XI International Academic Conference
'Foresight and Science, Technology and Innovation Policy'
OCTOBER 18, 2021

Prospects for science and technology in the post-COVID-19 era

-Follow up survey of 11th S&T foresight-

Dr. KUROGI, Yutaro
Center for S&T Foresight and Indicators,
National Institute of Science and Technology Policy
(NISTEP)
MEXT, Japan

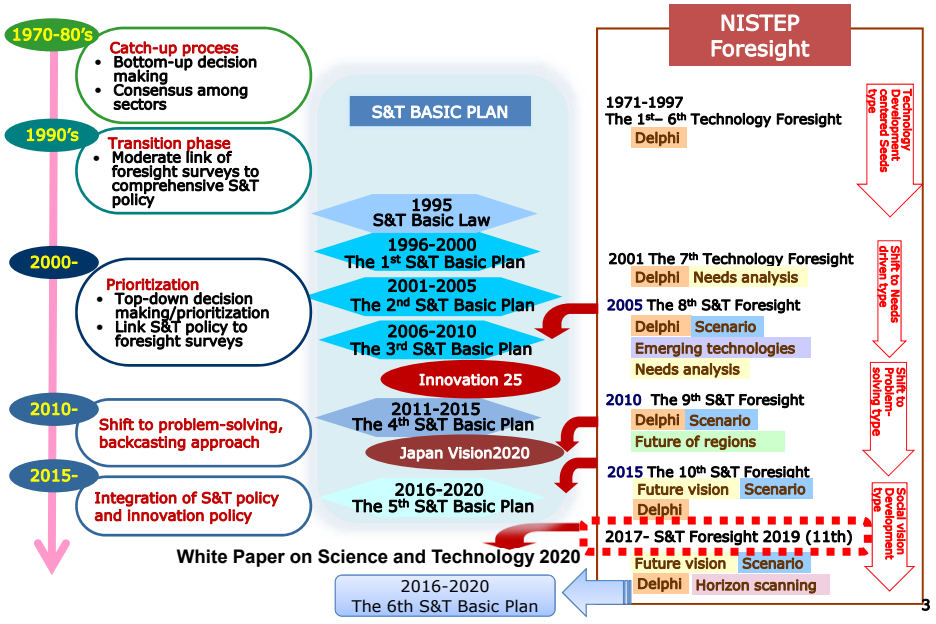
Today's topics

1. Background: Foresight history of NISTEP
2. Purpose: Follow-up survey after COVID-19 pandemic
3. Survey Design
4. Results: Impact of COVID-19 on the S&T Future
5. Conclusion

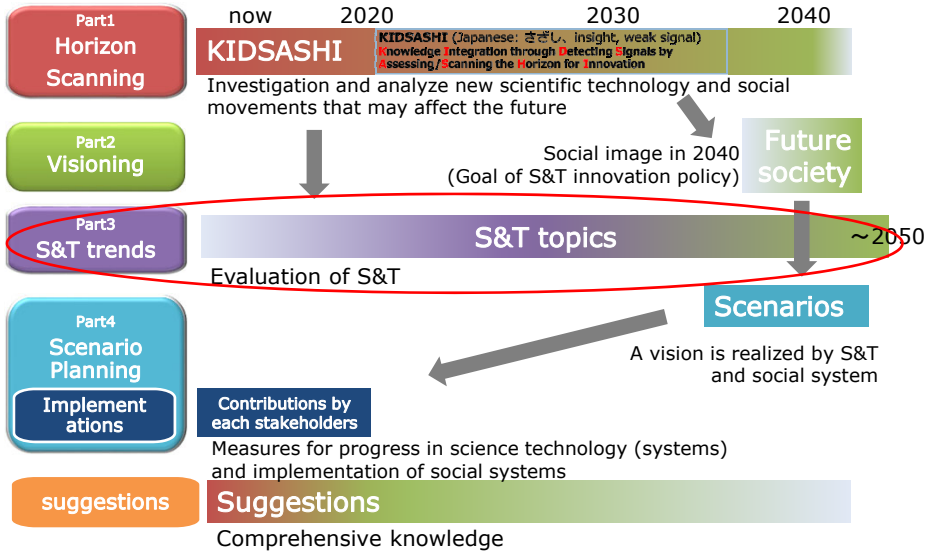
Today's topics

1. Background: Foresight history of NISTEP
2. Purpose: Follow-up survey after COVID-19 pandemic
3. Survey Design
4. Results: Impact of COVID-19 on the S&T Future
5. Conclusion

