Contents

004  Foreword

006  About KISTEP

010  Inl VIEW
   012  Forecasting the Development and Future of the Blockchain Industry
   018  The Direction of Science, Technology and Innovation within the Policy Framework of Inclusive growth
   024  Key Issues and Directions for the Mid-term R&D Expenditure Structure, in the era of KRW 20 Trillion

036  Inl PEOPLE
   038  Predict the Future of KISTEP and Korea

048  R&D Inl

050  Key Contents of the 4th Basic Plan for Science and Technology

064  The Role of IP-R&D in the Era of the 4th Industrial Revolution

076  The 2nd Social Problem-solving Comprehensive Plan for People’s Lives (Society) Based on Science & Technology

092  Innovative Growth and Regulatory Reform

096  Realize the Future of Science and Technology with Startups

106  SPECIAL

108  KISTEP 10 Emerging Technologies in 2018

112  Asian Innovation Forum: Towards Better Asia

124  EVENT HIGHLIGHTS

128  KISTEP NEWS

144  R&D INFOGRAPHIC

146  National S&T Innovation Capacity 2017

148  Changes in Preliminary Feasibility Study (PFS)
Foreword

In the year 2018, the world was swept by new science, technologies and innovation (STI). Since the 4th Industrial revolution, we are more closely connected and are able to interact at the fastest pace, changing systems in education, business, healthcare, and ultimately, every day of our lives—your pizza is delivered by a driverless car, your smart contract with a lawyer is managed by blockchain technology, and the city you live creates sustainable and clean environment through big data and AI.

The mere beginning of the new era introduced unimaginable future to us, and people’s expectation on S&T for the future world has been increasing continuously. With the best interest on what kind of future it will bring to us, S&T policy has drawn attention from not only S&T communities, but also from the general public.

As a STI think tank that specializes in S&T policy planning, R&D management and evaluation, the role of Korea Institute of ST Evaluation and Planning (KISTEP) is becoming more crucial. In 2018, the main functions of KISTEP—Technology Foresight, the S&T Policy planning, R&D budget allocation, Preliminary Feasibility Study and R&D Program Evaluation—were delivered to meet the demands from society, and KISTEP researchers made major achievements that shepherded the national system for better research environment and outcomes.

The year 2018 is very meaningful to KISTEP and SAT community with the 20th anniversary of KISTEP and the major leap toward 20 trillion KRW for government R&D budget. Therefore, KISTEP R&D and Beyond 2018 especially covers various SAT issues such as R&D budget and inclusive growth, research reports including the 4th SAT Basic Plan and 10 emerging technologies and infographics for Preliminary Feasibility Study.

Among countless activities and researches we have done in 2018, we have carefully selected what would be the most interesting topics for you.

The year 2018 brought new opportunity and changes to KISTEP, and the continuous support and collaboration from global partners have strengthened our motivation and capacity to join the international arena.

We hope to provide more information about KISTEP through this issue and that you enjoy reading them.

Sincerely,

Sang-seon Kim,  
President of KISTEP
History

1987
Establishment of Center for S&T Policy (CSTP), an affiliated organization of Korea Institute of Science and Technology

1993
Reorganized CSTP and renamed it S&T Policy Institute (STEP)

1999
Establishment of KISTEP

2001
Reorganized and strengthened planning function of KISTEP

2005
Redirected KISTEP’s main functions to national S&T planning, coordination and R&D evaluation

2007
Establishment of Korea Institute of Human Resources Development in S&T (KIRD) affiliated with KISTEP

2009
20th anniversary of the foundation of KISTEP

2011
KISTEP’s affiliation was transferred to National Science & Technology Council (NSTC) from the Ministry of Education, Science and Technology

2013
KISTEP’s affiliation was transferred to the Ministry of Science and ICT from NSTC

2019
20th anniversary of the foundation of KISTEP

Vision and Strategy

Vision
A Global Institute that Creates Innovative Values for the Future

Mission
To raise the effectiveness of R&D investment through enhancing the specialty in S&T planning and evaluation
To create innovative growth engines through strengthening support researches for policy and preemptively responding to future issues & regulations

Strategy
Vitalize support and implementation of policies that the public can participate and understand
Act as mediators and expand communication for the embedment of policies
Strengthen strategy researches and planning to make a leap forward as a Think-tank

4 Core Functions of KISTEP

Function 1 Establish National S&T Foresight and Policy Planning
Function 2 Conduct National R&D Program Survey, Analysis and Evaluation
Function 3 Support National R&D Program Budget Allocation & Coordination
Function 4 Conduct National R&D Program Preliminary Feasibility Analysis
Key Achievements

2018  Established 'The 4th Science and Technology Basic Plan'

2017  Suggested 20 Policy Projects for STI of New Government

2016  Ranked 'Excellent' in Mission-oriented GDI Evaluation

2015  Announced KISTEP 10 S&T Policy Issues of 2015

2014  'The Road to Creative Economy' Forum in Celebration of KISTEP's 10th Anniversary

2013  Established 'The 3rd Science and Technology Basic Plan'

2012  Conducted 'The 4th National Technology Foresight'

2011  Exclusively in charge of Feasibility Study on the Government R&D Programs

2010  Established 'The SAT Vision for the Future, towards the year 2040'

2009  Developed 'The Roadmap for the Green Technology and the Industrial Development Strategy'

2008  Established 'The 2nd Science and Technology Basic Plan' (5T7 Initiative)

2007  Created 'The Total Roadmap' for Government R&D Programs

2006  Built 'Certification System for Excellence' in Budget Management

2005  Formulated the 'National Evaluation System' and conducted 'The 3rd National S&T Foresight'

2004  Conducted Technology Assessment on the Convergence of NBIT

2003  Conducted 'Technology Level Evaluation' on 99 Core Technologies

2002  Built the 'Korea R&D Integrated Management System'

2001  Established a Comprehensive Coordination System for Government R&D Programs

1999  Launched Survey, Analysis and Evaluation of Government R&D Programs

Organization

KISTEP researchers come from diverse backgrounds such as natural sciences, engineering, humanities, law, economics and public administration. With their collaborative efforts, KISTEP contributes to setting the course and devising strategies for Korea's national S&T and R&D.
KISTEP
R&D AND BEYOND 2018

InI VIEW
Inside and Insight

Forecasting the Development and Future of the Blockchain Industry
Ho-hyeon Han, Professor, Kyunghee University

The Direction of Science, Technology and Innovation within the Policy Framework of Inclusive growth
Seo-Hong Oh, Senior Research Fellow, KISTEP

Key Issues and Directions for the Mid-term R&D Expenditure Structure, in the era of KRW 20 Trillion
Heung-kwan Lee, Director General, KISTEP
The definition of blockchain industry is not yet clear. In a narrow sense, the term only includes blockchain technology, while the broader meaning encompasses all fields of applications using blockchain technology. The blockchain technology is going through a rapid evolution, in the course of which its concepts are constantly changing and expanding. For this reason, it is still too early to limit the extent of the blockchain industry to a certain category. Furthermore, the term blockchain constantly involves cryptocurrency, a term which leads the public to observe the field from the viewpoint of the financial industry. There is also confusion from the involvement of the two large-scale industries of computers and finance. In this light, this paper aims to give an overview of the current status of the blockchain industry, its directions of development, and the future of the industry.

Blockchain, which is currently being discussed, should be seen as a technology that originated from Bitcoin in 2009. While the term is now used universally, it was first referred to as Bitcoin Blockchain to describe its unique system, and therefore Bitcoin’s blockchain technology is usually used to explain the gist of the concept.

The core of blockchain technology is the removal of central system from a universal environment that relies on existing central system. To actualize this, the technology creates a system which stores and manages the same contents in the computers of the entire user base, using a data structure named blockchain. The crux and core of the technology is the method needed to store identical data on innumerable computers, which the industry named the Consensus algorithm. Blockchain technology possesses a unique data structure, which is also named blockchain. In other words, the term blockchain can be used to refer to two concepts: one being the data structure, and the other being the entire technology in general, which is more widely used for expression.

The former-that is, the blockchain data structure-grants interrelationships among blocks, units of data groups. In the former-latter relations, the structure uses hash value, the value generated in regard to the data, of the former block data. To establish the blockchain, Bitcoin constructed a blockchain data structure named a digital signature chain, and stored the structure on innumerable user computers using a P2P (Peer to Peer) method. Bitcoin also adopted the Proof of Work algorithm to ensure that every user computer has an identical set of data stored. Bitcoin provided users with a system which takes about 10 minutes on average to generate the blockchain data structure, ensuring the security of the structure and allowing all user computers to have identical data stored. Based on these characteristics, blockchain technology is considered an innovation which realizes the philosophical concepts of distribution, sharing and openness.
“Nevertheless, what should actually be debated instead is how blockchain would be acknowledged by the market in terms of cost and benefit.”

Since the creation of the Bitcoin blockchain, blockchain technology has been evolving in various directions due to its technological characteristics and inherent problems. While the blockchain is often thought of as being ‘hack-proof’ or impossible to forge or falsify, it is in fact hackable and forgeable, and rather should be seen as a technology with a high level of resistance to falsification. Also, every additional member of the structure storing and managing identical data further limits the number of operations processed per second, which is one of the biggest issues of technology, and is the one that cannot be solved without improving blockchain structure itself. And so to compensate for this defect, the system is also evolving into a structure in which a minority possesses data rather than having it stored by every member. Another issue is that the limitations from data sharing and openness. This becomes even more significant when the transaction data should not be disclosed to individuals other than parties concerned. And thus, the so-called ‘closed blockchain,’ which limits the number or eligibility of blockchain participants, has emerged as a contrast to the original ‘open blockchain,’ which does not limit the number or eligibility of participants. The applicability of the blockchain industry is gradually expanding in line with technological evolution, with the technology being adopted in almost every sector including finance and distribution. Of course, the technology is still going through trials, with closed blockchains mainly being tested. IBM uses closed blockchains to manage information generated during the distribution of food, such as pineapples or pork. Also, Everledger of the U.K. is currently making attempts to manage information on diamonds using blockchain, as a way to utilize the stored information in cases of loss or theft. Central banks are also considering the adoption of the technology, with the European Central Bank and the Bank of Japan actually studying the feasibility of blockchain adoption in international settlement payments. Adoption of blockchain technology is being promoted in various other areas such as voting, real estate management, overseas remittance, and logistics. User certification systems have already adopted the technology to use it to establish a joint environment for certification processing among financial services. However, the results of the majority of these trials have proved to be negative, with some being evaluated as dissatisfactory, and some even being considered as inadequate due to lags in processing speed. The main reason is that the concrete ways of linking data in the virtual world of blockchain to the actual world have not been provided. While the technology may be contributory in logistics to a certain extent, it cannot magically solve every problem of the industry. For instance, blockchain is not helpful in dealing with actual missing deliveries, as maintaining the record of a purchase in the blockchain cannot ensure delivery in the actual world. Also, the actual benefit from the adoption of blockchain technology may not be as high as compared to when the technology is not adopted.

Open blockchains are usually adopted in pioneering new industries, rather than in existing industries, and initiatives to renovate the foundation of existing industries are also underway, with cryptocurrencies as the main agent. The active implementation of the technology was facilitated through ICO (Initial Coin Offering), a means of financing by selling cryptocurrencies to individuals wishing to claim dividends of the profit of the main agent which runs the central system. Digital content distribution is one of the sectors in which open blockchains are becoming rapidly adopted and widespread, with the technology being experimented with in areas such as data trade, SNS (Social Network Service), media reports, and digital photo sales industries. VR and video clip industries have also shown an interest in blockchains in the hope that the technology will contribute to solving problems in the digital content sector, such as illegal reproduction or infringement of copyright.

Another important aspect of the technology is smart contract. The core technology in realizing the smart contract is still in its infancy, and many blockchain companies are focusing on its technology development. Processing speed is the biggest constraint in the realization of smart contracts. The limitation on the processing speed of the blockchain is unavoidable due to its characteristics. Originating from the consensus algorithm which operates on the premise that identical data should be stored and managed by every user, the temporal limitations caused by the size of a block unit or consensus processing are difficult to resolve. Even for Ethereum, which was the first in the blockchain industry to implement smart contracts, the temporal limitation still remains its Achilles heel.

A semi-centralized system, which lets only the selected or entrusted minority process the consensus instead of allowing all users to participate in the consensus algorithm framework, is one of the options recently proposed to greatly improve the processing speed. While the option proposed is criticized for deviating from the original core philosophies of the blockchain, which are distribution, openness, and sharing, there are also claims that it is the only plausible solution if blockchains are to be implemented...
and commercialized in the actual market. So in general, the industrialization of open blockchains is still open to experimentation, with numerous blockchain companies attempting to make headway into new industries using new methods. And this is why some argue that these blockchains should be categorized by generations.

The trend of development of open blockchains can largely be categorized into three generations, with Bitcoin blockchain being the 1st generation, Ethereum being the 2nd, and the 3rd generation: blockchain boasting greatly improved processing speed. In short, the technology is going through a rapid transition from being incomplete to the enhanced versions. In this regard, it is currently too early to provide a clear outlook on the overall development of the blockchain industry. But one thing is sure: if one has to forecast the development of the blockchain, one should do so by considering direction of potential solutions to the problems of the technology.

There are several problems with blockchain, and the biggest problem is its low processing speed. Bitcoin blockchain’s processing speed is less than 7 transactions per second, which then take 10 minutes on average to be completed, making it too slow to be implemented in the actual market. Other than in special circumstances, the technology cannot be adopted unless real-time processing is realized. While the option of only the selected minority processing the consensus and other participants being provided only with necessary data is currently being implemented to improve processing speed, it is hard to avoid the criticism that such an approach is far from the three core philosophies of the blockchain:

distribution, openness and sharing. Recently, hardware-based blockchains such as SGX of Intel and TEE of NEC are being developed to maintain the original concepts while improving the processing speed. Also, attempts that use chip technology such as PUF (Physical Unclonable Functions) are also emerging in both Korean and overseas markets. Ultimately, processing speed is the key weak point of blockchain technology, and must be solved soon using software or hardware enhancements.

Another problem is the risk of hacking. One of the most popular misconceptions is that blockchains are safe from hacking. Hacking refers to the illegal extortion of the authorities of managers or users of the service provided through the network, which in the case of the rights of users of blockchain are represented by personal keys. This hacking of personal keys is increasing the loss of cryptocurrency. Also, there are often cases in which users lose their personal keys and are unable to access data or assets on the blockchain. Another problem is that the administrations of states are trying to implement anti-money laundering regulations which require blockchains to collect users’ personal information. This may cause invasions of privacy, and may damage the openness and sharing economy, which are blockchain’s core philosophies. Bitcoin was able to make rapid proliferation due to its anonymity, which allowed every user to share every piece of transaction data. Furthermore, if privacy protection measures are implemented on blockchain, the complexity of storage and management of data processed on blockchain becomes even greater. To protect data on personal information, they have to be encrypted separately, and then to use such data they have to be decrypted, which may cause lags in processing speed or cause new problems in data management.

Blockchain technology is still incomplete, and we may have to accept certain realistic compromises when it comes to some issues. However, the current debate on blockchain is focused on the question of the superiority of the technology, with one side claiming that blockchain is overrated and the other claiming that it is a new innovative technology which will replace the internet in the near future. Nevertheless, what should actually be debated instead is how blockchain would be acknowledged by the market in terms of cost and benefit. The technology will be adopted to form a new field of industry at any expense if profitability is ensured.

Another important topic is the question of whether the technology can provide bigger opportunities to service providers or users at lower cost compared to the existing options. Seen from the viewpoint of existing industries, the implementation of blockchain technology is generally costlier, contrary to claims that blockchains are more economical compared to centralized systems. However, those claiming that blockchains are less costly have to reflect the total system operating cost, and when this cost is reflected, it is generally more expensive to operate P2P than to operate a centralized system, and the gap becomes even bigger as the number of users or participants increase. Therefore, new ideas for blockchain technology are needed to lower the operation cost, or find new markets in their infancy.
The Direction of Science, Technology and Innovation within the Policy Framework of Inclusive growth

On July 24 of this year, President Moon Jae-in defined the concept of the new economic policy framework of “Inclusive growth” as “growth which widely distributes its outcomes to many people sharing the benefits” and said, “Income-led growth, innovation growth, and fair economy are specific measures for the realization of the broad concept of Inclusive growth.” Recently, the Korean government has made diverse efforts to revitalize the economy through innovation growth via regulatory reform, etc. Policies such as deregulation, technological development and infrastructure expansion are taking shape to facilitate corporate investment and support job creation.

In order for Inclusive growth to be established as an upper concept that sets a new goal of economic policy, it needs to be reviewed on the continuum of technological innovation and sustainable growth. In particular, it is necessary to apply the concept of “Inclusive growth” to the areas of science, technology and innovation (STI) and R&D activities to provide support for securing innovative competitiveness and examine the possibility of a conceptual expansion of the existing STI policies and national R&D projects. In addition, the significance of Inclusive growth in the process of planning science & technology and R&D policies needs to be reviewed.

Technological innovation in the policy framework of Inclusive growth should presuppose the innovation of a development model which encompasses the entire realm of society, culture and the environment. In other words, the key is to what extent the social contribution of science & technology (S&T) can be expanded, and how social and economic issues can be solved effectively. In principle, it depends on searching breakthroughs in innovation activity by “cooperation/collaboration” rather than “individualism,” and reducing the “gap” in the overall course from problem identification, R&D resource management, R&D process, research output creation to feedback of the result.

In this context, this study intends to review the direction of the implementation of STI in the policy framework of Inclusive growth, focusing largely on three questions.
Q1

Can the policy of ‘inclusive growth’ be applied to the policy of science, technology and innovation (STI) and R&D policy? (Locus and Focus)

So far, we have understood the concept of ‘inclusive growth’ as developing appropriate technology for each region and social problem solving. While technological development changes a local society, economy, industry, etc., social needs change technology as well. Digital innovation (smartphones, etc.), change of transportation system, AI (artificial intelligence), etc. have completely changed our lifestyle. Our continued low growth, aging society and low birth rate, brain drain, disasters & safety problems, and local extinction, etc. are causing changes not only in the problem-solving capabilities of S&T but also in the recognition of problems, approach methods (preparation of preventive methods, etc.) and way of working (convergence research, collaboration, etc.).

So, to approach this in the context of the social contribution of STI, the Locus of the policy of STI related to ‘inclusive growth’ should be expanded to ‘industrial inclusiveness’ (business/sector), ‘territorial inclusiveness’ (place/region) and ‘social inclusiveness’ (people) (OECD, 2017), and the Focus can be illustrated by how the ‘gaps’ have influence on innovation growth, distribution of growth, etc. Here, there are various types of gaps, including the size and ration of investment in each industry/region, brain drain, and the capability of commercialization.

The unique characteristics of national production system play a central role in forming ‘inclusive growth of science, technology and innovation (STI)’ (OECD, 2017). The application methods and content of ‘inclusive growth’ in STI must differ in developing countries compared to developed countries. While developing countries focus on appropriate technologies by using and improving (quantity of) knowledge using the existing knowledge, patents, etc., developed countries focus on digital conversion using ICT technologies and the 4th industrial revolution, and easily overlook the ‘inclusive growth’ as a secondary dimension. The distribution of the capabilities and opportunity to participate in the innovation activities in the area of business/industry (‘industrial inclusiveness’) and region (‘territorial inclusiveness’) is the most important factor in the determination of the characteristics of Inclusive growth. Industrial inclusiveness and territorial inclusiveness are closely related with social inclusiveness. Various kinds of disadvantages (such as low technology and low income) may result if the capability to carry out innovative activities is insufficient due to various gaps in technology innovation competence, industry, region, etc.

As examined earlier, STI is a very important as a major impetus for ‘inclusive growth.’ As the focus moves to improvements in quality of life, the demand for continuous economic growth, the expanded use of products and services of technological innovation, solutions to various social problems, etc., ‘inclusive growth’ based on STI can play a pivotal role between ‘innovation growth’ and ‘social problem solving.’ In principle, it is using STI to continuously secure future growth engines, solve various social problems caused by technological gaps, and create good quality jobs. Specifically, the ‘R&D programs for social problem solving’ of the Ministry of Science & ICT (MSIT) is also one of the excellent policies for Inclusive growth. However, if the focus is put on reducing the gaps, concentration should be on the policies that can enhance the innovation capabilities of small and medium-sized enterprises (innovative companies that can react fast); policies to encourage talents to knock on the doors of these SMEs; and policies to strengthen the digital connection between government-funded companies and SMEs. If job creation is the flower, we can see it bloom only if strong stems are grown by giving nutrients to the root of the plant and removing pollutants (an excessive regulatory environment). In general, it is necessary to reinterpret the Locus and Focus of ‘inclusive growth’ from a different point of view, and initiate a paradigm shift accordingly.
Is it possible to accelerate the general innovation of society by reducing the gap based on S&T? (Possibly to be connected with innovation growth?)

If the gap is reduced properly based on S&T, innovation growth can be accelerated, and as a result, inclusive growth can function as the fuel for the engine. In principle, the effect of reducing the gap based on S&T is greater when attention is paid not only to the value of cooperation/collaboration among the principal agents of innovation (industry/research/academia, etc.) but also to the distribution of resources. In the same vein, the effect is also great when the platform or connection pipeline is made to enable this cooperation/collaboration. That is the direction and strategic tasks necessary in the policy framework of “inclusive growth.” In particular, it is essential to concomitantly identify policy levers based on the expected outcome from reducing or removing the gaps. Ideally, innovation growth and general social innovation can be accelerated with a growth engine for the activation of the economy can be created by pulling the policy lever based on STI. Rather than seeking the conditional removal of gaps in the area of STI, a careful examination should be taken for replacing the tremendous causal loops connected to gaps with the performance indicators of innovation acceleration. In fact, the success or failure of innovation usually depends on the implementation capacity rather than the removal of the gap itself. Here, the point is that focusing too much on innovation input and expecting that the input will be directly connected with output will not only cause a vicious cycle but also generate such side effects as moral hazard. If cooperation in each technology area and the factors of inclusive growth such as consideration and respect in the conversion process that connected with input, various delays and obstacles will probably be resolved, accelerating the effect of innovation in a virtuous cycle.

