master's or Higher Avg. no., and (%)	Bachelor's or Below Avg. No., and (%)
Total		108	24.5	16.8 (68.6%)	7.7 (31.4%)
Company Size by No. of Personnel	49 or Fewer	64	6.9	2.1 (30.4%)	4.8 (69.6%)
	50~250	16	6.9	2.4 (34.8%)	4.5 (65.2%)
	251 or above	28	74.8	58.5 (78.2%)	16.3 (21.8%)
Per Sector	Manufacturing	19	19.1	11.6 (60.7%)	7.5 (39.3%)
	Wholesale/Retail	2	94	65.0 (69.1%)	29.0 (30.9%)
	Info-communications	54	7.9	2.3 (29.1%)	5.6 (70.9%)
	Finance and Insurance	3	6.9	0.0 (0.0%)	6.9 (100%)
	Science and Technology Services	28	58.3	47.7 (81.8%)	10.6 (18.2%)

Source: KIET (2020), Factual Survey of Corporate Use of AI
Note: Data from 108 companies (of 745 surveyed) that have a team exclusively dedicated to data science.

- Companies that have teams exclusively dedicated to data science (108 companies out of 745) devote an average of 24.5 people to data science tasks.

- Within these companies, the average percentage of data science personnel with a Master's degree or higher is 68.6 percent. The average number of data science personnel with a Master's degree or higher is 16.8 people per company.

- The average percentage of data science employees with only a Bachelor's degree or below is 31.4 percent. The average number of data science personnel with only a Bachelor's degree or below is 7.7 people per company.

- These responses suggest an industry-wide need for AI personnel who have received several years of higher education rather than a reliance on company-provided short-term training programs.

- A company's size is related to the number of data science employees and the final academic degrees employees hold. The larger a company's size in terms of personnel, the more data science employees will hold Master's degrees or higher and the more data science personnel the company will employ.

- The percentage of employees with a Master's degree or higher is greater in manufacturing and science and technology services than in info-communications.

◼ Challenges to the Application and Use of AI

● Key challenges to the application and use of AI are: human capital scarcity and the difficulty in hiring trained personnel, procurement of funds, and acquiring critical technology and infrastructure. The internal and external business environments confronting companies pose additional challenges (see Figure 1).

Figure 1. Challenges in AI Introduction and Planning

Unit: %
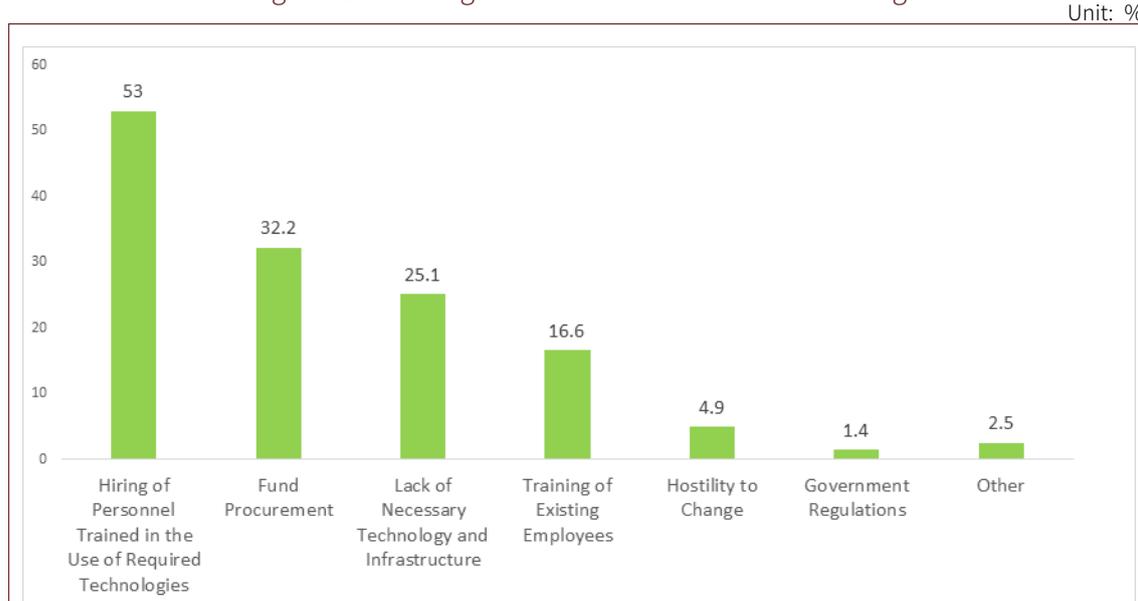
Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 283 companies (excludes the 462 of 745 surveyed companies that did not respond or responded "do not know").