Historical Development of NISTEP Foresight



Definition and time flame of the 11th Foresight Survey



Today's topics

1. Background: Foresight history of NISTEP
2. **Purpose: Follow-up survey after COVID-19 pandemic**
3. Survey Design
4. Results: Impact of COVID-19 on the S&T Future
5. Conclusion

Overview of The 11th Delphi survey: Future of Science and Technology

- **702 S&T topics** were set by the subcommittees.
- **Web questionnaires** to collect experts' thoughts on the S&T topics.

- Survey fields
  - i. **Health**, medicine, and life sciences
  - ii. **Agriculture**, forestry, and fishery, food, and biotechnology
  - iii. **Environment**, resources, and energy
  - iv. **ICT**, analytics, and service science
  - v. **Materials**, devices, and processes
  - vi. **Cities**, architecture, civil engineering, and transportation
  - vii. **Space**, ocean, earth, and science foundations

- Questions regarding S&T topics
  - **Importance**
  - **Competitiveness**
  - **Prospects of realization**
  - **Policy-means for realization**
- Questionnaire periods
  - February to June 2019
- Number of respondents
  - **5352**

*The respondents were asked to answer the same questions twice to converge the answers. In the second round, the respondents were asked to give additional thought, shown the results of the first round.

Purpose of this survey

- The 11th Foresight survey
  - The National Institute of Science and Technology Policy conducted the "**11th Science and Technology Foresight (2017-2019)** " and set 702 science and technology topics that are expected to be realized by 2050.
  - As a scenario, "**Society in 2040 by the development of science and technology**" was drawn.

After the 11th survey, COVID-19 pandemic has occurred…

- Purpose
  - A follow-up survey was conducted **to understand the impact of COVID-19 on the future of science and technology**.

Today's topics

1. Background: Foresight history of NISTEP
2. Purpose: Follow-up survey after COVID-19 pandemic
3. Survey Design
4. Results: Impact of COVID-19 on the S&T Future
5. Conclusion

Survey Design: Method (1/2)

- 11th S&T Foresight
  - A web questionnaire (Delphi survey)
    - Survey period: February to June 2019
    - Respondents: 5352 experts
    - Question items:
      - Importance
      - Competitiveness
      - Prospects of realization
      - Policy-means for realization
- Follow-up survey
  - A web questionnaire (one time questionnaire, not Delphi)
    - Survey period: September to October 2020
    - Respondents: 1363 experts(NISTEP expert network)
    - Question items:

      Changes in
      - Importance
      - Prospects of realization

Method (2/2)

11th S&T Foresight

Prospects of realization

Q:The period in which the vision will be scientifically/technologically realized somewhere in the world, not excluding Japan

- already realized
- by 2025,
- 2026 to 2030
- 2031 to 2035
- 2036 to 2040
- 2041 to 2045
- 2046 to 2050
- 2051 or later
- It won't be realized
- I'm not sure

Importance

Q:Present level of the topic's importance for Japan, in order to realize a desirable society 30 years from now

- Very high (+2)
- High (+1)
- Neither (0)
- Low (-1)
- Very low (-2)
- I'm not sure

Follow-up survey

Prospects of realization

Q:*How much will **the realization time change** after COVID-19 pandemic?*

- Very early (more than 5 years)
- Early (3-4 years)
- Slightly early (1-2 years)
- does not change
- Slightly late (1-2 years)
- Be late (3-4 years)
- Very late (more than 5 years)
- I'm not sure