Table 1 Characteristics of existing research on technology development versus research focusing on solutions to social problems

<table>
<thead>
<tr>
<th>Existing research on technology development</th>
<th>Research focusing on solutions to social problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Solving the problem of technology itself</td>
<td>Research for groups that do not benefit from technology (marginal class, isolated region, etc.)</td>
</tr>
<tr>
<td>2. Innovation for pursuit of profits by business enterprise</td>
<td>Business enterprise is not the principal agent.</td>
</tr>
<tr>
<td></td>
<td>Assistance is provided by engineers with good will and spare time; proper technology.</td>
</tr>
<tr>
<td></td>
<td>In case of support by the state/FABES(Solution) for solutions of social problems</td>
</tr>
</tbody>
</table>

Source: Hong Dae Hock. Technology innovation and technology R&D for solution of social problems, the STI innovation forum on national transport R&D (Sep. 20, 2017)

What are the effective implementation strategies and tasks? (Who receives the benefit of innovation in inclusive growth?)

Innovative inclusive growth is necessary to remove regional gaps and achieve balanced regional development (2018 vision meeting for decentralization and balanced development). Who receives the benefit of innovation in inclusive growth? This question is directly related with the implementation strategy of the policy of inclusive growth. To look at it from the aforementioned dimension of industrial inclusiveness, the policies to support large companies for inclusive growth based on S&T will include deregulation for cutting-edge technology, etc. and the resulting benefit of innovation can be derived from win-win cooperation between large companies and SMEs in STI. The core of support strategy of SMEs for inclusive growth is preparing the promotion plans for the creation of general social benefits, such as human resources and talent training and job creation. However, it is not easy to set the implementation strategy, as social consensus is often required. The pattern of occurrence and details of social problems will become increasingly diverse and complex. Above all, inclusive innovation growth will have to be implemented in the direction of expanding policy support significantly for inclusive growth, converging problem-solving capacity into future growth engines, and maximizing the resulting benefits (job creation, etc.). There may be some social problems that are caused by STI, and some others that can be solved by STI. However, the benefits of the solution may be concentrated in a certain group. Secondly, the science community needs to make a social climate of distributing the benefits to the society by re-creation of jobs, etc. Thirdly, while the new opportunities and solutions in ICT and other new technologies may generate a digital gap, their benefit is also large in the fact that they can solve various social problems. There are various benefits that can be generated by inclusive growth based on STI. Therefore, it is time to create new types of social benefits by combining the existing technology development with digital technology.

It is not strange to make an effort to combine innovation in an era of low growth with the concepts of sustainable growth and inclusive growth. Conflicts over distribution come ahead of optimism about growth in an era of low growth, and they cannot be overcome by the development of certain industries and the interconnection of these industries. A model of inclusive growth based on STI should be prepared to encompass the entire realm of society, culture, and environment, and the entrepreneurship that breaks through the era of low growth will be found in the model of inclusive growth.
Key Issues and Directions for the Mid-term R&D Expenditure Structure, in the Era of KRW 20 Trillion

The 2019 government budget on R&D finally surpassed KRW 20 trillion. Science & Technology (S&T) community is burdened with huge tasks and responsibilities considering heightened public expectations. Opening the era of KRW 20 trillion in R&D spending means that the S&T community should take the responsibility of leading the effort of innovation-led growth. It also means that we must secure a financial affordability by ourselves by constantly conducting strategic reviews on our spending. This paper consists of three parts: from the mid-term perspective, predicting changes in R&D policy environment, briefly reviewing 2018–2022 fiscal operation directions of R&D sector, and discussing key issues and directions for reorganizing R&D expenditure structure.

1. Changes and prospect for R&D policy environment

A. Changes and prospect for social and economic environment

First of all, it is expected that economy system and social structure will be reorganized fundamentally in terms of industry, employment and quality of life along with the emergence of the 4th industrial revolution in which machine replaces not only physical labor force, but also thinking and judgment of human. Automation and intellectualization in the entire industries and expansion of adopting smart technologies in the manufacturing sector will transform the ecosystem of existing industries such as medicine, manufacturing, energy, and

1) It is a personal opinion of authors who amended and revised the report on 2018–2022 government budget plan in R&D sector.
finance. Ever worsening natural disasters and social issues including fine dust, earthquakes, infectious disease, traffic accidents and others will be resolved with the help of smart technologies so that we can reduce exponentially increasing social costs and innovate public services. When the 4th industrial revolution is implemented in full force, the number of employees will decrease as the existing low- and mid-skilled jobs are replaced with machine owing to automation of repetitive process and new jobs will be created due to the emergence of new industry based on hyper connected intelligent innovation. Hence, it is inevitable to reorganize the employment structure. Accordingly, efforts to nurture talents who are equipped with creativity, diversity, and other characteristics that differentiating themselves from machine and the necessity of social safety net in order to respond to flexible employment environment will be all the more important.

Second, rapid population ageing, record-low birth rate, which made Korea to have a nickname of a demographic cliff, and crisis in major industries may weaken a driver for sustainable growth. Hence, a lack of labor force caused by decreasing productive population, shrinking production and consumption, and rapid increase in public welfare spending including social insurance are expected. In the financial projection on social security which was published in 2016, the Social Security Committee (SSC) predicted that the share of public and social welfare spending to GDP would increase by 25.8% in 2060 from 10.6% in 2015. The speed of finding and nurturing future growth engines that will replace shipbuilding industry and other major industries of Korea is slow as well. For this reason, the Bank of Korea during the period of 2016–2020 from 3.7% in 2006–2010 and 3.4% in 2011–2015. Lastly, a paradigm shift in R&D sector is expected. The keyword of public pledge of Moon administration in science and technology (S&T) is ‘people.’ Hence, the government will pursue policies focusing on researchers, main actors of S&T, and the ones that bring benefits to people through S&T, rather than building technological and physical infrastructure for the short-term. Therefore, the policy direction will be aligned to create an environment where people as the public as well as scientists and engineers can maintain happier life and build their capacities. To this end, the government will make preparations for the 4th industrial revolution to secure a future growth engine that brings economically affluent living to people and creates jobs. Also, much emphasis of the government’s policy will be put on its role of providing an environment to enhance SMEs’ capacity for innovation as they are the pillars of Innovation growth. In the meantime, the government will strive to transform the national research ecosystem to researcher-centered one based on autonomy and responsibility by reflecting the demands of researchers including expansion of creative and challenging research programs, ensuring academic autonomy, and providing sustainable support system to conduct researches stably.

"Opening the era of KRW 20 trillion in R&D spending means that the S&T community should take the responsibility of leading the effort of innovation-led growth."

B. Changes and prospect for financial operation environment

Recently, the world economy is showing signs of recovery. China, India, and other emerging countries are recording stable economic growth rate thanks to robust domestic demands and increasing exports. The US is also enjoying a sustained growth along with consumption increase and improving economic conditions, and the economy of EU is expected to show a stable growth under the expansionary monetary policy. However, global protectionism triggered by the US is spreading and uncertainties caused by US-China trade conflict still remain. Meanwhile, rate of the 2017 national debt increase was risen again compared to last year. The government debt GDP of 2017 is 39.6% increased by 1.3%p from 2016. The national debt amounted to KRW 669.2 trillion increased by 6.7%p from previous year. Some argue that the public spending should play an active role in overcoming structural challenges such as lack of jobs, low growth rate, bipolarization, low birth rate, and population ageing and providing policies that are required to improve the quality of life of the public including public safety, environment, support for startups and SMEs for Innovation growth, health, welfare, and balanced national development. In summary, the government spending on other sectors such as welfare, employment, public safety, and environment is expected to increase.

Considering that the national R&D investment has reached the world’s highest level and there is a need to consistently manage increasing government debt, the possibility of continued expansion of national R&D expenditure, which has reached KRW 20 trillion in 2019, is rather uncertain. Therefore, as the quantitative investment on R&D is restricted, we need to manage finance in R&D sector in a way to maximize the performance by restructuring R&D continuously, improving efficiency in investment, and innovating the entire process cycle. And, we also need to manage it in a way to strengthen strategic investment on core areas such as securing Innovation growth engines and support for SMEs.

2) As of 2017, Korea’s R&D spending to GDP ratio is 4.55%, ranking of the world’s 1st (OECD 2018).
2. 2018–2022 R&D financial operation direction

In order to accelerate Innovation growth and trigger innovation in economic fundamentals and ecosystem, we should create a ‘platform economy’ and expand strategic investment on data, blockchain, sharing economy, AI, and hydrogen economy to this end. We should drastically support to nurture core talents in promising sectors and innovate talent nurturing system. Also, we will provide a comprehensive and tailored support to connect financial investment, regulation innovation, and promotion of related policies on 8 leading programs in consideration of the current competitiveness and technology level, etc.

As conditions surrounding employment are worsening with increasing youth unemployment and decreasing the number of jobs in manufacturing sector due to restructuring of major industries, we need to build an ecosystem of virtuous cycle that creates quality jobs by finding growth engines and nurturing new industries based on S&T. To this end, we are planning to increase investment on technology-based startups, S&T-based services and R&D in new industries.

An active support to transform the government R&D system into researcher-centered one is required. The existing tracing and tracking approaches towards R&D are valid in achieving the tasks promptly, but certain limitations exist on developing competitive source technologies and triggering innovation. We will support to transform the government’s R&D system into a creative and leading platform in order to promote autonomy, creativity, and challenging spirit of researchers so that they can bring disruptive innovations.

Also, we will expand the investment on social problem-solving R&D to meet growing public needs on safe, healthy, and comfortable living and break away from R&D of which sole purpose is to achieve economic development. There are increasing demands from the public to deal with recently common issues such as environmental pollution caused by fine dust and hazardous substances as well as various natural and man-made disasters including fire, earthquakes, and new contagious diseases. The government should actively respond to such public demands by utilizing national S&T capabilities. We will also focus on the investment on R&D that is customized to the characteristics of each demand group by communicating with the public, consumer of S&T policies.

Strategies and efficiency of national R&D investment should be improved in order to fulfill the policy tasks with a limited budget. Although the expenditure allocated to basic research, R&D responding to the 4th industrial revolution, and the one to support SMEs should be increased dramatically during the term of the present government according to the national agenda of Moon administration, the total national R&D budget is increasing only slightly. Therefore, we need to create a system of a virtuous cycle of which the expenditure restructurings is connected to reinvestment and focus our investment on key policy areas with financial resources secured through the system.

3. Key issues and directions for reorganizing the mid-term R&D expenditure structure

A. Adopting a mixed policy perspective in large-scale R&D programs

1) A need to review the entire cycle of decision-making process in Innovation growth policy

In 2018, the government attempted to adopt a packaged R&D investment platform that connects R&D, related institutions and policies altogether centering on 8 core leading industries for Innovation growth. Such approach was made to increase investment effectiveness along with the criticism of insufficient investment effectiveness despite the quantitative expansion of government spending. It was because the government’s R&D investment has failed to closely connect to other policies during the implementation process. However, the government’s meaningful attempt to establish the packaged R&D investment platform also has some issues to be complemented.

First, the eight sectors of Innovation growth included in the packaged R&D investment platform have a limitation of the programs contained in each sector are simply bundled together by its own characteristics instead of being aligned to a well-planned goal from the beginning. Hence, efforts to enhance the consistency within the 8 sectors of Innovation growth should be made. For instance, when developing a new drug, of which entire process starting from basic studies to commercialization of a candidate substance should be executed consistently, or when planning a new sector such as a measure to reduce fine dust that requires connection and cooperation among multiple polices, they should be carried out from a mixed policy perspective encompassing R&D, institutions, and regulatory policies under a common goal.

Such mixed policy should be applied not only to the planning stage, but also to the entire cycle of policy process. To achieve this, we need to expand our vision to encompass the processes that were not considered by the current packaged R&D investment platform such as allocating budget, policy execution, evaluation, and feedback. In order for us to expand our vision to the entire cycle of policy process, restrictions on the government’s administrative system and governance should be overcome and this depends on the success of reinforcing the status of Science, Technology and Innovation Office and active engagement of the monetary authority.

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1) A platform economy refers to an ecosystem or platform of industries such as big data, AI, etc. which is needed in multiple industries.
2) Strategic investment directions for Innovation growth, Joint report from related ministries.
2) Program planning and budget/management system amendment to advance cooperation among multiple ministries

The government’s core R&D programs such as key leading programs of Innovation growth and social problem-solving R&D, are carried out in cooperation with many ministries recently. A joint planning and program execution system in participation of multiple ministries led by the Presidential Advisory Council on Science & Technology (PACST) is in operation in order to actively support the implementation of joint programs of multiple ministries. However, there are many rooms for improvement. For instance, they often fail to secure the budget as planned as they have a low priority in budget allocation compared to the ones pursued by a single ministry. In addition, cooperative ties among ministries become weak during the implementation phase after planning, often resulting in each ministry carrying out the program individually in the end. The following approaches can be applied in order to resolve the issues mentioned above. First, there is a need to support joint programs of multiple ministries first in budget allocation so that such programs can be implemented as planned. Second, appoint a program director (PD) under the pan-government S&T policy coordination division and develop a system in which the PD is in charge of planning, management, and evaluation of joint programs of multiple ministries in order to prevent cooperation among ministries from becoming weakened during the implementation phase. Third, PACST should attract active participation and cooperation of S&T related ministries by connecting the performance of joint programs to the next allocation of national R&D expenditure. Fourth, each ministry should operate its own research management office in the long term to prevent the disturbance in converging studies and active cooperation among main actors of joint programs. To this end, the governance structure should be reorganized constantly to the direction of strengthening functional integration and connection among dedicated research management offices of each ministry.

"The governance structure should be recognized constantly to the direction of strengthening functional integration and connection among dedicated research management offices of each ministry."

B. Optimization of investment priority for new large-scale programs

1) Including programs applied for Preliminary Feasibility Study (PFS) to the mid-term fiscal operation plan

The time is ripe for creating a new environment of national R&D spending based on innovation and challenging spirit as the government seeks to discontinue its financial support for a large number of R&D programs. The government has implemented sunset regulations since 2015 to prevent habitual execution of long-term programs. As a result, about 200 national R&D programs will be discontinued by 2021 and which stand at a 42.7% of the total 477 R&D programs excluding 277 in general areas such as defense, and humanities and social science.

It is a golden opportunity to break the pattern of budget allocation depending on path dependency theory and incremental model and revamp it as so-called leading R&D spending. Unfortunately, the reality is quite different from our expectations. After analyzing programs that applied for PFS recently, we found out that many of them were related to sunset programs and not differentiated themselves from the old practices of tracing and tracking approaches. In addition, R&D programs were allocated by simply distributing them to government-sponsored institutes as in the case of the past and some government ministries diversified them recklessly without consultation among related ministries. Concerns for the impact of government-led R&D programs were raised with an excess intrusion into the private sector, and reckless bottom-up programs with insufficient detailed strategies and narrow views or approaches caused by organization-led program planning were pointed out as issues to be resolved. All of these are considered as the result of complex reaction of many elements such as organizational structure, work routine in which previous tracing and tracking approaches coexist, lack of R&D planning tower within the ministries, and poor recognition on the need of innovation. The number of programs that applied for PFS and the scope of expenditure for 2018 are three times more than those of 2017. Naturally, concerns for side effects are raised which include a waste of program planning budget to the extend that a budget allocated to the new programs cannot be included in the spending limit of the concerning year of the ministry that applied for the program, and excessive waste of administrative costs.

Hence, we need to consider the R&R and priorities on program implementation of requesting ministries’ priorities and complement the institutions in conjunction with the mid-term
2) Introducing a fast track approach to sunset programs

The government has adopted the sunset system on R&D programs for efficient investment of its budget against the ones with poor performances and those that were habitually continued for a long time with vague goals. The reason behind introducing the system was the need to improve flexibility of national R&D programs by reflecting environmental changes such as industrial structure and demand from the private sector in time to highly rigid long-term programs. However, concerns are also raised from researchers at sites while implementing the system. For example, some programs were discontinued by applying unilateral criteria although they record high performances and are required to be implemented on a continued base. Or when programs that were planned again after discontinuation were not significantly different from previous ones, it took a lot of opportunity costs to replan and prepare for the PFS after they were discontinued. Therefore, we need to develop more flexible and various fast tracks to consider follow-up programs of sunset programs.

To be specific, we should adjust the basis for application criteria of the current PFS from KRW 50 billion to over KRW 100 billion in terms of total program budget in order to expand the authority of arbitrary budget allocation of the ministry. Also, there is a need to review the possibility of exempting PFS for regional development programs that are conducted with the special account for balanced national development and some SME support programs of which R&D and non-R&D sectors are mixed. In addition, we should introduce pilot programs for certain programs to enable prompt program initiation for the ones feedbacks that were collected while making the decision on discontinuation of the programs are reflected in order not to lagging behind the speed of rapid technological development.

C. Reorganizing R&D expenditure structure to support companies from the industry perspective

1) Discussions on three demands of the industry and reflecting them to national R&D planning system

So far, the government’s R&D programs have played a pivotal role in leading the R&D activities of the industries. As for mid- to long-term research programs that were difficult for companies to make an investment by themselves and risky ones that are highly likely to fail, the government made upfront investments to secure source technologies that can be used by the future industries. At the same time, the government contributed to enhance innovation capacities of corporations by directly providing support for R&D programs financially and helping their technology transfer and commercialization efforts. Meanwhile, there is a growing argument on the effectiveness of the government’s support for companies as R&D programs pursued by almost all ministries include contents that are overlapped with its corporate support as expenditure on R&D budget has increased rapidly over the past 20 years. Some industry insiders greatly misunderstand such efforts of the government by saying that government ministries are abusing R&D programs that were aimed to support corporate activities in order to secure their R&D budget and they even mention on uselessness of such programs. Considering the score of new program planning for this year, there is an urgent need to discuss on issues of R&D programs to support corporate activities and measures for improvement in general.

In order to increase the effectiveness of R&D programs to support companies, we need to precisely diagnose ‘industrial demands’ first, and develop a ‘process’ and ‘tailored program planning’ to reflect such demands systematically. The industrial demands that are raised during the planning phase of national R&D programs can be classified into three categories: A ‘potential demand’ that the government must find out for strategic technology nurturing, Δ ‘a ‘common demand’ that is required for the supply chain of each industry to enhance its competitiveness,
and Δ as ‘realistic demand’ that requires the support from the government to handle technical concerns of each company. One way to reflect industrial demands is to adopt a supply chain-based planning system and develop it based on cooperative partnerships between the government or specialized ministries and companies as seen by the example of European Technology Platforms (ETPs) in Europe. With regard to a formative demand survey based on pre-determined frameworks in planning R&D program to support companies, identifying common areas of demand through industrial associations and organization or installing a system that enable a constant use of resources by securing a talent pool consists of highly experienced experts of the industries can be helpful.

2) Entire reorganization of R&D priorities of supporting SMEs to strengthen their capability

The Moon administration newly installed the Ministry of SMEs and Startups (MSS) and expanded the R&D budget to support SMEs by twice to ensure a sound economic ecosystem and lay the foundation for Innovation growth in the long-term. According to the analysis on R&D programs of MSS that are recently planned, however, they are excessively overlapped and an old strategy to distribute R&D programs to government-sponsored institutes is still applied. Overall, national R&D programs are lacking implementation strategies, leading to a poor record of their passing the PFS and disturbing the implementation of national agendas. R&D programs to support SMEs are divided into support types and they are ones to promote the growth of national economy (stand-alone type), to establish an industrial ecosystem (cooperative type), and to secure resources and build the infrastructure. However, the scope of support targets (startups-innovative ones-SMEs and established companies) is wide according to such classification and there are no specific support strategies. Hence, they are hardly differentiated with each other. Considering this, the keyword for the mid-to long-term policy for Innovation growth of SMEs should be focused on securing sustainable innovative capabilities. Also, there is a need to simply program structure of each ministry by realigning their R&D goals by the level of innovative capabilities and development stages based on critical reviews on the existing R&D support type-based classification methods, and some programs should be adjusted. We need to get rid of old approaches that is short-term based and injecting a small sum of budget to instantly reduce complaints at sites. Instead, we should transform the system into the one that intensely supports the quality growth of startups and nascent companies as well as innovative ones recording a high growth rate among companies equipped with technology development and absorption capabilities. With regard to program maintenance and reorganization, programs that are simply related to venture incubation, training, consulting and subsidies should be migrated to non-R&D programs. If it is difficult to migrate such programs, actively adopting a turnkey budget system or packaging the programs from the comprehensive perspective can be an alternative.

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KISTEP
R&D AND
BEYOND 2018

Predict the Future of KISTEP and Korea
Wook Sahn, Chairman, KISTEP
Predict the Future of KISTEP and Korea

Wook Sohn, Chairman, KISTEP
Sang-seon Kim, President, KISTEP

Kim Thank you for all your time, chairman. How have you been? It is my honor to invite you as the first speaker of our series, KISTEP In4, after I was appointed as the 9th president of KISTEP. I guess you are filled with emotions as you served as the chairman during the period of various social and economic changes that were difficult to be summarized as ups and downs. Please give us your thoughts and impressions on that.