- The highest percentage of responses (53 percent) identified the difficulty of hiring personnel who are adequately trained in utilizing required technologies as a key challenge to the use of AI.

- Table 7 suggests that AI experts with a Master's degree or higher are needed by the majority of companies.

- Other difficulties cited include: fund procurement (32.2 percent), lack of technology

and infrastructure (25.1 percent), and the training of existing employees (16.6 percent).

- A small percentage of companies provided the following responses: lack of customers, lack of educational data, and difficulty in using technology.

▣ Corporate Challenges to AI Use by Field

● Difficulty in securing AI personnel is concentrated in the fields of software and model development (see Figure 2).

Figure 2. Technology Fields with Hiring Challenges

Unit: %
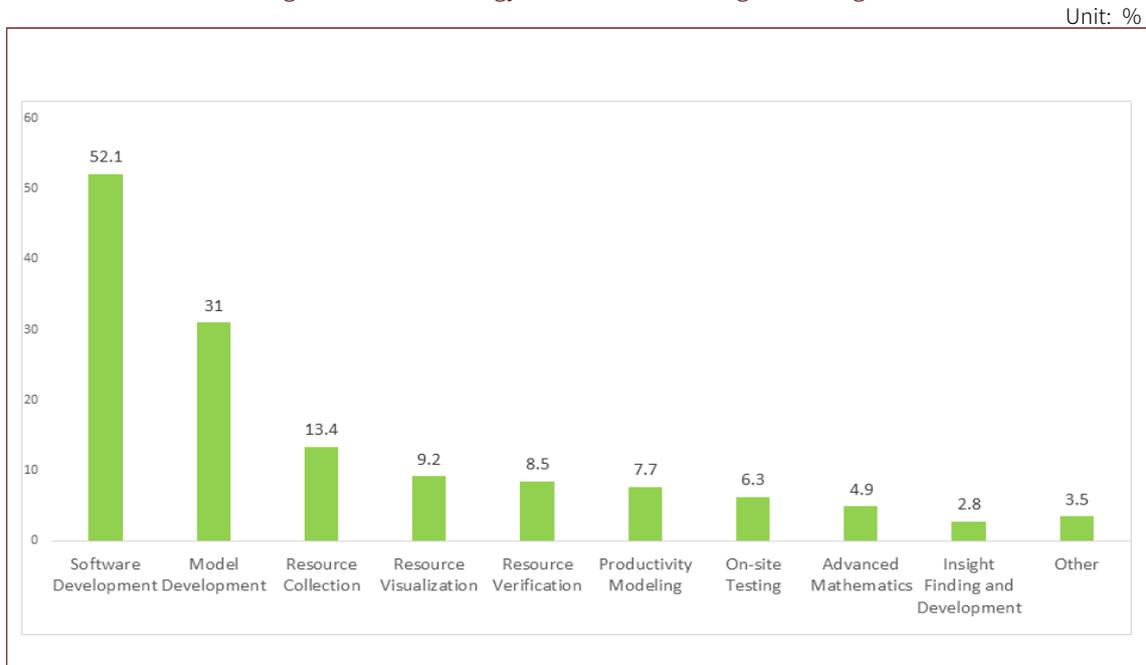
Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 142 companies. (Excludes eight of 150 companies that reported hiring difficulties but did not respond or stated "do not know")

- 52.1 percent of companies reported hiring difficulty in the software development field. 31 percent of companies reported hiring difficulty in the model development field.

- The fields of resource collection, resource visualization, resource verification, and productivity modeling also reported hiring difficulties.

▣ Technical Challenges to AI Application and Use

● Key challenges in the technological realm of applying and using AI are a lack of adequate equipment and infrastructure and a lack of accumulated data. (see Figure 3)

- The most frequently-cited challenge is lack of adequate equipment and infrastructure (49.3 percent).