Importance

Q:*Current importance for Japan after COIVD-19 pandemic.*

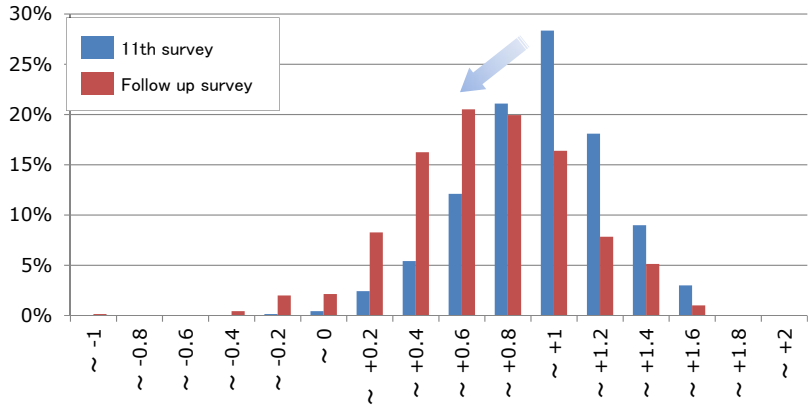
- Very high (+2)
- High (+1)
- Neither (0)
- Low (-1)
- Very low (-2)
- I'm not sure

Today's topics

1. Background: Foresight history of NISTEP
2. Purpose: Follow-up survey after COVID-19 pandemic
3. Survey Design
4. **Results: Impact of COVID-19 on the S&T Future**
5. Conclusion

Importance –over view-

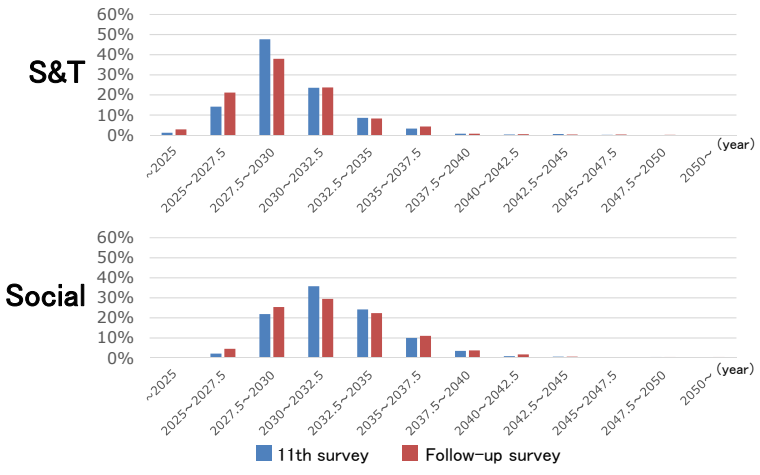
- The distribution ratio of topics in each section is shown.
- Importance index **peaked at 0.4 to 0.8 (high)**.
- Distribution varied compared to the 11th survey.



Importance: Indexed as very high (+2), high (+1), neither (0), low (-1), very low (-2)
Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020

Realization time -over view- (1/3)

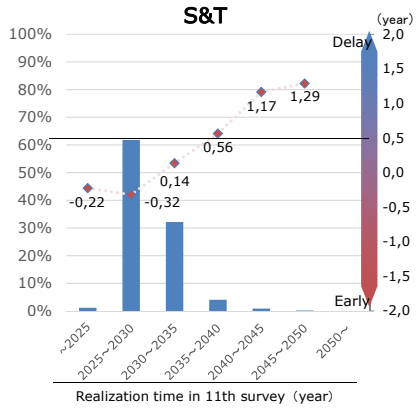
- The distribution ratio of topics in each section is shown.
- Compared to the 11th survey, the percentage of **peaks decreased** overall and the **distribution varied**.

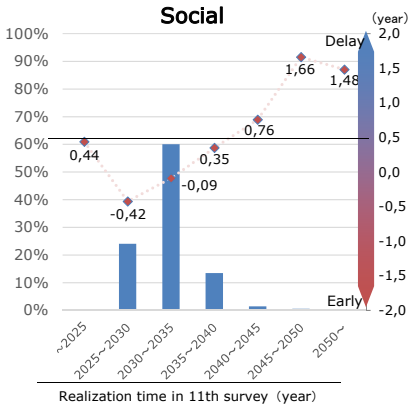


Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020

Realization time -over view- (2/3)

- Comparison of realization time in the 11th survey and delay/early in the follow-up survey
- Science and technology that will be realized soon will be realized sooner, and those that take time are expected to be further delayed.