Sohn First of all, I would like to congratulate you on your appointment as the 9th president of KISTEP. The number “nine” has an important meaning of completing a cycle and preparing for a new one. I hope you to deeply analyze frameworks of the past 8 cycles and prepare for a new one for the next hundred and thousand years to make Korea as one of the leading countries as in the case of creative country in the era of King Sejong. As for the roles and functions of KISTEP, exploration and planning should come first instead of development and evaluation. Furthermore, we need a think tank that creates a culture, rather than planning. To achieve this goal, the internet of thinking is required. S&T should provide a vision for the future society by considering its impact on the society and economy, and the think tank should be able to provide a big picture of the entire ecosystem of S&T. Isn’t it that KISTEP is preparing for the relocation to Jincheon next year? I visited the Jincheon headquarter which is under construction now, and the HQ had a formation of crane wing (Hakik-jin). As the turtle ship (Geobukseon) fleets won the Battle of Hansan Island with Hakik-jin tactics, I am certain that KISTEP, the turtle ship fleets of today’s Korea, will wisely lead the journey of the 4th industrial revolution.

I believe that S&T is something that should be handled by craftsmen. A truly advanced country is the one where craftsmen are respected. As a person who considers that S&T is a leading player of national development and value creation, I think the spirit of Seonbi, who does not compromise his policies derived from a long-term vision for the future of a nation and principles as an expert, is important. In a nutshell, 3 core elements of advanced countries are S&T, civil economy, and spirit of citizenship. People should respect S&T, and scientists and engineers should show the craftsmanship with pride and dignity. In addition, scientists and engineers should also turn over a new leaf. However, we must set one of the highest goals that make us tick first and have a system that allows us to be immersed into the them as prerequisites. It is true that we are also much focusing on “what,” instead of “why” and lacking in a platform-thinking approach in the era of the 4th industrial revolution. Thus, we need...
to remind ourselves of “why we are conducting a research (why)” and should take the lead in adopting scientific methodologies (how). Lacking in a platform-thinking approach in the era of the 4th industrial revolution. Thus, we need to remind ourselves of ‘why we are conducting a research (why)” and should take the lead in adopting scientific methodologies (how).

Kim I agree with your opinion on KISTEP, as our functions and roles are at the most critical period of our own. When its main office is relocated to Jinchoon, it is expected that many employees will experience difficulties due to changing working conditions considering commute, housing, etc. It is important for us to provide a better working environment. However, I believe the most important thing is to ensure that they recognize the significance of their workplace. With S&T and superior DNA of Korean people, Korea was able to achieve such progress only in 50 years after the Korean War. I believe that there is no future for Korea without S&T. I stress our employees to consider KISTEP where the future of nation is held all the time, rather than a public institute.

Sohn People-centered flowers can bloom only when an ecosystem is built as in the case of Silicon Valley, Israel, etc. When we try to make a connection between S&T and the perspective of job creation, outstanding talents leave the country by engaging in related activities based on short-term and microscopic approaches. We need to consider why the world’s best talents gather in Singapore, which ranked the 2nd in the global talent competitiveness index. People-centered policies are critically important and we need to have a culture of nurturing creative talents from the early stage of kindergarten.

How the children who wish to be scientists and engineers in the future are raised now? We need to change our framework and mindset from institute centered to university centered, from creating jobs to creating new growth engines, from evaluation based on distrust to ‘design reviews’ in order to create synergies from convergence. Namely, we should aim for research-centered university, free zones, customer-centered approach, and convergence.

Korea has maintained a paradigm of research-based R&D. However, advanced countries have shifted their research paradigm into university-centered one due to rapid changes. I once visited Technical University of Denmark. A nano expert from UC Berkeley was the dean of the department and I asked him why he moved here instead of staying in Berkeley. He said, “This small country is like a paradise for researchers.” I also asked him how the difference of Denmark compared with other countries. He told me that only people who really loved nano technologies with passion and dream were gathered here. It was possible as the government designated a free zone for university-centered research and linked the institutes, companies, and schools organically.

We definitely need a paradigm shift. Korea allocates a lot of budget but, most of them are spent centering on research institutes. We should help researchers at institutes to have their own dream. Creating an environment where researchers can happily focus on their study is one thing that the government should take care.

Kim Issues related to the government-funded research institute are not that simple. We need to be cautious in dealing with changes as there are some gains as well as losses. However, a significant change is needed. The reason why I feel burdened with huge responsibility as the president of KISTEP was because I had worked as a policy adviser at the Ministry of Science and Technology for over 30 years. After that, I observed the government policies from the outside of the government for about 10 years while working at Korean Federation of Science & Technology Societies (KOFST) and for connecting activities. Based on my experience, I also agree with your advice that we should be careful not to focus too much on minor parts. As we look into the future in the next 20, 30, and 100 years, there are many problems that need to be fixed fundamentally.

Sohn There is a need to push for a policy consistently if we want to move forward for the future. I asked a Finnish director who took in charge of education policy with regard to the success of providing creative education system of the country, and she said that she had been engaging in the same project for 21 years. In other words, policies are carried out consistently even if a new government is inaugurated. As for Germany, it has been said that the same person who were responsible for the country’s unification policy had conducted the same duty for 20 years. In a sense, it would be proper to say that the person has been playing his role as the basis for a country. Therefore, there is a high chance for Korea to become a leading nation if it can hire an expert for over 20 years in the same area.
The only distinctive features of Korea compared to other countries such as China, Japan, etc. are its creative technologies and talented people. In addition, we need a public consensus on the necessity of technology for the survival of the country in the future.

The only distinctive features of Korea compared to other countries such as China, Japan, etc. are its creative technologies and talented people. In addition, we need a public consensus on the necessity of technology for the survival of the country in the future. In order to survive among leading economies, we need to feel the consciousness of crisis and look at the S&T policy based on trust.

Kim The government’s budget plan passed the National Assembly on August 31. As you know it well, the government’s budget has increased 9.7% with KRW 470 trillion, compared to last year. Among them, KRW 20.4 trillion is allocated into the S&T sector. I considered that such figure has a great significance. First of all, I welcome the era of surpassing KRW 20 trillion in S&T budget while being burdened with a huge responsibility to respond to public expectations with outstanding results. I would like to ask your advice on that.

Kim In the era of KRW 20 trillion in S&T budget, we need to meet the expectation with results. It is considered that open innovation, a research culture that you mentioned earlier, is all the more important. The open innovation should go beyond the literature meaning of its slogan. The scientific community needs to get rid of the mindset that “It should be done only by me.” Scientists and engineers should map out specific plans to achieve the outcome and boldly change their fundamental thinking.

Sohn There is a thing called a ‘Golden Cycle’ and it is a process of circulating what, how, and why organically. As for Korea, we only focus on ‘what.’ If we continue to engage in competitions only with what approach, no visions and dreams can be created. I hope that people can think about why we should do this, and a culture of challenging spirit to move beyond the world’s best.

Kim We are blessed with a series of next generation technologies including artificial intelligence (AI), robots, AR/VR, self-driving car, etc. so that mentioning the 4th industrial revolution looks like a thing of the past. In a sense, it means that we are now on the doorstep of ‘S&T centered society’ where S&T has become the center of progress when it comes to national security, quality of life, revolving social issues as well as culture, art, and all other areas, not simply for strengthening the competitiveness in the manufacturing sector. I would like to ask your thoughts on the mindset of S&T community in preparing for the 4th industrial revolution and the upcoming S&T centered society.

Sohn We need to study the case of the US, a leader of the 4th industrial revolution. At the center of its competitiveness is Silicon Valley. Silicon Valley has a completely horizontal culture and the ecosystem itself is totally different. It has been said that Xiaomi, a Chinese electronics and IT company, is called as a ‘company that is more Silicon Valley like than the ones that actually operate there’ as it had already adopted the Silicon Valley culture into its own. We have just known that Samsung Electronics had become No. 2 following Xiaomi in India. When a former Minister of S&T asked the Chairman of Xiaomi on how the company was able to work creatively, he said, “We do the internet thinking.” The internet thinking refers to a culture of Silicon Valley, which is a culture of openness, sharing, cooperation, and respect. However, we are lagging behind as we only focus on responding to the 4th industrial revolution only with ‘what’ approach, with no efforts to create such ecosystem.

Kim Did you mean that we should take a different approach from previous technology-based mindset focusing on IoT, AI, and other promising technologies, make efforts to create an ecosystem of horizontal culture, fundamental change of thinking to have a creative, emerging, and open mindset instead of taking unilateral approaches, and pursue scientific methodologies based on ‘how,’ in order to respond to the era of 4th industrial revolution?

Sohn I was surprised that all projects of the Creative Center at Seoul National University were related to hi-tech. To me, it seemed...
that they were determined to develop all technologies within the team and pioneer the market based on them. If you look at the system of leading countries as an example, they consider what the markets want first and gather the technologies across the world to build a platform that can handle such issues unlike Korea. Today, we cannot win or lead the global market only with a determination that I would develop a kind of technology and achieve a certain goal based on this. Technologies we need have appeared to the world already. Hence, we need to act as a pillar in bringing them to us. Namely, we can take the lead only when we collaborate with others. Now, we can respond to the 4th industrial revolution by changing our tech-centered thinking.

Kim  In the past, the goal of government R&D was to enhance national competitiveness by strengthening the competitiveness of manufacturing sector. Recently, however, the government shifted its focus into improving the quality of life and resolving various social issues. It is considered that a demand-based approach is needed when applying S&T in real life to solve social issues and others.

Sohn  The meaning of the 4th industrial revolution is to form a creative vision. Hence, there should be more research institutes to deal with social issues among the ones related to national R&D projects. In particular, the issue of job creation should be handled by local universities. As for the US and Europe, there are research-centered universities that focus their efforts on research activities and the main mission of remaining ones is to deal with technological issues of local communities. We need to benchmark such structure of universities.

Kim  A so-called ‘Korea R&D paradox’ which refers to the paradox of high R&D input and low outcome is still a topic of conversation. Starting from minor issues concerning project based system (PBS) and other institutional problems to the major ones encompassing overall national innovation system (NIS), the scope of issues raised and their solutions are diverse and comprehensive. I considered that the recent government’s announcement of ‘National R&D Innovation Plan for Advancing NIS’ is a product of concerning such issues. How do you assess this ‘Innovation Plan’ and what should we prepare for a successful implementation?

Sohn  The NIS of Korea has initiated during the Roh administration. Its concepts were from the Japanese model. Japan changed its R&D system in the 1990s to yield R&D outcomes. And that’s where the concept of free zone originated. Starting from the Nobel Prize winners in Japan, many things have changed since then in national R&D. Korea also adopted the Japanese model that only looked alike in appearance. For example, the most critical concept to realize the NIS is a ‘critical mass.’ In order for us to achieve a critical mass, we should attract Korean and global talents to initiate the NIS system altogether. In fact, it is a very difficult process as it is considered as a part of balanced development of regions from the political aspect. A critical mass can be achieved by putting all the efforts into a single institute. In Korea, however, such efforts are divided into regions, resulting in the increase of total number of institutes.

I once visited Cornell University to attract talents. A member of Cornell university official pointed out peculiar characteristics of Korea. For instance, when Korea tries to make an investment in purchasing a set of equipment consists of 10 components, persons in charge of the acquisition ask and buy the first equipment only at a time, and second and the third consecutively. If we designate one leading institute to purchase such equipment, it could
Kim I think we should take note of what you said. The situation now is quite different from the 1970s and 1980s when the government provided financial supports and led the development efforts of industries. In a sense, what corporates need is not a financial support, but a direction where the future holds. The role of the government is to provide convincing technology predictions that they can truly count on. As for the national research institutes, their main function was to engage in R&D efforts directly in the past. Today, they should be able to provide policy services, that is, to guide the private sector that it can follow the course based on trust. They desperately need a think tank serving as their brain.

Sohn I believe that the success and failure of KISTEP depend on improving the quality of our employees. Right now, their mindset, passion, sense of responsibility, and dignity are sufficient enough to be proud of themselves. Hence, I would like to ask them to enhance their expertise and global competitiveness of KISTEP. We need to hire the world-class strategists and seek to improve the capabilities of our members by sending them overseas for work and educational training.

Kim KISTEP celebrates the 19th anniversary of foundation this year. In 2019, KISTEP will mark its 20th anniversary along with the beginning of the Jinchon era. It is considered that preparing for a hopeful future is equally important to deal with many issues we face today. Do you have any wish for the young KISTEP, celebrating its 20th birthday and starting a new life in Jinchon?

Kim I heard that you are called among employees as ‘Chairman long legs’ owing to your deep interest and support for KISTEP. We hope your affection to KISTEP and passionate activities will continue in the future for the S&T community of Korea. Thank you.

After graduating from Seoul National University majoring in Mechanical Engineering, Chairman Wook Sohn began his career in Samsung Electronics in 1975. Mr. Sohn developed the ‘10-year Vision of Samsung Electronics’ and led the innovative efforts of the company. He served the longest term as the president of Samsung Advanced Institute of Technology, head of Samsung Human Resource Development Institute, and chairman of Nangoism. Currently, he is the chairman of KISTEP, head of department at Advanced Institute of Convergence Technology of Seoul National University, and chairman of Happy 125.
Key Contents of the 4th Basic Plan for Science and Technology

Overview

The "Science and Technology (S&T) Basic Plan" is a statutory plan which the government is obligated to establish and implement every 5 years under Article 7 of the Framework Act on S&T, and is the highest-level plan in the field of S&T. The plan presents mid to long-term development strategies for scientific and technological innovation in Korea including visions, goals, and directions. With the term of the 3rd S&T Basic Plan (2013-2017) coming to an end, the 4th S&T Basic Plan (2018-2022) was formulated through procedures, beginning last year, that include the work of various committees consisting of industrial, academic, and research experts, the gathering of input from the public, and consultations among relevant agencies, and was finalized by the National S&T Commission on February 23, 2018.

To present future visions of S&T and the features of future society from a long-term perspective until the year 2040 and realize them, the 4th S&T Basic Plan derived strategies and implementation objectives for the next 5 years. Adopting a different approach from previous basic plans, the plan links long-term visions of S&T with the 5-year basic plan, in an attempt to enhance policy consistency and effectiveness, and facilitate the gathering of national competencies. In addition, it is a new approach for field-based plan formulated through the online platform "S&T Innovation Plus (www.scienceplus.kr)" which can encourage more participation of policy users (citizens, researchers, etc.) in the process of establishing the basic plan for S&T.

The Future Envisioned by S&T

A. Vision

The 20th Century was an era in which humanity pursued materialistic influence by maximizing the utilization of natural resources. But moving forward, the more developed a society becomes, the stronger the demand for improved quality of life over and above economic development will be. The 21st Century will be a time when people have to move from quantitative to qualitative growth, and thereby enhance the national happiness index. But the environment around us is rapidly changing (e.g., global warming, worsening environment pollution, and new infectious diseases), and Korea’s unique situation involving its low birth rate, aging population, and inter-Korea relations leaves many issues that still remain unresolved. This situation is amplifying the uncertainty and variability of Korea’s future, and making it even more difficult to achieve continuous economic growth and society’s qualitative advancement.

Vision and the Future Envisioned

- Improve the quality of life and contribute to the advancement of human societies through science and technology

The Future of Innovative Actors

- [Researchers]: Creating innovative knowledge in autonomous research environment
- [Entrepreneurs]: Leading the global market in business-friendly environments
- [Citizens]: Enjoying enhanced quality of life through advances in science and technology
- [Innovation Ecosystem]: Providing a vibrant environment that promotes risk-taking and growth environment

Abundant World

Convenient World

Happy World

World in Harmony with Nature

Vision

The Future World
To effectively respond to changes in an uncertain domestic/global environment and enhance the society’s overall standard of living by satisfying individual needs of citizens, efforts should be made to visualize the future we want and achieve it accordingly. By treasuring not only material affluence but spiritual values and endeavoring to achieve them, we need to keep making a future where we can carry a happy life. S&T have to play a central role in handling the new problems of the future society and realizing sustainable development and improvements in quality of life. Thus, the 4th Basic Plan for S&T sets the future vision of S&T as “improving citizens’ quality of life and contributing to the advancement of human societies through S&T.”

B. The Future World Envisioned by S&T

With future vision, the basic plan specified the future world we dream, in “four worlds” - abundant world, convenient world, happy world, and world in harmony with nature. Based on the “future until 2040” as presented by the future vision of S&T (2010), the basic plan presents the following by reflecting changes made thus far in the environment.

In the “Abundant world,” an economically well-doing society flourishing with innovative new industries and jobs will be realized. New, global market-leading goods and services will continue to emerge and rapidly-growing SMEs (small and medium-sized enterprises) will lead economic growth and job creation.

In the “Convenient World,” a society with greater convenience in everyday life will be realized. Advanced, intelligent technologies and services, by which people, things, and the environment are linked, mutually communicating all information on real-time basis, will be available, and AI (artificial intelligence) and robots will provide personally-tailored services.

In the “Happy World,” a society where everyone lives a healthy, safe, and security-conscious society will be realized. Advancements in biomedical technologies will allow elderly to enjoy life as energetic and stimulating as younger people, and will provide diagnosis and treatment technologies for major diseases. Crime prevention systems will prevent crimes and terrorism, and advanced defense systems such as drones will realize a safe society.

In the “World in Harmony with Nature,” renewable energy will bring about harmony with the environment and solve the energy shortage, developing the foundation for sustainable growth. Also, through recycling, ecological conservation will be achieved.

B. The Future of Acting Bodies Envisioned by S&T

The basic plan describes the specific activities of the researchers, entrepreneurs and citizens and the innovative ecosystem in the future world, and expresses their respective objectives and goals through relevant indicators.

“Future Researchers” will create innovative results in an autonomous research environment. They will reap global-leading, original research outcomes, while new researchers can also study conduct research without worrying about their research budgets. Also, unnecessary administrative burdens will be reduced in the research process, enabling researchers to devote themselves into research.

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1) Percentage of highly cited papers (top 1% among all SCI papers in Korea (Source: National Research Foundation of Korea)
2) Total number of times cited, among papers published for 5 years / Number of papers published for 5 years (Source: KISTI)
3) Percentage of hours spent for R&D, with total work hours set at 100% (Source: KISTEP)
“Future Entrepreneurs” will lead the global market in a business-friendly environment. SMEs will make their own active investments in R&D and acquire excellent technologies and manpower, developing into medium or large-sized companies. And based on these, existing and new industries will realize dynamic growth, leap forward again as a global industrial power, and lead relevant industries in the coming hyper-connected, hyper-intelligent societies.

The “Future Innovation Ecosystem” will have a structure of a virtuous cycle filled with challenges and growth. All parties involved in the national innovation (corporations, universities, research institutes, etc.) will continuously create value for the future through collaboration and convergence, and regions will also position themselves as leaders of innovation and growth. Innovative entrepreneurs with great ideas and technologies will facilitate startups and help Korea to leap forward as a country full of strong, national competitiveness-leading intellectual properties.

“Future Citizens” will enjoy the outcomes of S&T and improve the quality of life. Highly-satisfying and quality jobs will continue to be created in the field of S&T, enabling a healthy, energetic life in a pleasant, comfortable living environment. It will be a safe, inclusive society in which citizens can live without worries, and with a strong interest in S&T from the public, their ability to absorb and utilize new technologies will be improved.

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4) Score of SMEs’ technologies as compared to world-best technology (Source: KIBZ Korea Federation of SMEs)
5) Average number of researchers per research labs in SMEs (Source: Korea Industrial Technology Association)
6) Percentage of Patents on 19 Core Technologies of 4th Industrial Revolution, Applied in Korea, U.S., Japan and Europe, by Korean applicants to Total Patents on 19 Core Technologies (70,000 patents) (Source: Korea Intellectual Property Strategy Agency)
7) Life expectancy minus the period in which one suffers from diseases or injuries (Source: WHO)
8) Average density of ultra-fine particulate matters (PM2.5) in Korea (Source: OECD)
9) Survey on the degree of interest in new scientific discoveries, inventions and technologies (Source: Survey of citizens’ understanding on science and technology, Ministry of Science and ICT)
10) Number of Industry-academia-research joint patents / Total No. of researchers × 1000 (Source, USPTO)
11) Percentage of opportunity-seeking (innovation-type) startups, among all startups (Source, OECD)
12) Local governments’ R&D investment / Local governments’ total budget (Source, Statistics Korea)
The basic direction of S&T innovation policies for the next 5 years to realize future visions in the basic plan is as follows. First, we should transform our goals and short-term-oriented R&D to R&D that brings about disruptive innovation, and create an innovation ecosystem in which convergence and cooperation actively take place. Also, we plan to focus on accelerating the creation of new industries and jobs by fostering innovation growth drivers, and shifting away from a solely growth-centered economy to expand contributions to improving quality of life and solving the challenges to humanity. The 4 Strategies of the S&T Basic Plan and 19 objectives that reflect such directions are as follows.

**Objective 1** Promote creative and challenging research to elicit innovation from researchers, and expand support for free-topic research projects rather than investment-centered top-down projects. Moreover, in order to enhance the autonomy and creativity of researchers, we will improve the planning selection evaluation process for basic-core technology research, and arrange a stable and efficient operation system to enhance the utilization of national research facilities and equipment.

**Objective 2** Create a researcher-oriented, immersive research environment. We will provide a level of support that allows researchers to devote to one area for a long time, and enables talented researchers to continue their research without cessation. Furthermore, administrative procedures will be streamlined with a focus on researchers, and their autonomy in research funds will be strengthened. Even for government funded research institutes, the functions and key projects will be rearranged to allow the researchers to concentrate on their core projects, and evaluation system will be shifted to focus more on the missions of ORIs to strengthen the researchers' expertise and challenging spirit.

**Objective 3** We will actively discover and support outstanding talents so that we have abundant talents equipped with the creative capacity and the pioneer spirit needed to lead our future society. We will strengthen primary and secondary education to improve the creative capacity of the next generation, and innovatively improve education in natural science and engineering colleges to nurture a professional workforce that is ready for the coming changes in our industrial structure. Also, support for both discovering/nurturing new researchers with potential and career development for S&T talents that are adaptable to the changes will be strengthened.
Objective 4  Promote S&T as culture with public participation. We will diversify communication channels with the public and strengthen the social role of the S&T community to foster science as culture, where the public can enjoy communication and participation for S&T. Beyond this, we will expand the use of S&T in culture infrastructures such as science museums, and create a self-sustainable innovation growth ecosystem to foster a new science culture industry in the 4th industrial revolution era.