Figure 3. Technical Challenges

Unit: %
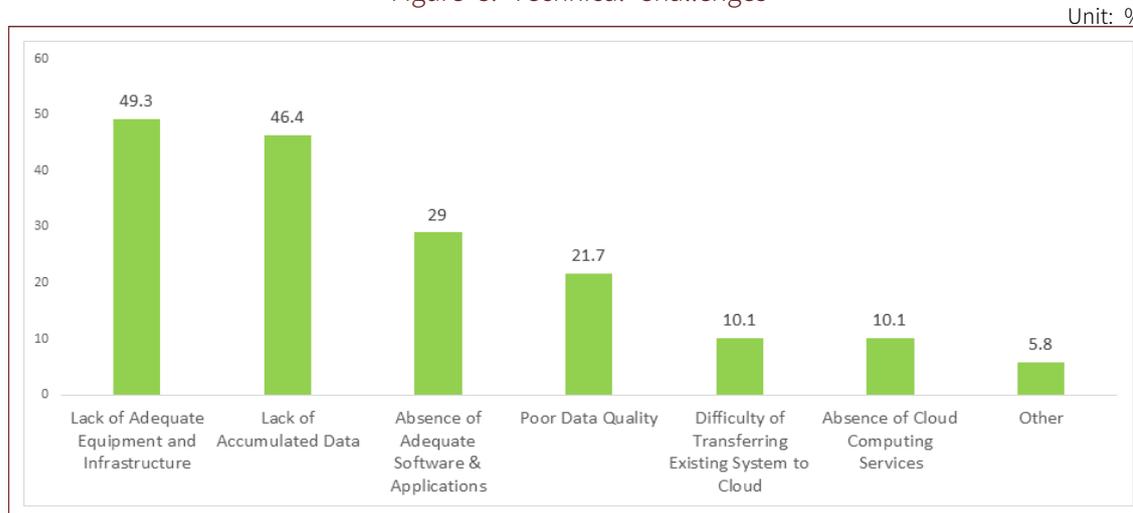
Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 69 companies. (Excludes two of 71 companies that reported having technological difficulties but did not respond or responded "do not know")

- Other major challenges cited are: lack of accumulated data (46.4 percent), absence of adequate software or applications (20 percent), and poor data quality (21.7 percent).

- Some companies identified commercialization of technology and algorithm analysis as key challenge areas.

▣ Internal Corporate Challenges to AI Use

● Key challenges related to the internal corporate environment are: a lack of organizational awareness and capability concerning AI technology and a low return on investment (ROI) (see Figure 4).

- The most significant internal challenges facing companies are lack of in-house knowledge of AI technology (46 percent) and low return on investment (25.7 percent).

- Other challenges include: lack of awareness by management (14.3 percent), incompatible business models (11 percent), and corporate culture (8.9 percent).

- Some companies provided responses such as: problems with educational data, lack of funds for investment, lack of opportunity for personnel development, and employees' lack of mathematical skills.