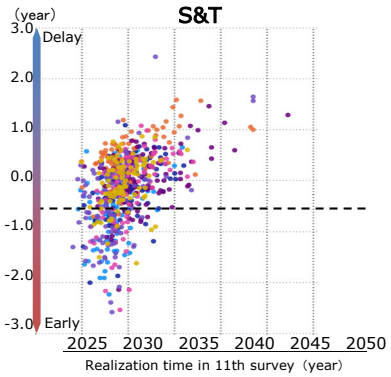


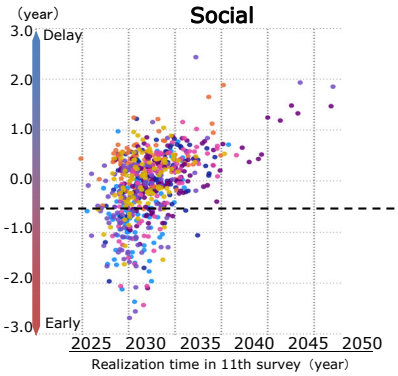


Note 1) Left vertical axis: Percentage of topics included in the section
Right vertical axis: Average of changing years in the topics within the section
Note 2) Right vertical axis: Calculate the number of years as, Very early (more than 5 years), Early (3-4 years), Slightly early (1-2 years),
does not change (0 years), Slightly late (1-2 years), late (3-4 years), Very late (more than 5 years) I'm not sure
Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020

Realization time -over view- (3/3)

- Comparison of realization time in the 11th survey and delay/early in the follow-up survey
- Colored by academic field, each dot represents each topic
- ~~There is no significant difference in trends between fields~~





Calculate the number of years as, Very early (more than 5 years), Early (3-4 years), Slightly early (1-2 years), does not change (0 years), Slightly late (1-2 years), late (3-4 years), Very late (more than 5 years) I'm not sure

Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020

i. Health, medicine, and life sciences
ii. Agriculture, forestry, and fishery, food, and biotechnology
iii. Environment, resources, and energy
iv. ICT, analytics, and service science
v. Materials, devices, and processes
vi. Cities, architecture, civil engineering, and transportation
vii. Space, ocean, earth, and science foundations

Science and technology predicted to be realized sooner
- scientific and technological realization-

- Top 10 topics predicted to accelerate scientific and technological realization after a pandemic
- Predicted to be **1.9 to 2.6 years** earlier
- It can be broadly divided into those related to **work styles (◆ mark)** and those related to **health crisis management (○ mark)**

Field		S&T Topics	11th survey	Follow-up survey
Cities	◆	Advanced and integrated worker productivity monitoring technology to improve the health and comfort office workers, and promote improved work efficiency and reformation of working style	2028	-2.6
Health	○	Ultralight sensors that can be used in the contaminated areas, such as aircrafts, that can quickly detect the infection with specific pathogens, the infectivity to other person, and the susceptibility of uninfected people.	2029	-2.5
Cities	○	Advanced indoor environmental health monitoring and control technology that suppresses indoor "health disorders" and "outbreaks of infectious disease"	2028	-2.4
ICT	◆	Transition to a highly productive society with highly free employment configurations, premised on not requiring to go into the office, and having multiple jobs	2027	-2.2
Health	○	Epidemic prediction and alart system for epidemics of infectious disease by using the comprehensive surveillance system with various medical and web data.	2027	-2.2
Health	○	A system that quantitatively predicts and evaluates the effects of emerging infectious diseases on humans, including the pathogenicity and the potentiaility of causing global epidemics, with comprehensive consideration of factors such as the environment, pathogens, and hosts.	2030	-2.1
Environment	○	A rapid and accurate detection system for minute amounts of pathogenic microorganisms in public and customer facilities as well as transportation facilities such as airports, harbors, railways, etc.	2028	-2.1
Cities	◆	Technology to constantly ascertain and analyze the status of work progress at the construction site using AI, which properly manages and automatically optimizes and modifies processes	2029	-2.1
Material	◆	High-level VR system (conference, manufacturing management) and a supporting high-speed information distribution system	2025	-2.0
ICT	◆	Technology to digitize all cash and make transactions (all cash becomes electronic money and cash disappears, fundamentally changing the mechanism of the money economy)	2027	-1.9