Objective 5  As international cooperation thus far has been focused on quantitative expansion and foundations for strategy, starting now it will secure international leadership that corresponds to the country’s position through strengthening international joint research on strategy, ODA policies on S&T and innovation, etc.

<Strategy 2> Build a Vibrant, Innovation-driven Ecosystem for Science and Technology

Independent technological innovation is showing its limitations as the R&D cycle becomes shorter. To overcome such issues, the invigoration of convergence and cooperation and establishment of a S&T ecosystem where creative challenges and growth actively occur are needed. To achieve this, we will build a system that can create outstanding knowledge properties that could lead the global market and swiftly connect research results to the creation of growth drivers and business. In particular, we will support R&D capacity enhancement for ventures, SMEs and local areas so that they can play a leading role in innovative growth.

Through the above measures, we will increase the number of joint patents among industry-academia research institutes from 0.7 (2017) to 0.9 by 2022 and expand the share of innovative startups among all startups from 21% (2014) to 30%. Also, we will expand S&T’s share of the total budget from 1.07% (2016) to 1.63%.

Objective 6  Facilitate collaboration and convergence among stakeholders and sectors. If efforts until now were focused on building the foundations for cooperation of industry, academia, and research institute, we will shift our focus to demand-oriented cooperation to produce actual results. In order to strengthen the problem-solving capacity for our national challenges, we will build an environment that allows for efficient collaboration among national-level public research institutes such as S&T, humanities and social sciences government-funded research institutes, national and public research institutes, and special research institutes. Moreover, to enhance corporate global innovation capacity, we will promote measures like tax support and support for joint research to attract more inter-corporate R&D cooperation.

Objective 7  Foster innovative technology-based entrepreneurship and startups. While there has been a lack of startups launched by talents with a high chance of success, we will increase their chances through startup promotions and support for the talented at universities and government funded research institutes, and expand the possibility of launching a startup to currently working employees and the general public by lowering the barriers for technology startups. In addition, we will not only promote the quantitative growth of startups but also their qualitative growth through scale-up and global expansion.

Objective 8  Create globally competitive intellectual property. To achieve this goal, we will strengthen strategies for the introduction of knowledge property in all R&D processes, and support the establishment of R&D strategies that create outstanding knowledge property by expanding the use of patent information in promising fields such as the 4th industrial revolution. Also, we will secure market-competitive IP to improve on unsatisfactory public IP, increase the economic availability of research results and promote transfer and commercialization of unused patented technologies.

Objective 9  Regional innovation systems should establish a region-led system rather than a centrally-dependent system. We will improve the central government’s support system for regions and promote region-led R&D projects that meet demands by strengthening each region’s R&D investment decision power. Furthermore, we will resolve regional disparities in S&T resources and R&D capacity, and strengthen and advance the network among a region’s innovation actors.

Objective 10  Widen public participation in the decision-making procedure related to S&T and enhance control tower functions. To achieve this objective, we will transition the government-led establishment of S&T policies and R&D planning and evaluation system to an ‘opened national R&D system’ in which the public actually participates. Moreover, we will improve the government R&D investment system to facilitate faster investment in challenging R&D, and strengthen pre-adjustments and partnership for mid-to-long-term plans among each division in respective fields.

<Strategy 3> Drive the Creation of New Industries and Jobs through Science and Technology

We will actively deal with the national challenge of preparing for the 4th industrial revolution, nurture growth engines through expanding investment in promising areas of the future, and create a virtuous cycle ecosystem where S&T create quality jobs through the creation of growth engines and new industries.
We expect to rise to the 12th highest industry value-added per capita by 2022 (from 18th in 2016) and create 260 thousand jobs based on S&T-ICT. We will increase the number of global SW specializing companies from 37 (2016) to 100.

**Objective 11** Enhance efforts to prepare for the 4th Industrial Revolution. In particular, we will secure AI, hyperconnectivity network-based technologies and establish foundations for data availability through strengthening data sharing using capacity. In addition, we will build an environment that creates new industries through the establishment of an institutional and empirical ecosystem for new technology new business.

**Objective 12** Nurture innovative growth engines with meaningful impacts on people’s lives. We will shift from R&D-centered growth engines to customized nurturing policies that consider specificity of each sector, and set up an entire cycle (identification, support, evaluation) management system. Furthermore, we expect to expand our connection with the everyday lives of people through demonstration, regulation identification, application of outcomes on disaster-safety areas, etc. In addition, we will promote promising industries to become growth engines and strengthen package support for the industrialization of growth engines.

**Objective 13** Revitalize manufacturing industries and nurture service industries to promote the convergence of manufacturing-service. We will strengthen smart factory based competency for major manufacturing industries and promote the adoption of smart technologies by manufacturing companies. We will expand the manufacturing-service convergence and advance services through R&D to overcome the issue of low value-added in the services industry.

**Objective 14** Foster SMEs as the backbone of growth through innovation. We will create a business-friendly R&D investment environment and enhance the effectiveness of SME R&D investment through efficient arrangement of the SME support system. Also, we will help SMEs and ventures to secure excellent human resources, and support the entry of outstanding companies to the global market.

**Objective 15** Increase job creation in S&T. We will expand R&D support for areas where there is high potential for job creation, and support S&T jobs through fostering research industries. Moreover, we will reinforce job-related policies by estimating future job demands based on future changes and discovering new jobs.

**<Strategy 4> Promote a Happy Life through Science and Technology**

These days, the purpose of S&T should shift from economic development to improving quality of life and resolving the issues of humankind. The Basic plan will spread ICT-based convergent technologies and services for people to maintain healthy and vigorous life in a convenient and pleasant environment, and enhance the level of contribution of S&T to resolving social problems such as disasters and safety issues.

Through this, we hope to increase the percentage of healthy elderly from 21.1% in 2015 to 25% in 2022, bring down the average ultra-particulate matter concentration of Seoul from 26μg/m³ to 18μg/m³ in 2022, and improve the technology level in the field of disaster response and safety from 73.5% of the country with the best technology in 2016 to 80% in 2022.

**Objective 16** Efforts will be made to enhance overall public health and establish a systematized national healthcare system, rather than focusing on the development of elementary technology, to respond to demographic changes such as low birthrate and the aging of society and to contribute to the realization of a healthy and vibrant life for residents. Also, the high-cost, inefficient medical system will be changed to an adequate cost, highly efficient system through S&T.

**Objective 17** A smart disaster management system will be established to create a safe and secure society, and R&D on national defense technologies will be expanded to enhance public protection and national defense capabilities.

**Objective 18** Responses to climate change and the new climate system will be pursued to create a pleasant and comfortable living environment. Environment management systems for air and water quality will be established, and the foundation for a resource recirculation society will be prepared to facilitate the sustainable management of the country. Also, smart cities will be built around the country to provide a convenient and excellent living environment for the public.

**Objective 19** S&T will support the improvement of overall welfare for the underprivileged to build a warm and inclusive society. Social gaps related to S&T such as the information gap and science culture gap will be reduced, and S&T will provide practical contributions to the resolution of social issues.
<Key Science and Technology Fields>

To effectively implement the strategies of the 4th S&T Basic Plan, 120 key fields of S&T with a significant level of economic, social, scientific and technological contribution were selected through the use of expert panels, collection of opinions of related government institutions, and expert surveys.

Key fields of S&T were selected based on 120 national strategic technologies of the 3rd S&T basic plan, reflecting the latest technological trends. 12 technologies including artificial intelligence, smart home, smart city, 3D printing, and air pollution response technology were newly added, and the title, scope, and division of the technologies in the national strategy were amended. After taking into consideration the latest technological trends, degree of development, and similar or overlapping technologies.

These key fields were linked with 8 objectives, such as Revitalize manufacturing industries and nurture service industries and Provide a pleasant and comfortable living environment.

References

The Role of IP-R&D in the Era of the 4th Industrial Revolution

At the 2016 World Economic Forum, Klaus Schwab exclaimed that “intellectual property is the prerequisite for winners in the 4th Industrial Revolution, and countries that protect intellectual property will enjoy innovation and creation of wealth.” That is, in the 4th Industrial Revolution era, a ‘strong and flexible intellectual property system will become the source of competency.’ Casting back a little further, John Howkins, the author of ‘The Creative Economy,’ stated in 2001: “The current money for the creative economy is intellectual property. The creative economy is meaningless without intellectual property.” As is well known, the paradigm of the 21st Century global economy shifted from an industrial society in which tangible assets such as land, labor and capital served as the source of competency, toward the knowledge-based society which places an emphasis on intangible assets such as patents, designs, trademarks and copyrights. This is well reflected in the fact that intangible assets such as patents account for more than 80% of the market value of the S&P 500 index in 2005 (Ned Davis Research, 2008).

However, Korea still has a long way to go. While government investment in R&D has increased continuously during the last 10 years, among patents, which are considered the core outcomes of R&D, the ratio of unused patents has also gradually increased. R&D is itself a means of technological innovation, but recently the view that government R&D should be a subject of innovation is one that has been amplified through the media. In light of this, it is important to have a glance at IP-R&D1 strategy, a methodology related to the innovation of government R&D.

1. Correlations Between IP-R&D-Technology-Economy/Business Administration

“Nothing lasts forever.” Based on this inexorable truth, Christianity pursues eternity through resurrection, and Buddhism and Hinduism through reincarnation. ‘Impermanence’ means that everything is subject to a cycle of birth, aging, sickness, and death. And in the context of technologies or products, this refers to the cycle of introduction-growth-maturity-decline. The ultimate reason behind the R&D activities pursued by enterprises is to create ROI (return on investment), which is directly linked to industrial development and the national economy. R&D activities are interrelated to technology and products as they are means to obtaining one to be used in the other. Also, as technologies lack appropriability2, the government awards the patent, a monopolistic and exclusive right, to the inventor of the technology. In this sense, IP – R&D – technology – acquisition of technology – product – industrialization-commercialization are intertwined throughout the entire cycle.

The author first aims to observe the cycle of economy/business administration, technology, R&D and intellectual property which has been displayed throughout history. Then, the author will observe and interpret the implications behind the status and correlation of these factors in the era of the 4th Industrial Revolution.

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1) IP-R&D means establishing an IP strategy with the generation of IP and implementing the strategy throughout the entire process of R&D, from planning to performance, completion and commercialization.

2) Appropriability: The degree of how much profit generated through technological innovation the innovator can capture. Governments award patents, which are monopolistic and exclusive rights. To eliminate non-rivalry, when others can use the technology/knowledge at the same time as the owner uses them, and non-excludability (when the owner of technology/knowledge cannot prevent others from using them) of innovations.
Intellectual Property

The patent, which originated in the Republic of Venice in 1474 and was first written into law in 1624 in the United Kingdom, was used for a long time as a means to protect inventors. While anti-patent policies were adopted by the U.S. Government during the Great Depression due to the negative consequences of monopolization, since the fall of the American manufacturing industry in the 1980s the U.S. government has continuously implemented pro-patent policies.

Since 1980, the U.S. has expanded the scope and improved the standards of patents. The United States Supreme Court’s rulings on Diamond vs. Chakrabarty and Diamond vs. Diehr in 1980 are significant rulings in the history of patents, as the court ruled that ‘patents can be awarded for ‘everything under the sun’’, expanding the scope of the subject of patents. And this became a global trend, with the scope being gradually expanded to include micro-organisms (1980), animals (1985), genes (1991), semiconductor arrangement plans (1984), BMIs (Business Models) (1998), computer programs (1981) and software (1991), opening the ‘Pro-patent era’ in which the government began to implement strict measures to protect IP. In 1999, 13 U.S. government agencies including the Department of State, the Department of Commerce, and the U.S. Patent and Trademark Office jointly founded the National Intellectual Property Law Enforcement Coordination Council (NIPPLECC) to reinforce cooperation and coordination on IP between the public and private sector. In October 2008, ‘The Prioritizing Resources and Organization for Intellectual Property Act (PRO-IP Act)’ which transitions the council to the Intellectual Property Enforcement Coordinator was enacted, based on which the Obama administration newly appointed the Intellectual Property Enforcement Coordinator in 2009 to place an emphasis on IP policy as a major strategy for the nation.

Technology, Economics and Business Administration

Land, labor and capital are the three traditional factors of production. In the era of classical economics, from Adam Smith to Keynes, the law of supply and demand explained everything. Products were sold immediately after being manufactured, as demand exceeded supply. However, after David Ricardo suggested the law of diminishing returns, which claims that production does not always increase with a higher input of labor, the future of capitalism seemed gloomy. But in reality, the speed of development of advanced countries was found to be higher than that of underdeveloped countries in the era of evolutionary economics, when technology was adopted as the endogenous variable which determines production. Such results originated from technological development and great inventions, described by some with phrases such as ‘mana from heaven’. On economic fluctuation, Schumpeter claimed, “Invention of machines or individual technology innovation causes a Juglar cycle with an average length of 9.5 years, while a Kondratieff wave, which usually exists for more than 50 years, is caused by great inventions such as railway or electricity, or technical progress.” Belle Époque (beautiful times) refers to the peace and prosperity of the Age of Imperialism in its prime. This era of dominance for the European countries, during which they exercised their influence all over the world. At this time, Europe enjoyed peace and a massive amount of innovative technologies. People were filled with hope, based on a progressive view of history which held that science would serve as the solution for every problem. Rapid technological development also took place during the two World Wars, and momentum in this area continued thanks to the post-war tensions between the U.S. and the Soviet Union, or the so-called Cold War. But during this time, the rapid increase in supply in contrast to limited demand led to fiercer competitions between enterprises, which then had to develop management strategies to survive the competition and maintain their positions in the market. In recent years, an understanding of the humanities has gained importance as consumer needs have transformed from ‘wants’ to ‘desires.’ Meanwhile, the era of technology, which seemed everlasting, is also experiencing changes, with the transition from analog to digital at the center. The computer was
invented in the 1960s, and telecommunications were invented in the 1970s, which developed from pulse-dialing to electronic, then to all-electronic. The home stereo and CD player dominated the 1980s; the video player and video camera emerged in the 1990s, and internet became popular in the mid-90s. Before the mid-90s, technological factors were more important than non-technological factors, and thus the efficient and effective procurement and management of internal technological resources was crucial. As technological development took place in a linear manner, enterprises with the leading technology secured long-term superiority and dominated the market. For instance, SONY’s trinitron method used on cathode-ray tubes was invented in 1968 and dominated the TV market for more than 30 years until 2008. Meanwhile, the transition from analog to digital caused many changes. As sound, data and video technologies have been transformed into digital technologies, technological development began to take place in a non-linear manner. Many alternative technologies emerged through the digital revolution, information revolution and knowledge revolution. While technological factors remained important, non-technological factors including marketing, R&M, solution, design, demand innovation, strategic decision and linkage, development and diffusion of industrial platform concepts, procuring horizontal partnerships, and external management rose to the fore due to the adaptiveness of technologies.

R&D

The first research institute established by an enterprise is the BASF Laboratory which was founded 1867, followed by Edison Laboratory founded in 1880. The visualization of public research was first initiated in the 1930s through the ‘Manhattan Project’ which was aimed at creating atomic bombs. The competition between enterprises intensified as supply began to exceed demand, and in the 1980s the concept of technology management was spurred as technology became more important in business management. As the goal of R&D changed to fulfilling not only the needs but also the wants and desires of consumers, it eventually experienced a transformation, and the future of R&D was determined based on demand surveys of consumers. Taking this into consideration, inventors should not ground themselves in labs, but conduct extensive research on earlier studies and engage in R&D to develop the outcomes of those studies in this era of technological abundance. Moreover, as technologies are inappropriae and create spillover effects that benefit those other than inventors, governments should award patents to protect and encourage invention, and conduct public R&D on technologies for which development would involve too much money and time for the private sector to handle.

Countries around the world have continuously invested resources in R&D in a bid for Technological Hegemony, which was first held by the U.K., followed by France, Germany and the U.S. In particular, the U.S. amassed a major fortune through arms exports during WWI and WWII, which was then invested into technologies. IT products and technologies widely used in the private sector such as the internet, the World Wide Web system, Google Maps, GPS, Siri, PACS (Picture Archiving and Communication System), and Digital X-Ray, and cutting-edge technologies and components used in the defense industry such as stealth aircraft, unmanned aircraft, unmanned vehicle, and Saturn rockets were all commercialized as a result of research by DARPA. Through war, technologies were developed, and during peace these technologies served as the driving force of industrial development. Silicon Valley has inherited the pioneering spirit of the gold rush, and the development of defense industries during the two World Wars and the Cold War led to the aggregation of technologies in the region. Nowadays, Silicon Valley is a cluster in which the creative ideas of an individual can be developed through the help of VCs, spin-off, technology transfer and M&A.

For various reasons, the U.S. government’s investment in R&D has declined in recent years. While better performance of private R&D is a contributing factor, the fundamental reason lies in the abundance of technology. This explains why with the exception of China and Korea, the R&D investment by advanced countries has remained constant.
Nowadays, global enterprises often use free-for-use patents for which the exclusive rights have already expired, or acquire registered patents for which the market is not yet formed, through acquisition & development (A&D)\(^1\), connect & development (C&D)\(^2\), research & business development (R&B&D)\(^3\), and merger & acquisition (M&A)\(^4\), and then conduct additional R&D to supplement these technologies and launch new products. The core philosophy of 6\(^\text{th}\) Generation R&D is “Re-focusing on Research.” Previous R&D activities involved a continued series of trials and errors due to a lack of references. For example, Edison conducted 10,000 experiments to invent the light bulb. He did not give up because of the errors, and after innumerable trials he was finally able to invent the bulb. Nowadays, however, almost all kinds of technology exist as a result of continued R&D, and therefore to avoid wasting time or duplicate the efforts of others, it is better to observe the research of others, and engage in additional R&D only when required. In short, in 6\(^\text{th}\) Generation R&D there are various strategies that can be employed to replace R (research), such as A (A&D), B (R&B&D), C (C&D), or F (M&A).

**Figure 3:** The Past and Present of R&D

Technological abundance has transformed the institute-centered r&D to R&D through Open Innovation

I have not failed, I have just found 10,000 ways that won’t work

Food Artists Copy

Great Artists Steal


\(^1\) A&D (Acquisition & Development): A strategy used to purchase future-proof technologies at a cheap price during early stages of development, and to launch them after the completion of R&D

\(^2\) C&D (Connect & Development): A strategy used to purchase technologies of other enterprises through open innovation, and combine these with own technologies to launch new products

\(^3\) R&B&D (Research & Business Development): Development in consideration of research and business conditions

\(^4\) M&A (Mergers & Acquisition): A type of strategy which allows enterprises to buy other enterprises after the formation of the market at a high price to seek market entry and build barriers in a short amount of time

**2. IP-R&D Strategy in the Era of the 4\(^{th}\) Industrial Revolution**

Intelligence (AI) + Information (ICBM) technologies are the core technologies of the 4\(^{th}\) Industrial Revolution. Data (memory) and Processing are the two components of intelligence, and during the era of the 3\(^{rd}\) Industrial Revolution only global enterprises or the military could use large storage devices because of its high price. However, as the price of data became cheaper and the capacity became higher, allowing for fast processing (a trend summed up in Moore’s Law), storage devices were commercialized. This represents an attribute of the 4\(^{th}\) Industrial Revolution: due to the decreased cost, the value captured by consumers may be infinitely large. AI+ICBM, the core technologies, are interconnected through the convergence of technologies and/or industries. And in the course of interconnected, different technologies spread out to the market in the following order: core technology → generic technology → system technology → products/services. This is also the same for patents, and the sequence is as follows: magenta patent → core patent → module patent → system patent → manufacturing patent. Stand-alone products cannot survive in the era of the 4\(^{th}\) Industrial Revolution, as consumers lose interest in products which cannot be interconnected. Universal products of the past were complicated and difficult to use. However, new devices pursue minimalism and process tasks through on-off-line connection to attract consumers. Due to this interconnected nature, the importance of the portfolio of technologies used in the product is decreasing, highlighting the concept of the platform. Now, companies should focus on establishing a sound business model based on the wants and desires of consumers, and purchase the technologies required to complete the DM, as substitute technologies which did not exist in the analogue era of the past are now more than enough in this era of technological abundance.

**Figure 4:** Directions of Development of Patent and Product Portfolio

All-directional development of the core factors of magenta technology

Production

Social Contribution

Source: University of Okayama, Magenta Patent (upper), Material from the Presidential Committees on the 4\(^{th}\) Industrial Revolution (below)
Core or source technologies projected to lead the 4th Industrial Revolution are applied extensively in all aspects of industry - such as manufacturing to create new products and services through the convergence of pre-existing technologies. After the initial stages of the Industrial Revolution, the momentum depends on who first develops products and services that coincide with changes in markets and consumer needs using existing technologies, and provides them to consumers through platforms to gain the first-mover advantage. This is why technological convergence and cross-company collaboration is being asserted emphatically.

With regard to the technologies of the 4th Industrial Revolution, global enterprises including Apple and Google did not blindly initiate R&D activities, but first purchased the technologies they required in the course of their objectives. Then, they conducted additional R&D based on their core competencies to launch products in the market as fast as possible. For instance, Google acquired Deepmind, created AlphaGo in a short amount of time and entered the market. These global enterprises first acquired core technologies (ICBM-AI) of the 4th Industrial Revolution, then purchased the technologies required to develop applied products and services. Google’s acquisition of Nest to realize the smart home, and Apple’s strategic partnership with global enterprises for the development of HomeKit serve as further excellent examples of this process. Thus, enterprises with ‘thought leadership’ purchase conceptual patents which include existing technologies at low prices, conduct additional R&D to develop products, and launch them on the market in a short amount of time.