Figure 4. Internal Corporate Challenges

Unit: %
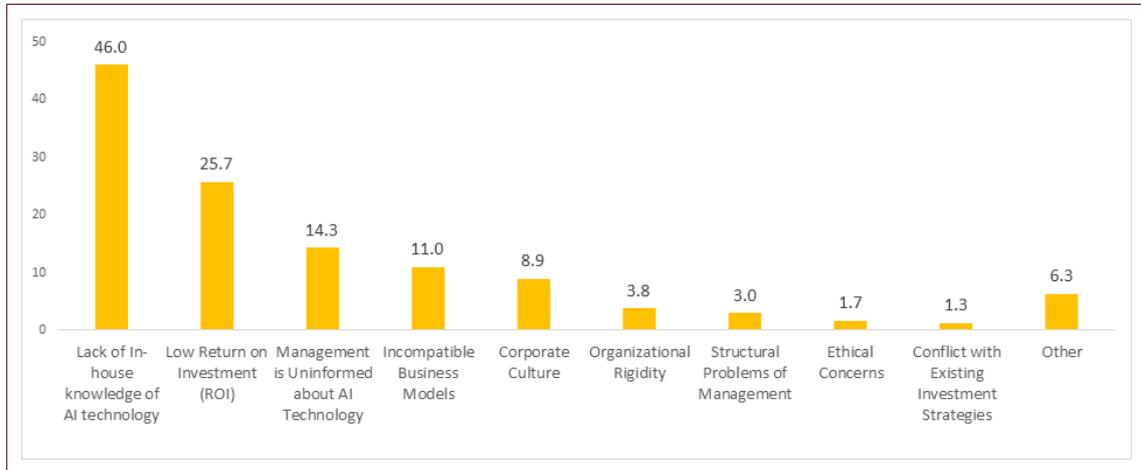
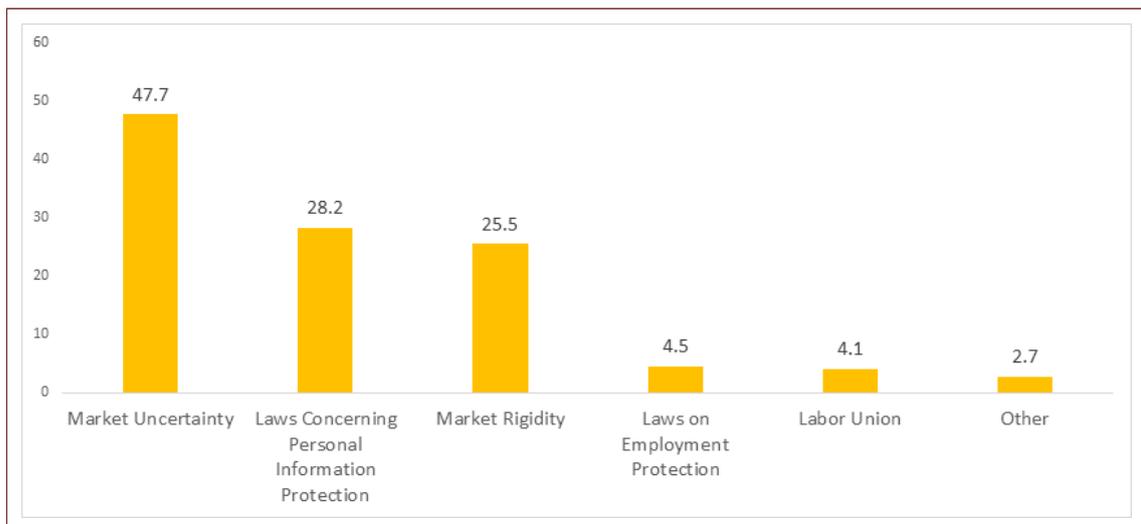Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 237 companies (excludes the 508 of 745 surveyed companies that did not respond or responded "do not know").

▣ External Challenges to Corporate AI Use

● Key difficulties related to companies' external environments are market uncertainty and laws concerning personal information protection (see Figure 5).

Figure 5. External AI-related Challenges

Unit: %

Source: KIET (2020), *Factual Survey of Corporate Use of AI*
Note: Data from 220 companies. (Excludes the 525 of 745 companies surveyed that did not respond or responded "do not know")

- Market uncertainty (47.7 percent) is the most-frequently cited challenge.

- Other challenges cited include laws on personal information protection (28.2 percent) and market rigidity (25.5 percent).

- Smaller companies tend to cite market uncertainty, while responses by larger companies focus on laws related to personal information as the biggest external challenge.

- Other responses include data collection challenges, difficulty of commercialization, costs, and management policies concerning customers.

◼ Conclusions and Policy Proposals

● The KIET survey revealed the need for comprehensive and substantive policy that is able to address the many, complex challenges that exist throughout the corporate process of applying and using AI.

Policy Proposal 1: Cultivate AI Personnel

● The most important step in resolving the personnel shortage is to cultivate workers with a Master's degree or higher. There is an especially urgent need to revise and expand personnel policies in the software and model development fields.

- AI experts are currently concentrated in the US, China and Europe.[4] The shortage of AI personnel is a problem that is becoming increasingly global.[5]

- Considering the fact that companies need personnel who have a Master's degree or higher, the recently-implemented policy of providing subsidies for AI-related Master's degree programs must be greatly expanded.