Note 1) Calculate the number of years as, Very early (more than 5 years), Early (3-4 years), Slightly early (1-2 years), does not change (0 years), Slightly late (1-2 years), late (3-4 years), Very late (more than 5 years) I'm not sure

Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020

Health; Health, medicine, and life sciences **Environment;** Environment, resources, and energy
ICT; ICT, analytics, and service science **Materials;** Materials, devices, and processes
Cities; Cities, architecture, civil engineering, and transportation

Science and technology predicted to be delayed
- scientific and technological realization-

- Top 10 topics predicted to delay scientific and technological realization after a pandemic
- Predicted to be **1.2 to 2.4 years** delayed
- It can be broadly divided into those related to **space, sea etc.(□ mark), energy conversion (● mark).**

Field		S&T Topics	11th survey	Follow-up survey
Cities		System technology to facilitate a supersonic passenger aircraft that can compete with existing subsonic aircraft in terms of environmental friendliness, safety and economy, as well as improving convenience by greatly shortening travel time	2032	2.4
Cities	□	Construction technology for 'space architecture' in space and on the surface of the moon and Mars for enlarging the human habitat based on a long-term perspective	2043	1.6
Space	□	Construction of a permanent manned base on an extraterrestrial object (the Moon or Mars), for scientific observation and resource utilization	2035	1.6
Space	□	Gravitational wave interferometer to be deployed in space	2037	1.6
Cities	□	Technology for construction of a "marine city", which utilizes the potential of the ocean, and facilitates a new eco-city and eco-lifestyle on the ocean	2043	1.6
Environment	●	Fast breeder reactor (FBR) system technology, including nuclear fuel cycle and integrated fast reactors (IFR)	2038	1.5
Space	□	Technology to construct a water generation plant utilizing robotics, with the aim of securing a water production and supply base on the lunar surface	2034	1.4
Environment	●	Nuclear fusion power generation	2047	1.3
Space		Novel Lepton Collider technology (muon collider, unprecedented electron and positron colliders including use of plasma acceleration, etc.)	2035	1.3
Space	□	Scientific deep drilling technology for sampling from deep Earth	2029	1.2

Note 1) Calculate the number of years as, Very early (more than 5 years), Early (3-4 years), Slightly early (1-2 years), does not change (0 years), Slightly late (1-2 years), late (3-4 years), Very late (more than 5 years) I'm not sure

Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020

Environment; Environment, resources, and energy
Space; Space, ocean, earth, and science foundations
Cities; Cities, architecture, civil engineering, and transportation

Science and technology predicted to be realized sooner
- Social realization-

- Top 10 topics predicted to accelerate social realization after a pandemic
- Predicted to be **2.0 to 2.7 years** earlier
- It can be broadly divided into those related to **work styles (◆ mark)** and those related to **health crisis management (○ mark)**

Field		S&T Topics	11th survey	Follow-up survey
Cities	◆	Advanced and integrated worker productivity monitoring technology to improve the health and comfort office workers, and promote improved work efficiency and reformation of working style	2030	-2.7
Cities	○	Advanced indoor environmental health monitoring and control technology that suppresses indoor "health disorders" and "outbreaks of infectious disease"	2030	-2.6
Health	○	Ultralight sensors that can be used in the contaminated areas, such as aircrafts, that can quickly detect the infection with specific pathogens, the infectivity to other person, and the susceptibility of uninfected people.	2031	-2.4
ICT	◆	Transition to a highly productive society with highly free employment configurations, premised on not	2030	-2.4
ICT	◆	Achievement of unmanned factories, unmanned shops, unmanned logistics warehouses, unmanned home deliveries by extensive spread of work robots to the three-product (food, cosmetics and pharmaceuticals) industry, service industry and logistics industry	2029	-2.1
Environment	○	A rapid and accurate detection system for minute amounts of pathogenic microorganisms in public and customer facilities as well as transportation facilities such as airports, harbors, railways, etc.	2032	-2.1
Cities	◆	Technology to constantly ascertain and analyze the status of work progress at the construction site using AI, which properly manages and automatically optimizes and modifies processes	2030	-2.1
Health	○	Epidemic prediction and alart system for epidemics of infectious disease by using the comprehensive surveillance system with various medical and web data.	2029	-2.1
Health	○	A system that quantitatively predicts and evaluates the effects of emerging infectious diseases on humans, including the pathogenicity and the potentiality of causing global epidemics, with comprehensive consideration of factors such as the environment, pathogens, and hosts.	2031	-2.1
Material	◆	High-level VR system (conference, manufacturing management) and a supporting high-speed information distribution system	2027	-2.0