The most essential process in discovering new businesses, products or markets is ‘concept building.’ First, the company establishes a business model, based on which it purchases the required technologies or conducts R&D to acquire technologies based on its core competencies. Subcontracting through Open Innovation can also take place, but only if required. While the process does not free a company from trials and errors made by advanced global companies, the delays they cause may be reduced through this process.

The Korean government is quickly adopting an IP-R&D strategy in the overall national R&D cycle to respond to the 4th Industrial Revolution. First, in Appropriation Standards of R&D Expenditure by Items [Table 2] (in relation to Article 12 Clause 5 of the Regulations on the Management, etc. of National Research and Development Projects, patent strategy establishment costs were excluded from technological information collection costs to allow government agencies to spend the budget allocated for direct expenses on the establishment of a patent strategy whenever the agency wishes.

Second, the government will expand the application of IP-R&D to up to 50% of all government R&D tasks, with a budget of over KRW 1 billion. Finally, the government will adopt the Chief Patent Officer (CPO) system (as a part of IP-R&D Implementation Plan, from March) on projects with an annual budget of over KRW 5 billion, and innovative growth engine projects. Global enterprises including IBM, Apple, Google and Qualcomm already have vice-president level CPOs, while several others have executive director level Patent Portfolio Managers (PPM) who manage the overall IP portfolio of the enterprise. Taking this into account, universities and government-funded research institutes should also appoint CPOs to manage patents overall, and prepare an IP-R&D strategy to appropriately respond to the 4th Industrial Revolution.

It was in 2011 when we realized the importance of patents as a result of the patent war between Samsung and Apple. The history of mankind has been a series of wars. During the era of the agricultural revolution, there were wars to gain land and slaves; during the era of the industrial revolution, there were wars to secure raw material and buyers. The 1st and the 2nd World Wars were started by countries which could not secure materials and buyers. War has accelerated technological development. Throughout the history of human warfare, the powers with better weaponry are the ones who have won. Those with iron weapons won the war in the Bronze Age. Those with cannons on vessels and guns won the war against those fighting with arrows. Nowadays, countries do not fight for land, and tend to avoid traditional
warfare, which causes great damage. Rather, they engage in weaponless wars, trade wars and patent wars, the tendency of which is perhaps best illustrated by President Trump’s administrative orders against China. But while protective trade wars are the domain of countries, enterprises can only suppress their competitors through patent wars. The reason why the term ‘science and technology war’ does not exist – while some might argue that the arms race during the Cold War was an S&T war, the author would prefer to define it as a needless competition to stroke one’s ego – is that technologies are unappropriable, and therefore the competition can only take place over patents.

Until now, Korea pursued a ‘catch-up R&D’ strategy of benchmarking advanced countries and localizing products to realize ‘the Miracle on the Han River,’ during which IP was completely disregarded, leading to a tendency to make light of patents or even consider them useless. But throughout their history, advanced countries and multinational corporations have opted for Pro-Patent Policies which value IP as a means of acquiring technologies through a ‘leading R&D’ strategy. For example, the United States overcame the weakened competitiveness of its manufacturing industry through a strong IP protection policy. And such differences in IP culture determined the fate of two countries in the current era of technological abundance: while Silicon Valley became a haven for inventors, with global enterprises purchasing patents of developers at reasonable prices, Korea has become the graveyard of inventors, with the will of start-ups to realize technological innovation being broken by a complete disregard for inventors and technology extortion. The 4th Industrial Revolution will lead to the advent of an era of technological abundance. That said, IP should not be seen as something that should be acquired as outcomes of R&D, but rather as a core element in establishing an R&D strategy. In other words, IP-A&D, IP-C&D, and IP-R&D strategies should be implemented in the field of R&D, along with an IP-BM strategy in economics and business administration, and an IP-BUY(M&A) strategy in technology development. IP-R&D is the key to success in the era of the 4th Industrial Revolution.
The 2nd Social Problem-solving Comprehensive Plan for People’s Lives (Society) Based on Science & Technology (2018~2022)

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Saerom Lee, Researcher, Center for Social Innovation Policy, KISTEP

The Moon Jae-in Government is reinforcing people-centered policies to respond to a high level of public interest in addressing social problems. Expectations for science & technology (S&T) are being expanded from the focus on economic growth to the role of S&T in improving quality of life, including in areas related to health and safety. A survey of the public and the experts[1] demonstrates the necessity of reinforcing the role of S&T in improving the capacity to solve serious social problems, which has been relatively lacking <Table 1>. In this respect, policies are being implemented to create outcomes in the solution of social problems that can be felt by the public in the area of S&T, and the government’s operations are realized with the participation of the public according to the management philosophy of the current government. This paper will introduce the key contents of “The 2nd Social Problem-solving Comprehensive Plan for People’s Lives (Society) Based on S&T (2018~2022)” (hereinafter “The 2nd Comprehensive Plan”) finalized in the meeting of the Presidential Advisory Council for S&T held on June 29, 2018 as a representative example of policy related to this matter.

Outline

The 2nd Comprehensive Plan was established with the expiration of “The Comprehensive Execution Plan to Solve Social Problems Based on S&T (2014~2018)” established in December 2013 (hereinafter “The 1st Comprehensive Plan”). The legal basis for the implementation of the plan is Article 16-6 (Resolving Social Problems by Utilizing S&T) of the Framework Act on S&T. The plan is a comprehensive pan-governmental plan made by piecing together the policies and programs of all ministries in the central government to resolve social problems closely related to people’s lives, such as fine dust, infectious diseases and household wastes and to achieve improvements in quality of life. The 2nd Comprehensive Plan includes a plan to establish a pan-governmental cooperation system and create an environment that promotes sustainable solutions to social problems, and was prepared after a review of The 1st Comprehensive Plan for the creation of the outcomes of problem solutions that can actually be felt by the public. It also includes ways of linking S&T with social innovation policies to strengthen the social role of S&T to solve regional problems, promote the balanced development of the nation and create jobs, etc.

Table 1  Results of survey of the public and the experts

<table>
<thead>
<tr>
<th>Seriousness of social problems</th>
<th>Potential to solve problems</th>
<th>The role of S&amp;T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q: In general, how serious are the social problems in Korea?</td>
<td>Q: What percentage of the social problems can be solved in our society?</td>
<td>Q: In general, how great a role is played by S&amp;T in solving social problems?</td>
</tr>
<tr>
<td>Not serious</td>
<td>Average</td>
<td>Serious</td>
</tr>
<tr>
<td>1%</td>
<td>17%</td>
<td>82%</td>
</tr>
</tbody>
</table>

[1] KISTEP surveys 1,000 of the public and 432 of the experts (March 2018)
Setting the direction for the establishment of the 2nd Comprehensive Plan

a. Reflecting the implications of the 1st Comprehensive Plan

The basic direction of the establishment of the 2nd Comprehensive Plan was set on the basis of the process and results of the execution of the 1st Comprehensive Plan. The legal basis for social problem-solving based on S&T was prepared in the 1st Comprehensive Plan established in December 2013, with which the government’s R&D policy efforts to find technology-based solutions to social problems began in earnest. A total of 30 areas of social problems were set, and 10 execution objectives to resolve social problems were proposed. As a result, some products and solutions related to problems were developed in the R&D objectives and applied to pilot programs. However, it was generally evaluated that the 1st Comprehensive Plan focused on technology development led by the central government and researchers rather than field-oriented problem solving. Moreover, some people pointed out that it lacked pan-governmental linkage and had limitations in terms of coping with social problems promptly, and as a result the public could not notice substantial effects in the field.

b. Expanding the areas of social problems due to changes in the living environment

The 2nd Comprehensive Plan intended to reflect the social problems that were newly emerging as a result of changes in people’s living environments. To accomplish this, the changes in the living environment were analyzed and related issues were identified through an analysis of related literature and the opinions gathered from the public and experts. The areas of social problems were finally reformed after a review of ministries of the central government and local governments. Specific problems were drawn out in relation to the major changes in the living environment such as ‘changes in population structure and lifestyle,’ ‘rapid changes in social structure and deepening problems with the ecosystem’ and ‘the advent of the hyper-connected society and the ego-centered society.’ On this basis 10 new social problems have been added to the previously classified 30 problems. The newly added social problems can be well perceived by the public from the perspective of seriousness and urgency, and include fine dust, earthquake, and fire safety.

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Table 2: Changes in Living Environment and Social Problems

<table>
<thead>
<tr>
<th>Change in population structure and lifestyle</th>
</tr>
</thead>
<tbody>
<tr>
<td>More elderly &amp; eccentrics</td>
</tr>
<tr>
<td>Increased aging rate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depopulation</td>
</tr>
<tr>
<td>Increase in rural areas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>40 major social problems in 10 areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental illness, chronic disease, rare intractable disease, addiction, degenerative cerebral nerve disease</td>
</tr>
<tr>
<td>Industrial waste, fine dust, household waste, indoor air pollution, water pollution, endocrine hormone</td>
</tr>
<tr>
<td>Cultural alienation, lack of culture &amp; leisure space</td>
</tr>
<tr>
<td>White collar crime, invasion of privacy, Side effects of virtual tokens (cryptocurrency)</td>
</tr>
<tr>
<td>Sex crimes, food safety, cyber crime, accidents in the home</td>
</tr>
<tr>
<td>Earthquake, fire safety, climate disaster, chemical accident, infectious disease, radioactive contamination</td>
</tr>
<tr>
<td>Power supply, energy poverty</td>
</tr>
<tr>
<td>Substandard and dilapidated dwellings, traffic congestion, traffic safety</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>40 major social problems in 10 areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low birth rate, alienation and suicide of the elderly, family violence</td>
</tr>
<tr>
<td>Education gap, school violence</td>
</tr>
<tr>
<td>Discrimination in labor, medical gap, information gap, inconvenience for vulnerable groups</td>
</tr>
</tbody>
</table>

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2) Article 16-6 of the ‘Framework Act on S&T, Resolving Social Problems by Utilizing S&T’ (May 2014)
3) The areas of social problems will not be limited to 40 social problems. New social problems will be added through continuously collecting the opinions of the public to be able to flexibly cope with the social problems emerging due to environmental changes.
The vision and goal of the 2nd Comprehensive Plan have been set in consideration of the recent changes in the living environment after reviewing the results of the 1st Comprehensive Plan. The strategies and execution objectives for the achievement of the vision and goal were proposed as follows.

### a. Vision and goal

The role and importance of S&T in improving the quality of people's lives and helping people realize happiness by solving social problems were emphasized in the vision. This means that while S&T used to be the means of economic growth, it should also contribute to improvements in quality of life for the happiness of people in the future. The specific goal was set as establishing a sustainable system that can solve the various problems of our society using S&T, together with diverse stakeholders. To accomplish this, the three detailed goals of understanding and making a consensus on problems through S&T, solving problems together with innovative solutions, and continuous solution of problems and enjoying the results with a social problem-solution type business model were suggested.

#### Vision

- Improving the quality of people's lives with S&T and contributing to realizing happiness within society by solving social problems
  - Reducing social problems and increasing people's happiness with S&T

#### Goal

- Understanding and building a consensus on social problems through S&T
- Solving problems together through innovations
- Continuous solution of problems and enjoying the results with a social problem-solution type business model

#### 3 Strategies and 10 Objectives

<table>
<thead>
<tr>
<th>3 Strategies and 10 Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Establishment of pan-governmental cooperation system enabling strategic investment in what people want</td>
</tr>
<tr>
<td>2. Reforming the system of social problem-solving R&amp;D programs and promoting investment</td>
</tr>
<tr>
<td>3. Conducting research programs to cope with urgent social problems</td>
</tr>
<tr>
<td>4. Revising and customizing the whole cycle of multi-ministry social problem-solving R&amp;D programs</td>
</tr>
<tr>
<td>5. Supporting the establishment of a participatory network of users</td>
</tr>
<tr>
<td>6. Establishing and operating an open online platform</td>
</tr>
<tr>
<td>7. Sharing the experience of solving social problems and reinforcing the basis of learning</td>
</tr>
<tr>
<td>8. Operating the S&amp;T Policy Center for Solution of Social Problems</td>
</tr>
<tr>
<td>9. Expanding the social role of S&amp;T by connecting them with social innovation</td>
</tr>
<tr>
<td>10. Spreading superior problem-solving results to the public</td>
</tr>
</tbody>
</table>

### b. Strategies and objectives

The following are the 3 strategies and 10 execution objectives that will be implemented for the next 5 years to achieve the vision and goal.

#### <Strategy 1> Establishment of pan-governmental cooperation system

The goal is to establish a pan-governmental cooperation system to cope with social problems as desired by the public. A pan-governmental policy coordination and support function will be established through the operation of a permanent ‘private and public joint council’ participated in by all ministries and local governments. In addition, the substantive effects of the government’s R&D budget will be enhanced by reforming the system of social problem-solving R&D programs. This will lead to practical solutions to social problems by strengthening R&D execution capability.

**Objective 1.** Operating a permanent ‘Private and public joint council to solve (social) problems in people’s lives’ and strengthening pan-governmental policy link

First, the permanent ‘Private and public joint council to solve (social) problems in people’s lives’ will operate at the government level. The council will be participated in by experts in all ministries of the central government, local governments and civil organizations, and will work to solve various social problems using S&T. The scientific and technological issues will be discovered in the pending social problems of the nation to carry out pan-governmental programs or check and offer advice on the programs in progress. Secondly, the pan-governmental policy link will be reinforced. Organic links or collaborations will be facilitated with the S&T and R&D policies related to social problem-solving being implemented in each ministry. In addition, field-oriented demonstration R&D programs and participation of local governments will be expanded so that the public can perceive the results of technology development in their daily lives.

**Objective 2.** Reforming the system of social problem-solving R&D programs and reinforcing investment

First, problem-solving R&D programs connecting technology development with demonstration will be prepared, as shown in <Table 3>. It is divided into the 3 sectors of ① Multi-ministry R&D programs, ② Certain social problems and ③ Regional Living-Lab. Field application and problem solutions will be reinforced in Multi-ministry R&D programs. To accomplish this, it will be made compulsory to include demonstration and commercialization for problem solutions when planning the R&D programs. Not only the central government but also local governments and social economic units will be able to participate in the programs through the
improvement. In addition, when a multi-ministry R&D program is executed, the program unit of each ministry shall be made by the actual executor of the program to enhance the efficiency of the program in terms of budget allocation, evaluation, etc. Integrated allocation and adjustment of budgets will be achieved by combining R&D programs being implemented by each ministry for the solution to a specific social problem. In particular, all the issues – from the definition of a social problem to the commercialization of a solution and system improvement – shall be reviewed inclusively at a pan-governmental level, and demonstration and commercialization shall be compulsorily included.

Regarding the regional Living Lab, the research of a living lab for demonstration and commercialization of solutions to regional social problems will be facilitated by increasing the budgets of existing individual ministries or supporting the discovery of new programs. In addition, at the time of selection of a problem-solving R&D program, the ‘alternative-competing R&D system’ will be introduced and the opportunities to participate in social economy organization will be expanded to increase the possibility of solving social problems.

Secondly, the support for the social problem-solving R&D of local governments will be reinforced. Local social problem-solving R&D programs will be discovered and executed through the special account for balanced national development, or the investment in the area of local social problems will be expanded with the fund for innovation of local S&T.

Third, the structure of program budgets will be reformed and the business model will be applied in a pilot program. In the reform of the structure of programs, the establishment of a new budget system in each program unit (Ex: promotion of basic research, promotion of cosmic development, support of S&T research, improvement of people’s living (new item), etc.) will be considered in the review of the budget for social problem-solving R&D programs and performance management mainly in major areas of social problems. In the pilot application of a business model, a business model appropriate for social problem-solving R&D programs will be determined. Next, the process and methods of program planning will be prepared and applied to the pilot social problem-solution-type R&D programs such as multi-ministry programs and living lab programs.

### Table 3
Direction of improvement of multi-ministry R&D programs

<table>
<thead>
<tr>
<th>Fields</th>
<th>Previously</th>
<th>Moving forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program type</td>
<td>- More participation by local governments</td>
<td>- Mainly determined by central ministries (1 or more ministries)</td>
</tr>
<tr>
<td>Content of program</td>
<td>- Focusing on substantive solutions to social problems</td>
<td>- Focusing on substantive solutions to social problems</td>
</tr>
<tr>
<td>Execution system</td>
<td>- No multi-ministry council or insufficient operation</td>
<td>- Formation and permanent operation of a multi-ministry council participating in program</td>
</tr>
<tr>
<td>Program requirements</td>
<td>- At the level of objective or the actual executor or the program</td>
<td>- Actual executor or higher level (1 or more)</td>
</tr>
</tbody>
</table>
| Minimum unit of program     | - Actual executor + Actual executor + Actual executor + Actual executor | 1) (Specific)  
                                |                                             | Specific program = Specific program + Specific program  
                                |                                             | Specific program = Specific program + Specific program  
                                |                                             | (Actual executor)  
                                |                                             | Actual executor + Actual executor + Actual executor |

4) A social economy organization refers to an organization whose main goal is to realize social value. It has a participatory decision-making structure and renews profits in the realization of public good such as the development of the local community or employment of people from vulnerable groups. Social enterprises, cooperatives, community companies and social ventures belong to this category.

5) Social problem-solving business model: A business model which can achieve the social and policy mission of solving social problems and creating sustainable profits at the same time.

6) If an urgent search becomes necessary due to the outbreak of a disaster, calamity or large-scale accident when there is no allocated budget.
Objective 4: Receiving consulting customized for the whole cycle of multi-ministry social problem-solving R&D programs

A system of consultation by experts will be established to provide consulting for other ministries during the whole cycle of R&D programs so that the programs concerned can lead to substantive solutions to social problems [Figure 1]. First of all, the mentor group will review the social problem-solving R&D programs selected by the special committee of other ministries from the viewpoint of the whole cycle of the programs. The stages of the program will be divided into program planning, research execution, program review and spreading performances for systematic customized consulting of the experts in the mentor group. In doing so, the programs concerned could lead to substantive solutions to social problems. In addition, the indexes and criteria for evaluation of the performance of the program will be prepared, focusing on the degree of contribution to solutions to problems, and the results of evaluation will be applied to the evaluation of social problem-solving R&D programs.

<Strategy 2> Establishment of social problem-solving ecosystem

The goal is establishing a platform-type environment to resolve social problems based on communication and cooperation. An open approach to solving problems will be attempted through the participation, communication and cooperation of various stakeholders, including general public and social economy organizations. In addition, the problem-solving capacity of the organization will be increased and reinforced by sharing and spreading the experience and knowledge about solutions of social problems. Furthermore, related resources will be linked and an innovative environment will be created by the exclusive organization supporting solutions to social problems.

Objective 5: Supporting the establishment of a participatory network of users

First, a network will be established to pool the intellectual resources of the public and the researchers together. A network organization will be organized through the participation of general public and experts. In this way, the public can actively participate in the discovery of the demands of the field and the preparation of solutions <Table 4>. In addition, a study group on social problems will be formed with the S&T researchers as well as humanities and social sciences researchers to identify various alternatives, including scientific and technological solutions. Secondly, the link with the organizations related to the solutions to social problems will be reinforced. In other words, related information will be shared and discussed by expanding the exchanges and cooperation with related organizations in the central government and local governments that are created to solve social problems through the participation of the public. Thirdly, a channel for communication between social economy organizations and government-funded research institutes will be provided. This communications channel will be prepared at government-funded research institutes to support the capacity for technology utilization and its commercialization by social economy organizations.

Table 4: Organization of the network of general public and researchers (draft, sample)

<table>
<thead>
<tr>
<th>Organization</th>
<th>Participants</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Companion Group for Solution of Social Problems</td>
<td>General public + Experts</td>
<td>Visiting local sites and interview; Investigating and discovering issues in the field</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finding methods to solve social problems; discovering and suggesting policy alternatives</td>
</tr>
<tr>
<td>Social Issue Study Group</td>
<td>S&amp;T researchers + Humanities &amp; Social science researchers</td>
<td>Permanent communication and exchange; sharing knowledge and information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prompt discussion of pending issues and suggestion of alternatives</td>
</tr>
</tbody>
</table>

7) Example: Self-solution Corps in the Ministry of Public Administration and Security; Social Youth Policy Network
Objective 6: Establishing and operating an open online platform
First, NSIB will be established and provide services. Information about social issues will be collected and analyzed through various channels to prepare an in-depth analysis brief which will include the cause of specific social problems, map of stakeholders, and the direction of the solution. The results will be used for finding and planning of R&D policies and programs to resolve social problems. Secondly, participation and communication will be reinforced in the process of deriving solutions to social problems, and the online hub will be established and operated to strengthen the problem-solving capacity. Social problems will be investigated and an issue-finding system will be prepared through the online hub. The online hub will facilitate permanent online communication and exchange between various stakeholders. Furthermore, it will function as a channel for public participation in the collection of various ideas for solutions to social problems. Lastly, the resources and knowledge that are necessary in the process of social problem-solving will be systematically built and shared through the online community.

Objective 7: Sharing the experience of social problem-solving and reinforcing the basis of learning
First, a program for sharing experience and knowledge will be operated to improve the problem-solving capacity. Participants in social problem-solving multi-ministry R&D programs will be able to share the results of investigation of performance and the experience of execution of each program through workshops, forums, etc. Secondly, educational and cultural programs about social problem-solving based on S&T will be prepared. Professional education institutes (such as KIRID) and online education channels (such as K-MOOC) will provide learning contents for general public and researchers. In addition, scientific culture programs related to social problem-solving will be developed and provided for general public, social economy organizations, business enterprises, etc.