- There is an especially urgent need to revise and expand policies concerning the cultivation of trained personnel, particularly in the software and model development fields, the two areas most severely impacted by the personnel shortage.

- Efforts must also be made to anticipate future AI needs by addressing the need for personnel cultivation in other areas including resource collection, resource visualization, resource verification, and productivity modeling.

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4) Number of AI-related articles uploaded to arXiv (an online, preprint repository) as of December 2019: USA: 47.9%, China: 11.4%, UK: 5.3%, France: 4.9%, Germany: 4.8% (Element AI, 2020).
5) Institute of Information & Communications Technology Planning & Evaluation (2019), *Direction and Implications of AI Personnel Cultivation Policies of Major Countries*.

Policy Proposal 2: Simplify and Streamline AI Funding

- In order to improve the internal corporate environment related to AI use, the financial burden experienced by companies in applying and using AI must be alleviated. Funding for R&D and AI utilization must be increased.

  - The following aid programs must be continued and expanded: Provide AI service purchase vouchers to companies in need of AI services; Provide financial support for the development of new AI-based products.

  - Other technology-related areas that need improvement include: in-house equipment and infrastructure, data accumulation, and software.

  - Close the AI Gap. Considering the fact that most companies that have already applied AI are increasing related investments, expenditures, and expanding AI utilization, in order to close the gap with companies that have not yet applied AI, effective policy is needed to alleviate the complex challenges that arise in the process of applying and using AI. According to a survey by KIET, at least 85 percent of surveyed companies do not have an AI strategy.[6]

Policy Proposal 3: Increase Ease of Doing AI Business through Regulatory Reform

- Broad reform is necessary to improve the operating environment beyond the corporate walls. Companies must be able to attract more investment for AI and acquire critical technology and infrastructure. Regulatory reform concerning personal information laws is also necessary.

  - ACompanies must be given additional incentives through expanded tax benefits for AI-related R&D and infrastructure investments in order to address low AI ROI as well as address the challenge of market uncertainty.

  - Efforts to improve AI-related technological infrastructure must be made consistently, for example by: fully releasing public data (already included in Korea's national AI policy), linking public and private data maps, providing computing aid for AI Hubs, creating an AI technology complex and building AI Hubs.

  - A comprehensive AI plan must be designed based on existing road maps that provides substantive solutions to challenges related to the protection and security of personal information and the use of such personal information.

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6) 637 of 745 companies surveyed did not have an AI Strategy.

Appendix
Survey of Corporate AI Use

Survey Design, Background, and Objective

In order to encourage the efficient uptake and use of AI by domestic industrial sectors, a survey of AI use at Korean firms was undertaken.

With many countries facing economic slowdowns, AI is increasingly seen as having the potential to transform and reinvigorate economies. Research based on international cooperation is thus increasingly important. KIET believes that this survey can serve as a cornerstone for such efforts.

Survey Period

Sep. 30 - Dec. 18, 2020 (on-site: Nov. 23 - Dec. 23, 2020)

Survey Recruitment Targets

Corporate representatives (assistant manager or higher) by sector (Management Support Team, R&D Team, Data Systems Team, etc.). Individuals able to answer questions concerning the general circumstances and operating environments of their companies.

Survey Sample Design

- 745 companies in the sectors of manufacturing, wholesale/retail, info-communications, finance and insurance, and science and technology services were surveyed.
- Large categories and characteristics of AI usage were used as the explicit stratification variables.
- The survey sample was designed based on the distribution of AI-using companies by industrial sector as appeared in the *Survey of Business Activity* (Statistics Korea, 2019).

Method

An online survey was conducted simultaneously with outreach via email and fax.

Characteristics of Survey Respondents

Sub-Table 1. Characteristics of Survey Respondents by No. of Employees and Sector

Unit: no., %

		No. of cases	Proportion (%)
Total		745	100.0
Number of Employees	49 or fewer	532	71.4
	50 - 250	151	20.3
	251 or more	62	8.3
Sector (Large categories of the Korean Standard Industrial Classification List)	Manufacturing	260	34.9
	Wholesale/Retail	138	18.5
	Info-communications	180	24.2
	Finance and Insurance	61	8.2
	Science and Technology Services	106	14.2