Note 1) Calculate the number of years as, Very early (more than 5 years), Early (3-4 years), Slightly early (1-2 years), does not change (0 years), Slightly late (1-2 years), late (3-4 years), Very late (more than 5 years) I'm not sure
Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020
Health; Health, medicine, and life sciences **Environment;** Environment, resources, and energy
ICT; ICT, analytics, and service science **Materials;** Materials, devices, and processes
Cities; Cities, architecture, civil engineering, and transportation

Science and technology predicted to be delayed
- Social realization-

- Top 10 topics predicted to delay social realization after a pandemic
- Predicted to be **1.2 to 2.5 years** delayed
- It can be broadly divided into those related to **space, deep sea etc.(□ mark), energy conversion (● mark).**

Field		S&T Topics	11th survey	Follow-up survey
Cities		System technology to facilitate a supersonic passenger aircraft that can compete with existing subsonic aircraft in terms of environmental friendliness, safety and economy, as well as improving convenience by greatly shortening travel time	2037	2.4
Cities	□	Technology for construction of a "marine city", which utilizes the potential of the ocean, and facilitates a new eco-city and eco-lifestyle on the ocean	2048	1.9
Space	□	Construction of a permanent manned base on an extraterrestrial object (the Moon or Mars), for scientific observation and resource utilization	2040	1.9
Space	□	Construction technology for 'space architecture' in space and on the surface of the moon and Mars for enlarging the human habitat based on a long-term perspective	2051～	1.9
Cities	□	Technology to construct a water generation plant utilizing robotics, with the aim of securing a water production and supply base on the lunar surface	2038	1.7
Environment	●	Fast breeder reactor (FBR) system technology, including nuclear fuel cycle and integrated fast reactors (IFR)	2047	1.5
Environment	●	Nuclear fusion power generation	2051～	1.5
Environment	□	Space solar power generation system (a system that generates electricity using sunlight in space and transmits the power to the earth)	2048	1.3
Space	●	Next-generation light water reactor technology with features such as being able to use enriched fuel exceeding 5%, plant life of 80 years, and no requirements for the selection of site conditions	2045	1.2
Space	□	Scientific deep drilling technology for sampling from deep Earth	2030	1.2

Note 1) Calculate the number of years as, Very early (more than 5 years), Early (3-4 years), Slightly early (1-2 years), does not change (0 years), Slightly late (1-2 years), late (3-4 years), Very late (more than 5 years) I'm not sure
Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020
Environment; Environment, resources, and energy
Space; Space, ocean, earth, and science foundations
Cities; Cities, architecture, civil engineering, and transportation

Top 10 science and technology with high importance index

- Top 10 **most important topics** in follow-up survey
- Importance index ranges from **1.37 to 1.57**
- Not only work styles (◆ mark) and health crisis management (○ mark), but also those related to **disasters and security, which were important before the pandemic are included.**

Field		S&T Topics	11th survey	Follow-up survey	difference
Material	○	A wearable device that monitors in vivo information (pharmacokinetics, cancer markers, infection, other blood components)	1.32	1.57	0.25
ICT	◆	Transition to a highly productive society with highly free employment configurations, premised on not requiring to go into the office, and having multiple jobs	1.27	1.56	0.29
ICT		Technology that utilizes sensitive personal data without leaking privacy information to facilitate secure electronic voting and sharing of electronic medical charts while protecting personal data (including standardization of safety level)	1.39	1.50	0.11
Cities		System that ascertains damage in real-time and conducts expansion prediction during large-scale	1.48	1.45	-0.02
ICT	◆	Achievement of unmanned factories, unmanned shops, unmanned logistics warehouses, unmanned home deliveries by extensive spread of work robots to the three-product (food, cosmetics and pharmaceuticals) industry, service industry and logistics industry	1.24	1.45	0.22
Health	○	Ultralight sensors that can be used in the contaminated areas, such as aircrafts, that can quickly detect the infection with specific pathogens, the infectivity to other person, and the susceptibility of uninfected people.	1.00	1.44	0.44
Health		Ultradispersed hospital system (regional network of home, clinic, and hub hospital) that enables treatment and care of dementia etc. remotely	1.36	1.43	0.07
ICT		Technology to prevent unauthorized access into control systems such as important infrastructure, vehicle control and personal IoT devices/ services (technology to reduce the probability of fraudulent communication to an almost negligible level)	1.56	1.39	-0.17
Environment	○	A rapid and accurate detection system for minute amounts of pathogenic microorganisms in public and customer facilities as well as transportation facilities such as airports, harbors, railways, etc.	0.61	1.37	0.76
Cities		Disaster evacuation navigation system using multilingual/ nonverbal communication with the use of personal mobile terminals	1.20	1.37	0.17