Objective 8: Operating the S&T Policy Center (hereinafter the ‘Policy Center’) for social problem-solving
First, the Policy Center will exclusively support the performance of the execution objectives of the comprehensive plan. It will support the practical operation of the ‘Private and public joint council for (social) problem-solving in people’s lives’ and also the formation and activities of various network organizations (Ex: Companion Group for Social Problem-solving, Social Issue Study Group, etc.). In addition, the National Social Issue Bank will be established, an online hub for the provision of sharing service for related resources and knowledge will be established and operated, and the social utilization and spread of the performances of social problem-solving will be promoted through PR of superior cases and performances, publication of a yearbook and white paper about social problem-solving, and promotion of international cooperation. Secondly, the policy center will carry out strategic research on social problem-solving and the establishment of related policies. It will also perform research on the establishment and activation of the basis for problem-solving based on S&T, and support the execution of policies to solve social problems based on S&T by preparing the execution plan according to the comprehensive plan, etc.

<Strategy 3> Enhancement of the social value of S&T
The goal is to establish a pan-governmental cooperation system to cope with social problems as desired by the public. A pan-governmental policy coordination and support function will be established through the operation of a permanent ‘private and public joint council’ participating in by all ministries and local governments. In addition, the substantive effects of the government’s R&D budget will be enhanced by reforming the system of social problem-solving R&D programs. This will lead to practical solutions to social problems by strengthening R&D execution capability.

Objective 9: Expanding the social role of S&T by connecting them with social innovation
First, ‘regional’ social problem-solving will be supported by strengthening cooperation with social innovation policies and regional problem-solving policies. Cooperation with social innovation policies will be reinforced by holding a regular open forum with the participation of residents using the local
base communication and cooperation space provided by the Ministry of Public Administration and Security. In addition, the opportunity to participate in social problem-solving R&D will be expanded by matching the region with ministries and agencies conducting R&D. Secondly, job creation will be facilitated through cooperation with social economy policies. Links with a social economy talent training policy will be supported and expanded by providing R&D education programs for social economy organizations. And also cooperation with social economy promotion policy will be reinforced by making it obligatory to participate in social economy organizations during the stage of demonstration and spreading of social problem resolution R&D results. Third, the quality of life in developing countries such as countries in Southeast Asia and Africa will be enhanced through the overseas transfer and spreading of research results in the area of social problem-solving (Figure 2).

Objective 10: Spreading superior problem-solving results to the public

First, communication with the public will be reinforced by expanding the opportunities to experience the results of research. The performance of research on social problems will be shared in the form of easily readable contents through online media, and supports will be provided for the events held to experience the performance of R&D on social problem-solving, including exhibitions and fairs. In addition, prizes will be awarded to the people who contribute to the resolution of social problems. Secondly, commercialization of research performances will be facilitated by providing sales channels and improving laws and regulations. Support for sales channels or superior research results made by social problem-solving R&D programs will be reinforced through the provision of public purchase, R&D voucher, etc. Also, the status and performance of the companies and social economy organizations that contribute to the resolution of social problems will be opened on the online hub so that the related information can be linked to private companies. Not only the demonstration and commercialization of research results but also utilization (certification, standardization, etc.) and sharing of the results will be facilitated through the continuous improvement of the related laws and systems in consideration of the characteristics of social problem-solving R&D.

Concluding Remarks

The 2nd Comprehensive Plan has been prepared after examining the performance and limitations of the 1st Comprehensive Plan from various viewpoints. Existing problems have been addressed and the limitations of the 1st Comprehensive Plan have been overcome by collecting a vast array of opinions from the public and experts in the process of establishing the strategies and execution objectives of the 2nd Comprehensive Plan. In particular, the number of social problems has been increased from 50 to 40, reflecting the changes in the living environment in order to cope with the overall social problems more effectively. The obligatory scope of R&D programs has been extended to the demonstration stage, and the execution system has made it possible to comprehensively link ministries for substantive problem solving and securing the impetus of policy execution. In addition, problem solving capacity has been reinforced through accumulating and sharing of expertise with the online communication channel and the social issue bank. A sustainable environment for problem solving can be created based on the active participation of policy consumers (Table 5).

16) Online platform which supports the resolution of pending regional issues by residents and activists (MOPAS, 2017).
18) Plans to create jobs by promoting social ventures (MSS, 2018), Reforms of management evaluation of public agencies (MOGEF, MOPAS, 2017), etc.
19) SAT Support Program for developing Countries (MEST); Supporting solution of common international problems by reinforcing the SAT capacity of developing countries through support of joint research by research institutes, global problem solution, etc.
In comparison to major OECD countries, while Korea’s S&T innovation capacity (ranked 7th among 34 nations, COSTH of MSIT) and social innovation capacity (ranked 12th among 29 nations, EIU SII) as of 2016 are rather high, the quality of life (ranked 9th among 34 nations, OECD BLI) is relatively low(28). An analysis of the OECD countries shows that the S&T innovation capacity contributes to quality of life, and the relationship between S&T innovation capacity and social innovation capacity was closer in countries with higher quality of life(29). Therefore, the 2nd Comprehensive Plan is expected to contribute to the efficient utilization of S&T innovation capacity, and will reinforce the relationship between S&T innovation capacity and social innovation capacity if the plan is faithfully implemented for the next five years. We hope that a high S&T innovation capacity can contribute to improving quality of life to a level befitting the size of Korea’s economy.

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28) EIU (The Economist Intelligence Unit), SII (Social Innovation Index), BLI (Better Life Index)
29) Lee, Sung-gyu; Yang, Hyun-suk; Shin, Young MOTOR N (2016), Suggestions about the direction of change of S&T innovation capacity for improvement of people’s quality of life and solution of social problems, KISTEP ISSUE Weekly 2018-07

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References

Innovative Growth and Regulatory Reform

Failure of national policies in the era of digital market

1. Failure to foster dominant platform providers that retain CPM of national big data

A critical element of creating national wealth in the digital market is to nurture platform providers and occupy the market by increasing their dominance. Such strategy can be established by analyzing the data that compares the 2017 annual sales of main platform providers including Google, Amazon, other giants with Korea’s GDP of the same year.

<table>
<thead>
<tr>
<th>Company/Country</th>
<th>Annual sales/GDP</th>
<th>Market Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google (Feb 2018)</td>
<td>USD 100B (KRW 110T)</td>
<td>USD 962 billion</td>
</tr>
<tr>
<td>Apple</td>
<td>USD 224B (KRW 260T)</td>
<td>USD 1T (KRW 112T)</td>
</tr>
<tr>
<td>Amazon</td>
<td>USD 177.9B (KRW 191T)</td>
<td>Surpassed USD 1T (Sept 2018)</td>
</tr>
<tr>
<td>Korea</td>
<td>USD 1.568T (KRW 1.74T)</td>
<td></td>
</tr>
<tr>
<td>Samsung Electronics</td>
<td>USD 224.2B (KRW 259T)</td>
<td>KRW 266 t.h on</td>
</tr>
</tbody>
</table>

Dominant platform providers that occupied the digital market will take control of C (Contents), P (Privacy), and M (Money) of each country in the end. In particular, when the digital market of a country is dominated by certain foreign platform providers, the CPM will be drained overseas due to various service that the platform providers offer. It will send the data and national wealth of the country concerned to overseas and it will become a zombie nation. This process can be expressed by using a formula \[ \text{CPM} = \text{C} \times \text{P} \times \text{M} \], and which can be interpreted as that the “drain of CPM (Contents, Privacy, Money) from a nation’s big data makes it a zombie (small nation).” Based on the data and interpretation mentioned above, it is confirmed that the existence and non-existence of dominant platform providers that occupy the digital market become an important factor that defines the rise and fall of a nation in the era when the significance of digital media has strengthened.

2. Lack of development and implementation of policies to migrate key industries by the government and national assembly

Likewise, most of CPM produced within a country is overflowing to many dominant platform providers in overseas including Google to the extent that creates damages to the national wealth. However, the Korean government and national assembly continues to hinder the growth of domestic platform providers that can play a role in avoiding the outflow of CPM through reverse discrimination or reinforced regulations, etc.

Taeon Koo, Lawyer & CEO, TEKLAW
It is difficult for Korea's large internet companies such as Naver and Kakao to block the attacks of Google and other global giants. It is due to that Google, an international platform provider, can promptly create and improve various services that meet the various demands of users sufficiently by using only a small portion of their revenue as it records a massive amount of annual sales as stated above. Therefore, the growth of large domestic IT companies such as Naver and Kakao is important to defend the nation against such attacks. Also, startups that pioneer a new frontier of promising services should grow together.

3. Necessity of 'Do Not Harm' policy

One of the weaknesses of national projects related to the digital market in Korea, a country that is lagging behind such global trends, is that we are particularly lacking in strategies on national agendas concerning the implementation of digital market, namely, nurturing the platform business. The purpose of government in implementing and leading such projects strategically is to foster domestic industries with the aim of reviving the national economy. Therefore, laws and policies of a nation should not interfere the technological development of domestic industries at the least. Despite the fact, however, it is true that numerous provider-centered laws and regulations of Korea hinder the purpose of national projects and impede the development of industrial technologies.

As for Korea, triple regulations including ones for information protection, traditional industries, and online get in the way of the growth of IT startups. Such regulations hinder the growth of startups as more than 2 types of regulations are applied at the same time to block the provision of innovative services in concerning sector. Take the financial sector for instance, regulations on information protection and traditional industrial regulations are enforced at the same time, creating an environment that it is difficult to secure a customer base on various online financial products, or unable to create new models such as big data-based credit ratings, etc. Another example is to prohibit the transmission of opt-in-based ads to make profits by applying both information protection regulations and online regulations simultaneously, or such ads are banned in accordance with regulations on data processing for e-commerce. The situation in Korea where the growth of startups is not guaranteed or cannot be successful due to too many regulations cannot be considered positive for the nation's economy and industries in the future. Therefore, we need to take measures on regulations. However, the government and national assembly that are in charge of setting up and implementing such measures fail to fulfill their responsibilities.

1. Innovation to promote the industry by the national assembly

First, the national assembly should pursue a negative regulation in order to improve the legislative culture that only increases regulations and adopt the positive system for restrictive interventions. The 'negative regulation' is to define things that are disallowed to guarantee a sufficient level of freedom of action. In the same time, the positive system, which defines things that are allowed only, should be applied in a very limited manner. In order to use the ‘positive system’, therefore, terms like others, etc. and other than, that are hard to define the scope of application should not be used in acts and provisions. It is because of that the current regulatory method that cite a series of examples are one of core reasons that create regulatory barriers, hindrances of the government to industrial growth, by mandating the implementation of lower statuses. Therefore, a process of creating new regulations should be transformed into restrictive positive system by banning the use of terms listed above.

2. Innovation to promote the industry by the government

As for the government, it should adopt policies preferential to platform business and the ones that help to create related markets in order to support the growth of platform business in the digital market. To make this happen, an assessment on the impact of transferring data to overseas should be applied to all policy-making and legislation process of the government. Currently, Korea is degrading to a colony when it comes to information control that its data is overflowing into overseas due to the ministries and national assembly that fail to draw a big picture and pursue partial gains only. In order to tackle such obstacles, an impact analysis on information sovereignty should be introduced to the entire policies and legislative procedures to prevent the outflow of domestic data into overseas and establish the data sovereignty at the same time. To this end, there is a need to install a committee for impact analysis on data sovereignty from the national security perspective and improve all organizational structure and legislations that hinder the innovation to guarantee the data sovereignty.
Realize the Future of Science and Technology with Startups

One of the most frequently used words in the science and technology (S&T) community in recent years is to the extent that people felt exhausted to hear might be the ‘4th industrial revolution.’ From the days when we begin to ask its meaning, the same answer was heard. Namely, ‘technologies such as artificial intelligence (AI), Internet of Things (IoT), 3D printing, autonomous driving, big data, robotics, and cloud computing will lead the emergence of 4th industrial revolution, and the sharing economy will be the talk of the town.’ The same answer is heard over and over and the fatigue still remains till this day.

The reason is clear. We know that such technologies would bring a significant impact, but do not know how they would change our lives. Of course, we are aware of the importance of AI. However, the only and most accessible AI technology that is well known to the public is a robot advisor that helps us manage our assets based on a robot advisor. Even the robotix advisor is an unfamiliar concept to ordinary people who do not have many assets that require such assistance or are not interested in finance. What about autonomous driving? It is surely interesting. However, it seems a foregone future considering the news of fatal accidents from overseas. According to news reports, we can now build a house by applying 3D printing technology. In reality, we barely afford our houses that are already on the market. Then, the 3D printed houses that are easy to build at an affordable price seem to appear only in the news and it is not relevant to us. Considering such a gap between promising future of S&T and the reality, it is difficult to readily agree on the slogan that we will meet the surprisingly different future. If that is the case, it may come from a certain knowledge power. In order to gain the public consensus, we should start from the farthest point. From such perspectives, it appears that the 4th industrial revolution and the S&T community that is exhausted by the slogan have not reach the public.

It has been almost 14 months since I joined Startup Alliance with such concerns. I felt a thirst for the gaps for years while studying and working at areas that were closely related to S&T policies. I flushed into my mind that I might find the answer to end such exhaustion from ‘startups.’ As it is the startup industry that the latest technologies are applied at the fastest speed, we can sense such rapid changes promptly from market reactions.

When we talk about startups, we need to define them first. People who are not familiar with its characteristics may ask ‘what is a startup?’ When we explain its concept, they may ask again, ‘If it is like to start one’s own business, then what is the difference between ‘startup’ and ‘self-employed business?’ What are they asking is that it is nothing more than ‘changing names’ to ‘look better.’ It is not a wrong question. It is due to that there is no clear definition of a startup with regard to its scope that can be defined as a startup business.

A startup is commonly defined as ‘a young venture company that is just beginning to develop’ based on innovative technologies and ideas.’ In his book titled ‘Lean startup,’ Eric Ries defined a startup as a ‘company that is newly created and not received a massive financial support (before listing) with a huge potential of rapid growth through its ideas and technologies.’ Many can define a startup with their own words. However, the common concepts of startup can be explained as the ‘reinterpretation of existing market,’ and ‘innovative ideas and technologies.’
Here, ‘innovative technologies and ideas’ can be easily understood as a ‘disruptive innovation’ that Clayton Christensen, a chair-professor at the Harvard Business School of Harvard University, argued in his book, ‘The Innovator’s Dilemma’. A ‘disruption’ is the latest jargon of startup industry expressing innovation led by startups. It generally means a series of efforts to reinterpret existing markets with new ideas and innovative methods, and tear down or improve the current industry with prompt executions. Members of startup businesses respond that the S&T community should be prepared to meet the era of the 4th industrial revolution in the midst of ‘disruption’ as ‘markets are disrupted.’ From the results of ‘Startup Trend Report’6, an annual survey of Startup Alliance and Open Survey that investigates changing attitude of founders and employees of startup businesses, employees of large companies and prospective university graduates regarding startups show such realization. 500 employees working at large companies and 200 prospective university graduates responded to the survey. They answered that they reminded of ‘innovativeness and creativity’ when they thought of ‘startups’ and it was the most frequently answered one for 2 straight years.

We disrupt the market and build the future

Startups are showing a rapid growth across the globe and changing the existing industry structure. The list of unicorns companies by CB Insights which was announced in September 2018 reflects changes in market led by tech companies. Here, ‘unicorns’ is an industry term indicating unlisted startups of which value exceed USD 1 billion (about KRW 1 trillion).

It is noteworthy that Uber and Didi Chuxing, on-demand autonomous ride-hailing service providers, ranked at the 1st and 2nd of the list, respectively, as they were serving in the sector where starting in business is not available in Korea due to an ongoing backlash from taxi companies and conflicts with the Ministry of Land, Infrastructure and Transport (MOLIT). Airbnb, a company that has grown into a sharing model of using surplus spaces of houses as hospitality service, and WeWork, a company that provides shared workspaces, are listed as the 4th and 8th, respectively.

If we consider the related industries as hospitality service and leasing real estate, we cannot understand that why their values are increased to the level to be called as unicorns at all. Changing attitudes of millennials7 who extend the concept of ‘possessions’ into ‘everything that can be shared’ and their spending patterns reflecting such attitudes are realized in the form of industry. People can truly understand the increased value of unicorns only when they recognize such changes. This is what it looks like to rewrite the rule of existing industry.

Then, how can startups make such try? Why can they do better than larger organizations? A prompt decision making and execution that can be carried out only by small organizations is the driving force. In addition, their commitment to achieve goals they believe play a part in the process. Of course, large organizations have many outstanding talents and huge capitals. However, it takes a long time for them to make decisions and they are more likely to lose a golden time for innovation due to conflicts of interests and issues with other business sectors within the organization. As for startups, people who are willing to strive to the project are gathered together and they throw the ball with maximum effort. For them, it is easier to change the direction if something goes wrong, and this means that they can do better when it comes to new attempts. These can be considered as their advantages. Insiders of large companies say, “It is far better to acquire promising startups for large companies in terms of ideas and executing capabilities than to set up a taskforce to imitate R&D activities within the company.” It might be because of that global IT companies that have already grown into giants are making efforts to identify startups that would lead the 4th industrial revolution and strive

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6 The government has established the Act on Special Measures for the Promotion of Venture Businesses (hereinafter referred to as ‘Venture Business Act’) to support venture businesses in order to create jobs and reinvigorate national economy after the financial crisis in 1997. Hence, companies that are accredited as ‘venture businesses’ that receives the policy support by satisfying the requirements stated in the Venture Business Act are called as venture businesses and others that fail to meet such requirements are referred differently in Korea. 4 Startup Alliance, Open Survey, 2018 Startup Trend Report

7 Although there is no precise definition, millennials refer to the generational demographic cohort of which birth years are from the late 1980s to 2000s with outstanding capability to use IT.
to grow together with them. We must pay attention to this trend. They considered that the ‘task of creating a future’ starts from the efforts of startups that disrupt the market. Google is a representative US company that actively seeks to acquire or invest in startups the most for its future business. Google successfully acquired about 220 startups during the period of 2001 and 2017\(^8\), and it established a holding company called Alphabet Inc. In the Alphabet, there are a large number of independent affiliates equipped with technologies of so-called 4th industrial revolution such as AI, autonomous driving, smart city, etc. Among them are Verily, Alphabet Inc.’s research organization devoted to the study of healthcare, IoT startup Nest, a company that Google acquired at about KR$ 3.4 trillion in 2014\(^7\), and Deepmind, a company well-known in Korea as the developer of AlphaGo. Likewise, Google continues to manage, invest, and acquire startups besides its core areas such as search engine and YouTube through ‘Other bets,’ meaning an ‘investment in other fields.’

Cases of China are more noteworthy. The fact that the speed of innovation by leading Chinese Internet companies has already exceeded the speed of domestic ones is well known. There are Baidu, Alibaba, and Tencent, collectively known as BAT, at the center of such change.

Figure 3
Investment share of Alibaba and Tencent by sector

A new word, BAT round, was created in China, and which refers to a trend indicating that startups, which are grown to have a certain size, are receiving a large investment by the three companies\(^6\). They actively invest in startups when it comes to the investment volume. It was known that their investment amount reaches to KR$ 98 trillion during the period of 2015 and 2017\(^8\). Among the three giants, the two-sided competition between Alibaba and Tencent is called Big 2. As they were grown into global giants based on the platform business, they make an aggressive investment to services that are directly related to customers and they also invest in promising future technologies as in the case of Silicon Valley, because they see them as opportunities to expand their business. AR and VR, AI, and autonomous driving are representative areas of investment that they are paying attention. With a strong leadership of Chinese government and open mindset toward data, they secured an environment to support the rapid growth of new industries as well.

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\(^6\) Jungong Il Jo, "KR$ 1T startup set up in every 3 days in China thanks to the ‘BAT culture,’" Aug 28, 2018.


\(^8\) Junho Yang, "Pyeongchang’s IT GDP is doubled while global startups are attracting domestic IT and electronics companies," Aug 28, 2018.
According to the “Hurun Greater China Unicorn Index in H1 2018” released by the Hurun Research Institute, a Chinese survey agency specializing in corporate analysis, the trio invested in more than one third of the total investment in Chinese unicorn startup companies. A Chinese market survey agency ITjuzi also told that about 50.8 percent of Chinese unicorn startup businesses received investment from the BAT directly and indirectly as of the end of 2017. Among the 10 greater China unicorns mentioned earlier, Toutiao, Meituan Dianping and Didi Chuxing are collectively known as TMD and they established themselves a long time ago as the next-gen giants following the BAT. The TMD has grown into large companies thanks to the investment of the BAT as well.

What about the situation in Korea? The startup ecosystem of Korea has also shown rapid growth in recent years. There can be many criteria that can be used to assess the degree of development. We can find such growth intuitively by observing the increase of investment amount. In fact, the investment volume towards domestic startups has been increasing each year since 2014.

Startup Alliance has published a sectoral startup map of companies that received investment worth over KRW 1 billion from venture capital since October, 2015. In October, 2015, when Startup Alliance released the map for the first time, 76 startup companies received over KRW 1 billion in investment among the total. Three years later, the number of startups receiving the investment of which amount exceeds KRW 1 billion surpassed 464 among the ones of which information is disclosed as of October 30, 2018. There can be many reasons that explain the increasing volume of investment such as startup support policy and financial support by the government. However, it can also be interpreted that the number of startups that are worthy to attract investment has increased in Korea.