Importance: Indexed as very high (+2), high (+1), neither (0), low (-1), very low (-2)
Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020
Health; Health, medicine, and life sciences **Environment;** Environment, resources, and energy, **Cities;** Cities, architecture, civil engineering, and transportation **ICT;** ICT, analytics, and service science **Materials;** Materials, devices, and processes

Top 10 science and technology with importance index increased

- Top 10 topics of increasing importance
- The range of increase is 0.32 to 0.76
- It is divided into those related to **work style and life (◆ mark)** and those related to **health crisis management (○ mark).**

Field		S&T Topics	11th survey	Follow-up survey	difference
Environment	○	A rapid and accurate detection system for minute amounts of pathogenic microorganisms in public and customer facilities as well as transportation facilities such as airports, harbors, railways, etc.	0.61	1.37	0.76
Cities	○	Advanced indoor environmental health monitoring and control technology that suppresses indoor "health disorders" and "outbreaks of infectious disease"	0.76	1.28	0.51
Health	○	Ultralight sensors that can be used in the contaminated areas, such as aircrafts, that can quickly detect the infection with specific pathogens, the infectivity to other person, and the susceptibility of uninfected people.	1.00	1.44	0.44
Health	○	A system that quantitatively predicts and evaluates the effects of emerging infectious diseases on humans, including the pathogenicity and the potentiality of causing global epidemics, with comprehensive consideration of factors such as the environment, pathogens, and hosts.	0.89	1.32	0.43
Health	○	Epidemic prediction and alart system for epidemics of infectious disease by using the comprehensive surveillance system with various medical and web data.	0.85	1.25	0.40
Material	◆	High-level VR system (conference, manufacturing management) and a supporting high-speed information distribution system	0.82	1.20	0.38
Agriculture	○	Technology to eliminate zoonotic pathogens and other such agents from animal bodies that are harmful to human health	0.97	1.31	0.35
Cities	◆	Advanced and integrated worker productivity monitoring technology to improve the health and comfort office workers, and promote improved work efficiency and reformation of working style	0.71	1.05	0.34
Cities		Technology to monitor, predict and control infrastructure with seamless coupling of physical and cyber space	0.96	1.29	0.32
ICT	◆	Development and dissemination of life-sized personal robots and telepresence robots able to facilitate shopping and meeting with other people on behalf of a person	0.50	0.82	0.32

Survey period) 11th survey: February-June 2019 Follow-up survey: September-October 2020
Importance: Indexed as very high (+2), high (+1), neither (0), low (-1), very low (-2)
Health; Health, medicine, and life sciences **Environment;** Environment, resources, and energy
ICT; ICT, analytics, and service science **Materials;** Materials, devices, and processes, **Agriculture;** Agriculture, forestry, and fishery, food, and biotechnology

Conclusion

Key findings

- Science and technology that will be realized soon will be realized sooner, and those that take time are expected to be further delayed.
- The difference was about 1 to 2.5 years, whether it was realized earlier or later.
- For example, science and technology that were predicted to be realized sooner were related to work styles and health crisis management.
- For example, science and technology that were predicted to be realized delayed were related space, deep sea, energy conversion.

NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY POLICY

Thank you for your attention

Fore more information, please visit

www.niste.go.jp/en

STFC Science and Technology Foresight Center