Apart from the struggle and ceaseless efforts of startup companies, inadequate areas that have rooms for improvement due to peculiar conditions of Korea are evident. The most conflicting issue may arise in ridesharing sector. If we view the business as a new industry to replace or complement existing taxi industry, it can be considered as a conflict of interest. If we take a different approach, however, from the perspective of autonomous driving which will lead the 4th industrial revolution and encompassing the future of change, we can think it differently. We can save the number of idling vehicles by sharing cars, daily transport becomes easy, and it can bring a fundamental change in transportation and logistics.
Based on this, Didi Chuxing overtook the Chinese carpooling service with the acquisition of Uber China and is accelerating its pace in the development of autonomous driving. GM and other traditional leaders of automobile industry invested in Lyft. As seen from the expression, ‘big data is the fuel of the 4th industrial revolution,’ data driving services can open up a new industrial opportunity as itself. However, many unfortunate moments were encountered in Korea as such business activities could not be carried out here. Hyundai Motor Company invested KRW 284 billion to Grab, Southeast Asian version of Uber, and decided to deploy its electric vehicles. Hyundai has already run a pilot program in Singapore and plans to expand its service to other Southeast Asian countries through Grab. Hyundai has deployed its EV model, Ioniq EV, in the Netherlands in October, 2017 and began to provide the ridesharing service directly. It was pity to consider that it could be the case in Korea, namely, an established domestic car maker could have made an investment worth thousands of billions won to startups in Korea if ridesharing providers could engage in business and grow together in homeland to bring a rosy picture of autonomous driving.

The same is applied to the digital health care sector. Recently, Startup Alliance conducted a research for policy recommendations to vitalize a startup ecosystem in the digital healthcare sector in cooperation with the Asan Nanum Foundation, Google for Startups Campus, and Banks Foundations for Young Entrepreneurs (D. Camp) 12. The result shows that, even though Korea has a high-quality medical technologies and infrastructure, the digital healthcare sector is lagging behind in the arena of innovation competition due to entry regulations that restrict the release of services and products, time-consuming licensing and permit process, and restricted market conditions caused by issues related to medical insurance fees and de-identification of personal information. When we look into 100 global digital healthcare startups in terms of cumulative investment amount, there were no Korean startups and 64 of them were not allowed to engage in their business activities in Korea.

It is an irony as the result shows that technologies that are expected to lead the 4th industrial revolution cannot be started in a form of business here in Korea when the importance of 4th industrial revolution is stressed in the government level. I cannot help but wonder what it means to cite the types of technologies leading the 4th industrial revolution, referring to foreign examples, and mention that well-known speakers commented on such technologies in the world’s popular conferences in a series of congratulatory messages and new year’s addresses when they are difficult to be commercialized in Korea.

KISTEP
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BEYOND 2018

SPECIAL

KISTEP 10 Emerging Technologies in 2018

Asian Innovation Forum: Towards Better Asia
KISTEP’s Selection of 10 Emerging Technologies, the first of which was published in 2009, aims to identify emerging technologies from diverse viewpoints. Since 2013, KISTEP has identified emerging technologies with high social demand after selecting what it sees as “the core issue of Korean society in the future.” This year, ‘the realization of a people-centered smart society,’ which seeks to create new values through the medium of intelligent high technology, was selected as the core issue with significant ripple effects on our society over the next 10 years, based on which the ‘10 Emerging Technologies in 2018’ were selected through a comprehensive analysis of the roles and directions of development of science and technology. First, the domains which constitute the smart society were categorized into the five areas of residence/living, transportation, energy/resource, health, and food resources, and detailed issues were analyzed through a process that included a review of the relevant literature, analyses of social data, consultation with experts, and a survey of the general public. Several emerging technologies required to actualize products and services relevant to the issue were identified, which were then narrowed down to 20 core candidate technologies. Finally, 10 emerging technologies were selected through an expert review based on the possibility of their realization within 10 years, their potential to respond to future issues, and their economic and technological impacts.

The ten selected emerging technologies are: ▶ responsive housing technology ▶ life log virtual assistant software technology ▶ smart tattoo technology ▶ soft robot technology ▶ connected car technology ▶ modular public transportation technology ▶ wireless power transfer technology ▶ smart farm technology ▶ artificial intelligence security technology, and ▶ mixed reality technology. Responsive housing technology allows the responsive and autonomous customization of lighting and flooring in accordance with the preference, emotions, and activities of the user. The technology is expected to address safety issues related to the increasing number of single-person and senior households, and provided user-oriented services exceeding those of IoT smart homes. Smart tattoos, which can be easily applied to the skin, allow the monitoring of blood glucose level or self-diagnosis of cancer through changes in the color. A smart tattoo can also be used as a miniature wearable storage and control devices which can be used to load stored information such as voice files or play music, simply through scanning, which is already used in QR codes. Soft robots are robots built with soft and flexible materials, thus providing better flexibility and shock resistance than typical robots with a rigid structure. Due to such attributes, soft robots can be utilized in various circumstances which require physical interaction with humans, and are expected to evolve into “social bots,” establishing communion with people, with Baymax of Big Hero 6 as an excellent example. The 10 Emerging Technologies of 2018 are of great significance in the sense that the selected technologies emphasize the roles of science & technology in resolving social issues caused by urban concentration, the prolonged low fertility rate, the intensification of population aging, and the continued increase of single-person households.
**Responsive Housing Technology**

**Definition:** Eco-friendly housing with spatial/functional/lighting variability to actively manage risks from outside and respond to user needs, using IoT-based intelligent flooring, active sensor and display technology.

**Application:** User-customized housing in which lighting or flooring respond to the preferences, emotions and activities of users. Resolves safety issues caused by the increase in the number of single-person households and elderly, while providing a more convenient residential environment to the users.

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**Life-log Virtual Assistant Software Technology**

**Definition:** Intelligent Virtual Assistant software technology which accumulates knowledge and provides customized services by analyzing life-log data (daily lives, health conditions and behavioral patterns of the individual).

**Application:** Is being developed into a problem-solving agent which deals with various needs and provides solutions in reflection of one’s life pattern, through convergence with AI, voice recognition, smart home, and autonomous vehicle.

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**Smart Tattoo Technology**

**Definition:** Adhesive biometrics monitoring sensor (patch or tattoo type) involving a thin layer of electric circuit that includes sensors to monitor health condition and memory chips.

**Application:** Enables convenient self-diagnosis without having to collect blood with color changing patches based on blood glucose level. Can also be used as a wearable storage/control device through which the stored information can be loaded or music can be played by scanning the tattoo image.

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**Soft Robot Technology**

**Definition:** Robots manufactured with soft and flexible material, in contrast to traditional robots made with hard and rigid material.

**Application:** Offers better flexibility and shock resistance compared to normal robots built with steel, and can be used in a more diverse environments which require physical interaction with humans.

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**Connected Car Technology**

**Definition:** Future human-friendly vehicle infrastructure and mobility technology which allows vehicles to recognize the surrounding environment, minimize driver fatigue through autonomous control, and provide safe driving and connected services through the convergence of ITS technologies, internet technology and intelligent control.

**Application:** Enables real-time interactive communication with road network system, providing automatic collision alarm, speeding and safety alarm, ideal route navigation, and intelligent transportation systems (ITS).

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**Modular Public Transportation System**

**Definition:** Automatically assembled block-type transportation system operated based on smart technologies including IoT, remote control and autonomous driving.

**Application:** Enables door-to-door transportation of the elderly, disabled, and vulnerable. Modules can be assembled or disassembled to assume the form of taxi (up to 3 passengers), van (up to 6) or bus (dozens).

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**Wireless Power Transfer Technology**

**Definition:** Technology which allows wireless power transfer to fixed/mobile devices in the same space using WiFi hotspot.

**Application:** Enhances the usability of smart products and devices by conveniently supplying power to mobile phones, home appliances, wearable devices and IoT sensors.

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**Smart Farm Technology**

**Definition:** Technology which controls the entire process of agriculture, livestock and fisheries industries in an intelligent manner and enhances productivity, efficiency and stability based on information and communication technology.

**Application:** Resolves safety issues in the entire process of food production, distribution, and consumption, and contributes to alleviating the qualitative and quantitative polarization of food resources through enhancement of productivity and efficiency.

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**Artificial Intelligence Security Technology**

**Definition:** Technology for AI-level security system which discovers weak points or blocks attacks through automatic collection and analysis of data, or for monitoring of AI itself.

**Application:** Applies AI technology in responds to risks of unfair use or malfunctioning of AI and accident prevention, detecting security risks.

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**Mixed Reality Technology**

**Definition:** Technology which interacts with users through real-time combination of virtual information such as computer graphics, sound, haptic information and smell with objects of actual environment.

**Application:** Can be used in various aspects of life, including smart work (resolves difficulties caused by comparability of work and household duties to provide a more flexible working environment), smart home schooling, and leisure activities of mobility impaired.
Asian STI Think Tanks Network (ASTN)

The day before the AIF, the convention hall across the corridor was bustling with people preparing for the event, and representatives of the member institutions of ASTN gathered in the conference room one by one. Approximately 40 seats were soon filled with representatives from the Think Tank who are in charge of innovation policies of each member nation.

The ASTN Roundtable Meeting, which was convened for its second time following the last year’s meeting, is a meeting held to mark the expansion of the network in terms of both member nations and institutions, and at the same time a venue for discussion on the directions for the forum and a network facilitating the common growth of the entire Asian region. The fact that this year’s AIF was held in Taiwan after three consecutive meetings in Seoul is itself a significant outcome that was realized through a proposal by the Science & Technology Policy Research and Information Center (STPI) of Taiwan to co-host the forum.

Before the general meeting, a welcome ceremony was held for the four new member think tanks: Chung-Hua Institution for Economic Research (CIER) of Taiwan, National Institute for S&T Policy and Strategy Studies (NISTPASS) of Vietnam, National Graduate Institute for Policy Studies (GRIPS) of Japan, and Higher School of Economic (HSE) of Russia. Representatives from the four institutions signed the memorandum, pledging to pursue the joint objective of the network.

At the following meeting, active discussions took place on the hosting of future forums and measures to promote actual cooperative activities such as talent exchanges and joint research. Various S&T issues including pending tasks of member states have been proposed as the theme for future forums, which all correspond to the themes of ‘science and technology’s contribution to the economy and society’ and ‘sustainable growth.’ The Think Tanks were focused not only on promoting the role of science and technology in contributing to technological advancements and enhancements in productivity, but also fulfilling its social role and achieving joint objectives such as the resolution of global difficulties.
The 4th Asian Innovation Forum (AIF)

Despite the bad weather from typhoon Maria which poured down all night long, the convention room was brisk with the upcoming opening ceremony of the forum. Two AI robots fluent in both English and Chinese welcomed participants at the registration desk in front of the entrance. The registration process was simple: after reading the QR code sent to a mobile phone after the on-line pre-registration on the robot’s camera, the robot loaded information previously entered and the registration was complete. The smile on the robot’s screen after a light pat on its head showed how close AI technology is to becoming a part of our daily lives.

The forum began with opening remarks from Minister Liang-Gee Chen (劉季銘) of the Ministry of Science and Technology of Taiwan. Delivering his welcome message and expressing his wish for a successful forum, Minister Chen showed the Taiwanese government’s strong interest in strengthening S&T competitiveness through continued investment in cutting edge technologies such as artificial intelligence and quantum computers, and cooperation with other Asian states. Minister Chen’s kind welcome was followed by the welcome speeches of the representatives of the two hosting institutions, KISTEP and STPI, who cooperated for the last several months to jointly host this year’s forum. Senior Research Fellow Se-in Park, attending the forum on behalf of KISTEP, conveyed the institute’s gratitude toward STPI, stating that the 4th forum being held in Taiwan is a significant step of AIF toward a cooperative stage of discussion, where more Asian states can voice their views.

Innovation, a Flying Leap for the Growth of Asia

The main topics of the two keynote speeches were fundamental questions that deal with what ‘innovation’ is, and why Asian states need “innovation.” First, Professor Patarapong Intarakumpnerd of the National Graduate Institute for Policy Studies of Japan (GRIPS) analyzed the status of the manufacturing industry of ASEAN economies and emphasized the role of innovative growth as the solution to the middle-income trap. It was discovered through an analysis that ASEAN economies, in which small and medium-sized enterprises form the majority of the industrial ecosystem, were highly dependent on value chains of foreign capital and multinational corporations. Prof. Intarakumpnerd then went on to emphasize the systematization of informal R&D which occurs sporadically inside the enterprises, the absorption of new technologies, and the need for internalization of innovation through enhancement of productivity.

Then, Laouine Kerbache, Chief Innovation Strategist of the Qatar Foundation Research Development and Innovation (QF RD), explained the concept of the organically connected supply chain, and emphasized the synergy effect in generating knowledge and innovation through an innovative ecosystem. According to Mr. Kerbache, value creation is maximized when the agents of innovation such as enterprises form an ecosystem and cooperate based on a multi-layered interdependent supply network. The keynote speeches mentioned an important fact which was brought up at the ASTN Roundtable Meeting; while the member states of the forum are all Asian states, there exists a wide spectrum in terms of STI capacity or the level of economic-social development. The gaps among member states is a matter that should be considered in order for the forum to create outcomes through substantive multilateral cooperation, and at the same time a factor which should be kept in mind in the following discussions.
National Strategy for STI: Visions, Roadmaps & Action Plans - Different Countries, the Same Concerns

The first session organized by the STPI of Taiwan provided a chance to discuss the strategies for STI. After following presentations from four speakers, from Korea, Japan, Taiwan, and Thailand, respectively, active discussions were held on planning the ideal future society and the roadmap to accomplishing this at the national level.

Associate Researcher Albert Li from STPI of Taiwan explained the core issues of the economy, society, S&T and environment which the Taiwanese government seeks to resolve. KISTEP’s Research Fellow Changtaek Choi began his presentation with the introduction on trends of future society resulted from foresight analysis, then explained how they were reflected on the 4th S&T Basic Plan (2018–2022). The plan sought to integrate the opinions of not only technology and policy experts but also those of researchers and the general public. Also, in the same context, Strategist at the National Science Technology and Innovation Policy Office (NSTIPO) of Thailand Suchat Udomsopaglit delivered a presentation on Thailand’s 20-Year National Strategy on Research Innovation (2017–2036), and the Spearhead Research Innovation Program on 9 technology sectors to achieve the objectives. Lastly, Professor Naohiro Shichijo of Tokyo University of Technology proposed ‘Society 5.0,’ the basis of Japanese S&T policies, and horizon scanning using big data as the response strategy to address an uncertain and ever-changing future.

The presentations by the speakers and the discussions that followed were interesting in the sense that they all shared similar concerns despite the differences in the level of economic or industrial development and S&T capacities. When the issues that were selected as core tasks by the Taiwanese government—low birth rate and aging society, safe food, pollution and climate change—were displayed on the screen, many participants nodded as if the presentation was on their own concerns. Everyone also agreed with how the countries should prioritize and approach complex social issues to resolve them accordingly. The importance of selective approaches, which precisely designate and focus on issues that are resolvable through S&T, to maximize policy effectiveness using limited resources, was also emphasized.

They all shared similar concerns despite the differences in the level of economic or industrial development and S&T capacities.
The 2nd Session, organized by the ECO Science Foundation of Pakistan, provided a forum for the participants to observe how emerging technologies are changing industries and society.

Singaporean start-up Positive Energy Community’s Co-founder Nicolas Payen presented the audiences with a business model which improves investment accessibility of renewable energy and facilitates the financing of emerging markets using blockchain technology.

Tony An, Chief Marketing Officer of LITE-ON, demonstrated the possibility of a smart city model by introducing their pilot project that installed 6.5 million smart streetlamps around Taiwan and China. The streetlamps collect real-time information on weather, air pollution, noise and traffic conditions.

Also, Aslam Pirzada, CEO of Ideal Autonetics (Pvt) Limited, shared various examples based on actual cases of using IT technologies to support sustainable growth by developing countries, including the use of AI or IoT to enhance agricultural productivity, or an e-Governance system to facilitate transparent decision-making.

Executive Director of IPOS-International, Dexter Teo, shared with the audiences the case of Living Lab for Renewable Energy of Singapore, in which the technology status of photovoltaic (PV) system and R&D fields with intensive investment were identified through patent analysis.

The above innovation strategies with different cutting-edge technologies showed a similarity that they contribute to a long-term sustainable plan, allowing maximum efficiency of resource consumption. In particular, the cases provided insights into the common concerns of Asian countries, such as the continued increase in the urban population which accounts for the majority of energy and resource consumption. In the discussion that followed, three preconditions were suggested to effectively adopt the technologies of the 4th Industrial Revolution. The first is that in the big picture, the governments should understand what issues need to be resolved, and establish realistic visions using the proof of concept.

The second is that when new technologies such as blockchain are applied, education and interactive communication targeted at the general public, who are the end users, should take place. Lastly, the introduction of technology should be accompanied by the appropriate institutional apparatus, such as intellectual property rights, standards and norms. The session ended with the conclusion that when these series of efforts work in line with the adoption of new technologies, the disparity and chaos caused by different viewpoints of regulators, stakeholders and users will be minimized and the effects of innovation will be maximized.
The last session of the forum, organized by KISTEP, sought to discuss how policy goals and plans previously discussed can be implemented practically. Researcher Nguyen Hong Anh from NISTPASS of Vietnam delivered her presentation on political suggestions to increase the R&D investment by introducing public and private financing methods implemented to support innovative activities of Vietnam.

KISTEP’s Research Fellow Jinwon Kang introduced the Korean government’s efforts to make a transition from Korea’s National R&D Evaluation from project-based evaluation to policy-related evaluation.

Senior Research Fellow Trina Fizzanty from PAPPITEK-LIPI of Indonesia provided diagnoses on tasks encountered during the implementation of national strategy in achieving “Indonesia 4.0” through invigoration of the manufacturing industry, and proposed political suggestions accordingly.

Lastly, Director of the Qatar Foundation Salvino Salvaggio emphasized the importance of simplifying and organically operating a governance system by introducing the promotion of Qatar R&D Innovation Governance System Reformation, which took place over the last 18 months, and its future plans. During the discussion that followed it was observed that the Asian countries were constantly asking “what the next stage is.” The participants agreed that fulfilling a designated role as a component of the whole and achieving a comprehensive policy goal are more important than carrying out each political agenda of individual.
Social Changes Brought About By Science and Technology, and Recurrent Tasks

Director of the Qatar Foundation Salvino Salvaggio, the last speaker in the last session, asked the audience an interesting question. After showing some of the contents of discussion on new technologies excerpted from the minutes of European countries’ national assemblies, Mr. Salvaggio asked which technology the assemblies were discussing. Audience members shouted out their guesses: “Internet!” “Smartphone!” “YouTube!”

Shaking his head, Mr. Salvaggio revealed: “phones.” Yes, ‘that bloody device’ which the members of the European Assembly called for strict regulation on in the 1890s due to concerns that it would put an end to the newspaper industry, disseminate inappropriate content, and harm the joyful mealtime gatherings of families was the phone.

Perhaps the destructive wave of innovation generated by the 4th Industrial Revolution may not be unprecedented, considering the entire history of humankind which has progressed in line with the development of science and technology. From the very beginning of mankind, when new technologies were introduced, similar concerns existed, but people were able to adapt to the changes and turn crises into opportunities to become what we are today.

Science, technology and innovation are not only the cause of new problems, but also a solution to a great social crux. Now, we are at the moment when STI think tanks should take the lead so that innovation can resolve various issues, lead economic growth, and act as a driving force in changing our society. Cooperation between members of the society with diverse roles and viewpoints, and between countries sharing borders, is becoming more important than ever, and the Asian Innovation Forum will take the initiative to lead the future.

More details and materials on the Asian Innovation official website.
(www.asianinnovation.org)
Event Highlights

January 2
KISTEP 2018 New Year’s Kick-off Meeting

January 31
2018 Future Innovation Forum

February 8
National Polytechnic Institute visited KISTEP

March 29
Groundbreaking Ceremony for New Office Building

March 29

May 2
Public Forum on National R&D Innovation Plan

June 26
Ministry of S&T and NCSTE visited KISTEP

July 9
The 2nd ASTN Roundtable Meeting

July 10
The 4th Asian Innovation Forum

August 3
Inauguration of Dr. Sang-seon Kim

September 11
Pakistan Ambassador in Korea visited KISTEP

November 14
KISTEP Participated the 13th Trilateral S&T Policy Seminar

November 26
The 10th KISTEP-ISTIC STI Training Program
KISTEP NEWS

Groundbreaking Ceremony for New Office Building in Chungbuk Innovation City

Public Forum on National R&D Innovation Plan

Public Participation Forum for the Government R&D Mid and Long-term Investment Strategies

Inauguration of Dr. Sang-seon Kim, as the 9th President of KISTEP

KISTEP, NRF and IITP had MOU with MSIT for R&I (Role & Responsibility)

Pakistan Ambassador in Korea Visited KISTEP

‘The Problem of Microplastics, Can Science & Technology Solve it?’

2019 National Innovation System for Innovative Growth Forum, Held by KISTEP
Groundbreaking Ceremony for New Office Building in Chungbuk Innovation City

KISTEP had its groundbreaking ceremony for new office building in Chungbuk (Jincheon · Eumseong) Innovation City on March 29th (Tue) at 11am.

The construction will be completed in December 2018. Currently, 10 institutes completed the relocation including Korea Gas Safety Corporation (KGSC), Korean Agency for Technology and Standards (KATS), Korea Consumer Agency (KCA), Korea Information Society Development Institute (KISDI), Korea Employment Information Service (KEIS), Institute of Justice (IOJ), National IT Industry Promotion Agency (NPIA), National Human Resources Development Institute (NIHI), Korean Educational Development Institute (KEDI), and Korea Institute for Curriculum and Evaluation (KICE), among 11 institutes scheduled to relocate to Jincheon Eumseong Innovation City.

President Kihun Lim said, “The year of 2019 is the 20th anniversary of KISTEP and moving to our own office building has been long-cherished ambitions. It is also a pleasant event for Korea’s Science and Technology Innovation.” He promised to strengthen the institute’s capacity as the door of regional innovation policy.

Public Forum on National R&D Innovation Plan

The Ministry of Science and ICT (hereafter MSIT) and KISTEP held ‘Public Forum on National R&D Innovation Plan’ at the EL Tower Seoul on May 2nd, 2018.

This forum was held to gather opinions from experts in the private sector, academia, and research institutes; field researchers, and the general public, which would contribute to making ‘National R&D Innovation Plan (tentatively named)’. The plan will outline strategies to lead innovation and growth by enhancing innovation capacity and improve the quality of life for people.

This forum began with an opening address by Dae-sik Lim (Vice Minister for Science, Technology and Innovation, MSIT) followed by a presentation on ‘National R&D Innovation Basic Plan’ (Seong-su Kim, Director for Science and Technology Policy Division, MSIT). A series of presentation and discussion followed on (1) ‘Construction Leading R&D Supporting System’ (Seong-bok Lee, Professor of Seoul National University) (Chair: Hye-seong Cho, Professor of Ajou University) (2) ‘Enhancing Capacity of Innovation’ (Jun-mo Ahn, Professor of Sogang University) (Chair: Hyo-jeong Park, Professor of Ajou University) (Chair: Byoung-ho San, Vice President, KISTEP)

Henceforward, MSIT plans to finalize and announce the National R&D Innovation Plan (tentatively named) by reflecting the opinions gathered from the forum.
Public Participation Forum for the Government R&D Medium and Long-term Investment Strategies

The forum, attended by the Director General of R&D Investment Coordination Bureau (MSIT), 42 civilian representatives, subcommittee and working commission members, and KISTEP researchers, began with a keynote speech by Visiting Professor Jae-won Kwak (College of Engineering, Seoul National University), with the theme of “S&T by the people, for the people.” Each session was composed of presentations by experts and department discussions, with input from 10 civilian representatives and over 4 members from the subcommittee and working commission members.

▲ Smart health care technology for real-time health services ▲ Resolving safety issues in our everyday lives through S&T ▲ Clean and safe future energy ▲ R&D needed to address the issue of particulate matter ▲ Strategies to become a leading nation in AI ▲ People-centered smart city ▲ The blockchain era and the role of the government ▲ Can R&D resolve job shortage issues for the young

Ministry of Science and ICT (MSIT) and KISTEP held a public participation forum for the government medium and long-term R&D investment strategies at the EL Tower Seoul on July 25th (Wed), 2018. This forum was held to identify and gather public opinion on policy demands with high real-world impacts related to improving the quality of life for people.
Inauguration of Dr. Sang-seon Kim, as the 9th President of KISTEP

KISTEP welcomed Dr. Sang-seon Kim, as the 9th president of KISTEP on August 3rd.

KISTEP held a special meeting of board of directors (Chairman Wook Son) on July 31st and appointed Dr. Kim as the 9th president. Approved by the Minister of Science and ICT (MSIT), President Kim began his 3-year term from August 3rd.

President Kim, who passed the 13th Public Administration Examination (Technology), has had a dedicated career for 30 years at the Ministry of Science and Technology (current MSIT). He has served in major government posts, including Public Information Officer (Ministry of Science and Technology), Director General of Science and Technology Cooperation Bureau, Science Counselor at ambassador to the US and Assistant Minister for Policy Management & Public Relations (Ministry of Science and Technology). President Kim received his doctorate degree in PREST (Policy Research in Engineering, Science and Technology) from University of Manchester. After resigning from the civil service in 2007, he has worked as Secretary-General of Korean Federation of Science & Technology Societies (KOFST), President of Korea Institute of Human Resources Development Science and Technology (KIRO), member of Presidential Advisory Council on Science & Technology, and Chair of Expert Committee for Policy Coordination, National Science & Technology Council. His career attests to his long-established expertise in S&T policy planning.

In his inaugural address, President Kim highlighted, "By developing KISTEP as the best S&T policy think tank in Korea, we will aim to enhance national competitiveness, lead the 4th industrial revolution and S&T-based society, and focus on new growth engines and job creation."

Meanwhile President Kim stated, "Since the outcome of S&T performance depends upon researchers, we will make efforts to create favorable conditions for researchers to be immersed in research."
KISTEP, NRF and IITP had MOU with MSIT for R&R (Role & Responsibility)

Ministry of Science and ICT (Minister Young Min You, hereafter MSIT) announced a plan for establishing new role and responsibility (hereafter R&R) with Korea Institute of S&T Evaluation and Planning (President Sang-seon Kim, KISTEP), National Research Foundation of Korea (Chairman of the board Jung-Hye Roe, NRF) and Institute for Information and Communication Technology Promotion (President Jae-bum Seok, IITP), and signed MOU to implement the plan at Gwacheon Government Complex on August 7th (Tue), 2018.

The background of establishing the R&R agreement for national R&D supporting institutes such as KISTEP-NRF-IITP are as follows. Although these institutes have performed R&D preliminary feasibility study and supported improving efficiency of budget coordination & allocation, evaluation, and researcher-oriented systems, there had been some issues raised for its intangible impact on creation of results and actual fields for researchers and the general public due to mannerism and habitual practices. In addition, in order to meet the expectation of the public and society, needs to lead the 4th industrial revolution and accelerate R&D innovation through self-innovation have been suggested.

Each institute autonomously made a R&R reestablishment team including their own researchers and outsourced key players in policy. After holding inter-institutional meetings and external expert meetings focused on 6 core components: 1)the team established missions and core policy projects, and drove inter-institutional cooperation plans.

1)Reestablishment R&R in order to lead the 4th industrial revolution 2)Strengthen autonomous innovation, responsibility, and ethics in management 3)Focusing on increasing capacity to dispense K-RORE4.0 and generate new jobs 4)Creating good results from national agenda 5)Enhancing the quality of life and public benefit 6)Promoting inter-institutional cooperation.

KISTEP has chosen core missions of enhancing R&D investment effectiveness and generating growth engine for innovation through strengthening S&T expertise in planning/evaluation and supporting policymaking; and proactively identifying future issues/regulations. In order to enhance investment effectiveness, they will establish “One-stop R&D budget information system (completed by 2019)” and support “strategic investment” through establishing an evidence-based” strategic budget allocation and coordination support system.

Establishing Role and Responsibility of Government-Affiliated Institutes towards People-centered R&D Innovation - KISTEP, NRF and IITP had MOU with MSIT for R&R-

* Establish a system that shows results of feasibility analysis, evaluation opinions/main issues of each R&D program at a glance
* Strengthen public participation for the medium- and long-term R&D investment strategy through organizing civilian representatives, and research to promote budget allocation and coordination of package-type R&D investment platforms.

In order to maximize efficiency of R&D preliminary feasibility study”, KISTEP will support ‘reliability-based analysis,’ with improved dependability and expertise through establishing ‘Big-data based system for R&D projects and results,’ shorten the period of feasibility study to 6 months and develop customized methodology for the study. KISTEP will also actively support developing policy capacity for implementation of R&D Innovation plans” and “S&T Innovation Policy” to proactively respond to future social issues such as environment and safety, identify growth engine and improve regulations.

* Enhance openness and reliability of results through establishment of online platform that will share the process of pre-feasibility study and related information with the public; and through promotion of policy research on evaluation system to improve towards researcher-oriented system.
* Support medium- and long-term plans for innovation of government research institutes and fostering human resources in S&T; research on regulations for commercialization of innovative growth engine and on fostering technology-driven start-ups; and lead a standardization of management systems for R&D projects.
Pakistan Ambassador in Korea Visited KISTEP

The delegation from the Embassy of the Islamic Republic of Pakistan in Korea visited KISTEP on September 11th (Tue). The purpose of the visit was to discuss the major roles and functions of KISTEP and future cooperation plans between KISTEP and Pakistan.

President Sang-seon Kim (KISTEP) said “KISTEP performs various tasks such as technology foresight, R&D evaluation and analysis, and S&T basic plan for development of national science and technology.” He continued, “Twenty trillion won, the budget for government-led R&D, takes 5% of national budget, and KISTEP takes the role of allocating the budget for R&D programs.”

Ambassador H.E. Mr. Rahim Hayat Qureshi said, “Pakistan has middle-sized infrastructure of science and technology in the world. We would like to learn R&D systems and evaluation methods in Korea through cooperation with KISTEP.”
‘The Problem of Microplastics, Can Science & Technology Solve it?’ KISTEP held Social Problem-Solving Forum • Hackathon

KISTEP held social problem-solving forum-hackathon with the theme of ‘The Problem of Microplastics, Can Science & Technology Solve it?’ at Hotel Payto Gangnam on November 27th (Tue) and 28th (Wed), 2018.

Recently, social demand for science & technology is increasing to solve social problems that are closely related to people’s lives and to improve the quality of life of people. KISTEP arranged a forum and hackathon to provide a platform to discuss measures to solve the problem of microplastics in-depth through science & technology, as the problem has emerged as a major environmental issue worldwide.

The event consisted of ▲ forum (27th) that shared the problem of microplastics and ▲ hackathon (27th~28th) that allowed in-depth discussion on detailed solutions for the problem.

Keynote presentations consisted of ▲ [Presentation 1] Microplastics, plastic pollution that threatens our food safety, and its solution (Team leader of Plastic Campaign, Greenpeace) ▲ [Presentation 2] Social awareness and possibility of scientific and technological solution to the problem of microplastics (Director Seung-Kyu Yi, Center for Social Innovation Policy, KISTEP), and then panel discussion with experts and open-ended discussion followed.

In the panel discussion after the keynote presentations, Chairman Soon-Choon Byeon (Director General, Office of S&T Policy Planning, KISTEP) and panels including Jae-Hyun Nam (Reporter, MBC), Jeong-Gue Park (Chief Research Fellow, Korea Environment Institute), June-Woo Park (Group leader, Korea Institute of Toxicology), Jaeik Choi (Lawyer, Korea Institute of Intellectual Property) participated and discussed about the role of science & technology to solve the problem.

In the Hackathon, about 20 people participated including R&D managers-researchers, consumer organizations, and researchers in relevant regions and discussed ways to establish a solution system that would resolve the problem in the view of a cycle - from a cause to a social issue - based on KISTEP problem analysis report.
2019 National Innovation System for Innovative Growth Forum, Held by KISTEP

KISTEP held ‘2019 National Innovation System (NIS) for Innovative Growth Forum’ at the Main Auditorium of the Korea Science and Technology Center on December 13th (Thur). The year of 2019, the third year of the Moon Jae-in administration, is the time to comprehensively review the major S&T policy implemented so far, and to discuss the direction of future policy and the 2020 S&T policy. In this light, KISTEP held the forum to reflect on the current national S&T policy and to suggest the direction of Korea’s future S&T policy.

The forum began with a keynote speech by Professor Han Woong Yeom of POSTECH ("What is the Role of Government R&D in the Innovation Economy?"). There were presentations followed by Director Jang Jae Lee (Research Institute of S&T Innovation and Strategy, KISTEP) and Senior Research Fellow Sukin Chang (Korea Institute for Industrial Economics & Trade (KIET)); and the discussion with experts followed the last.

During the opening address, president Sang-yeon Kim (KISTEP) said, "The year of 2019 is an important period to prepare for the direction of Korea’s future science and technology. KISTEP, as a think-tank of STI strategy, promises to strengthen the institute’s capacity to successfully lead innovative growth with the Ministry of Science and ICT (MSIT) and Science, Technology and Innovation Office of MSIT."

During the keynote speech, Professor Han Woong Yeom (Physics, POSTECH) urged that, "Different from the general knowledge, Korea’s innovation capacity (R&D capacity, human resources, level of technology) has already reached an international level. Innovative growth has been stuck at some point with such factors as markets, regulations, institutional arrangements, creativity, and education. In order to bridge the gap between innovation capacity and innovative growth, we need to break free of existing industrial policies, and introduce innovation policies smart enough to reflect the current society."

During the presentation of ‘National Innovation System, the Issues and Tasks in 2019’, Director Jang Jae Lee pointed out the increasing difficulties Korea has been facing by introducing statistical results; the decrease of total factor productivity (TFP), obsolete activities of technology innovation (frustrating the effort for transformation to the post catch-up innovation system), lack of new growth engine, and hollow achievement as number one country of R&D investment ratio to GDP. He then emphasized the importance of new innovation management system to counteract technology innovation in the 4th industrial revolution era and the role change between government and the private sector.

As the issues in 2019, he suggested embarkation on activities for innovative growth, suggestion of integrated message and signal from the government, and establishment of new government role. Especially, he emphasized that the government should not be a leader of innovation growth, but rather become a vision provider, coordinator, and pace maker. He also urged the importance of specialized and differentiated role of government in the R&D, commercialization, and regulation areas.
5 tasks are suggested as below to resolve the issues

(1) Establish ‘The Vision for the Era of 20 Trillion Won for Government R&D Programs and Long Term Roadmap’ which will deliver reliability of innovative growth and a clear signal to the market and public; and will reflect the paradigm integrated with manufacturing industries and data economy. Also, establish Korean version of DARPA to increase the openness of military protection R&D programs, and develop and diffuse advanced technology.

(2) Pursue innovative growth through strengthening connection between innovation bodies such as forming consulting groups to link private sector and government, promoting cooperation between enterprises, creating new ecosystem for new innovation growth, and fostering human resources in the field of advanced technology.

(3) Design researcher-centered R&D system such as establishing evaluation system based on innovation capacity and creativity, and creating research-friendly environment and infrastructure.

(4) Take an initiative as a control tower of KOSBIR programs of the Ministry of SMEs and Startups (MSS) for innovation of SME’s R&D programs, double the number of SME’s R&D by setting clear goals and strategies, enhance the capacity for designing R&D, differentiate the programs by each stage, develop SME’s demand-focused R&D programs, and introduce a supply-focused assistance system of R&D programs to foster innovative SME’s.

(5) Establishing inspectorate system in Science, Technology and Innovation Office to strengthen its expertise and expand the function, enhancing comprehensive functions in microeconomics, and fulfilling a role as a control tower that connects research organizations in order to improve the governance for innovative growth.

Additionally, it is also necessary to pursue inclusive growth through social problem-solving R&D and to extend investments in creative and challenging basic study.

During the presentation of ‘Industrial and Technology Innovation Tasks for Innovation Growth’, Senior Research Fellow Sukin Chang pointed out, “The environment and the momentum for innovative growth has been deteriorating. Even though tangible and early achievements for the public is important, designing sophisticated and strategic policies are crucial such as setting policy goals for innovative growth (high-value added manufacturing and service industries), and selecting effective policy instruments and an implementation system. He then emphasized the need for expanding proactive and strategic government R&D Investments to respond to the change of global production system and value-chain affected by the 4th industrial revolution and manufacturing fields which lead demands of components, raw materials, and equipment.

Experts from various fields participated in the subsequent panel discussion including Doh-yeon Kim (President of POSTECH), Young-joo Ko (President of Korea Technology Innovation Society (KOTIS)), Sung-soo Kim (Director of Science & Technology Policy Division, Science, Technology and Innovation Office, MSIT), Jn Doo Kim (President of Korea Science Journalists Association), Haryoung Peo (Member of Local Science and Technology Promotion Council Presidential advisory Council on S&T (PACST)), Seung Kyu Lee (Vice President of Korea Biotechnology Industry Organization), and Jeong-Dong Lee (Professor of Technology Management, Economics and Policy Program, Seoul National University). They discussed the direction of national S&T policy with opinions of experts and the public.

Research Institute of SAT Innovation and Strategy of KISTEP plans to drive the diagnosis of the current situation and measurements for the main issues and tasks discussed in the forum. They will go through in-depth analysis and research, opinion gathering, and deliberative procedure with experts in KISTEP and outside experts.
National S&T Innovation Capacity 2017

1 Evaluation on National S&T Innovation Capacity 2017 by MSIT and KISTEP (2017.12)

Major Results of COSTII

- Top 5 countries in COSTII ranked higher than the OECD average in all 5 dimensions except Japan, with a balanced innovation capacity over all categories.

2017 Composite Science and Technology Innovation Index (COSTII) of Major Countries

Korea ranked 6th, with a score of 15.202, in the OECD Average of 8.216.

2017 Korea’s COSTII Ranking of 5 Dimensions

Korea ranked 6th in Resources, 3rd in Activities, 14th in Network, 23rd in Environment, and 9th in Performance.

Korea’s COSTII in each Dimension

Korea ranked 3rd in the Activities dimension including R&D investment etc., while Environment dimension composed of R&D support system and R&D culture etc., was ranked 23rd, showing a major disparity among dimensions.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Score</th>
<th>Korea</th>
<th>OECD Average</th>
<th>Top-ranked Country (Point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources</td>
<td>1,753</td>
<td>6</td>
<td>1,773</td>
<td>1,942</td>
</tr>
<tr>
<td>Activities</td>
<td>3,633</td>
<td>3</td>
<td>3,673</td>
<td>3,918</td>
</tr>
<tr>
<td>Network</td>
<td>1,504</td>
<td>11</td>
<td>1,676</td>
<td>1,508</td>
</tr>
<tr>
<td>Environment</td>
<td>2,909</td>
<td>25</td>
<td>2,921</td>
<td>2,639</td>
</tr>
<tr>
<td>Performance</td>
<td>1,787</td>
<td>11</td>
<td>1,848</td>
<td>1,876</td>
</tr>
</tbody>
</table>

Note: Distribution of Scores is equal to the number of indicators in each dimension. The index refers to the standardized index obtained based on the COSTII methodology. Relative rank refers to a country’s relative position in the list country, judging the base country at 100%.
Changes in Preliminary Feasibility Study (PFS) on National R&D Program

**SMART**
- Analysis system reflecting S&T perspectives
- PFS constructs the basis to invigorate Innovative & challenging researches

**SPEED**
- Expeditious PFS

**SMILE**
- Expansion of communication and interaction

**SMART**
- PFS on National R&D Program performs with S&T characteristics

**Changes in PFS Guideline**
The weight of S&T feasibility becomes increased, and the economic feasibility becomes more flexible.

<table>
<thead>
<tr>
<th>Change of the weight range of PFS indexes (Unit: %)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
</tr>
<tr>
<td>Technological Feasibility: 50</td>
</tr>
<tr>
<td>Political Feasibility: 40</td>
</tr>
<tr>
<td>Economic Feasibility: 30</td>
</tr>
<tr>
<td><strong>After</strong></td>
</tr>
<tr>
<td>SAT Feasibility: 60</td>
</tr>
<tr>
<td>Political Feasibility: 50</td>
</tr>
<tr>
<td>Economic Feasibility: 40</td>
</tr>
</tbody>
</table>

*The weight of each index reflects the characteristics of the program.

**Actual Results**
The weight of PFS indexes becomes to change according to the S&T-centered guideline

<table>
<thead>
<tr>
<th>Importance of S&amp;T Feasibility</th>
<th>Importance of Economic Feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.7% (Ministry of Economy and Finance (Before PFS transferred))</td>
<td>31.8% (Ministry of Economy and Finance (Before transferred))</td>
</tr>
<tr>
<td>48.1% (Ministry of Science and ICT (After PFS transferred))</td>
<td>43.7% (Ministry of Science and ICT (After PFS transferred))</td>
</tr>
</tbody>
</table>

*Average weight of index of programs for which PFS was conducted

*The average weight of S&T feasibility becomes increased, the average weight of economic feasibility becomes reduced.*
**SPEED**
The prompt PFS is performed to secure the timeline of R&D investment

- To reduce average period of PFS to 6 months
- To provide a change to retry for PFS screened-out programs
- To reduce the period by performing PFS on the original proposal
- To select program for PFS by a brief assessment

**SMILE**
KISTEP tries to increase the receptivity of PFS through active communication

<table>
<thead>
<tr>
<th>Regular PFS Education &amp; Training</th>
<th>PFS based on Mutual Solicitude</th>
<th>'PFS Platform for R&amp;D sector' (launched at Nov. 2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 times 2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 times 2018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 times 2019</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- To enhance the competency of planning officers based on expanding PFS Education & Training
- To increase transparency and receptivity of PFS through disclosing PFS progress
- To provide the opportunity to access information on PFS by handing out PFS regulations and guideline
- To request data only for its necessity and importance, not excessive demands
- To increase the opportunity for practical discussion between ministries and KISTEP

**KISTEP will**
continue enhancing and intensifying our specialty on PFS

- Extensive and various experience in PFS as the only organization to execute PFS of the R&D sector
  - KISTEP has conducted PFS on 168 R&D programs since 2008

- Formation of PFS Researchers and Advisory Panel composed of experts from various fields
- Research for PFS practical Guideline and Publication
- Cooperation system establishment with external agencies for the fair and objective analysis

- Building the experts' pool in forecasting, policy planning, PFS and evaluation fields
- Searching investment methodology and practical guideline to reflect SAT characteristics
- Outsourcing to other agencies such as National Research Facilities and Equipment Center(NFEC) and Korea Intellectual Property Service Center(KISTA)

**KISTEP, as the only agency for Preliminary Feasibility Study,**
pursues professionalism and fairness with maintaining humility and mutual respect.
Global Cooperation

MOU with 18 institutes, 11 countries
(As of January 2019)
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- A Study of Business Venture’s Successful R&D Mechanism through Open Innovation By Do-hyung Park

Science and Technology Trends — The Advent of Smart Cities

- A Big Data-based Approach for Understanding Smart City Initiatives of South Korea By Choongik Choi
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ARP Volume 9 Issue 2

Special Article

- Industrial Technology: Competitive Analysis and its Implications By Woo-hyung Lee

Articles

- Measures to Promote Public Technology-based Startups By In-jong Lim

Science and Technology Trends — Blockchain Industries, Regulations and Policy

- Blockchain Industries, Regulations and Policy in Columbia By Diana Rojas-Torres
- Blockchain Industries, Regulations and Policy in Estonia By Risto Hansen
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- An Analysis and Diagnosis of the Korean Blockchain Ecosystem By Sung Jun Kim
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