Overview of 2016 White Paper on Information and Communications in Japan

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1. Introduction

The Ministry of Internal Affairs and Communications published the "2016 White Paper on Information and Communications in Japan" on July 29, 2016.

The special theme of this year's White Paper is "IoT, Big Data, and AI: New Values Created by Networks and Data," which details the current status of IoT, big data, artificial intelligence (AI), and other new information and communications technologies (ICT), and outlines the prospects these technologies have for changing the overall socio-economic structure of society.

Chapter 1, " ICT-based Innovation and Economic Growth," deals with the contribution paths of IoT, big data, AI, and other new ICTs to economic growth, and quantitatively examines the potential effects ICTs have on supply and demand side economic growth while varying examples, corporate status, etc. associated with the various paths. Non-monetary values (consumer surplus) brought about by ICT will also be examined. Chapter 2, "Analysis of ICT Industrial Trends in the IoT Era," examines the ICT industry which is expected to contribute to economic growth, and quantitatively assesses the scale and growth potential of ICT device and service markets and competitive environment while sorting out the overall structure of the ICT industry based on development of the IoT. Chapter 3, "New Products and Services in the IoT Era," will take up fintech, the sharing economy, and other new ICT devices and services, and analyze the current status and issues affecting these services by comparing awareness, utilization intension, and other factors based on the results of an international consumer questionnaire. This chapter will also introduce cutting-edge examples of ICT utilization in healthcare, education, and other public sectors, and during the recent Kumamoto earthquakes. Finally, Chapter 4, "ICT Progress and Future Work Styles," will examine the impact ICT has had on employment and work styles and discuss the rapid advances that have been made in AI technology. Then while comparing these conditions and the results of a Japan-U.S. workers questionnaire, we will consider the direction of education and human resources development that is required for changing skills in the years ahead.

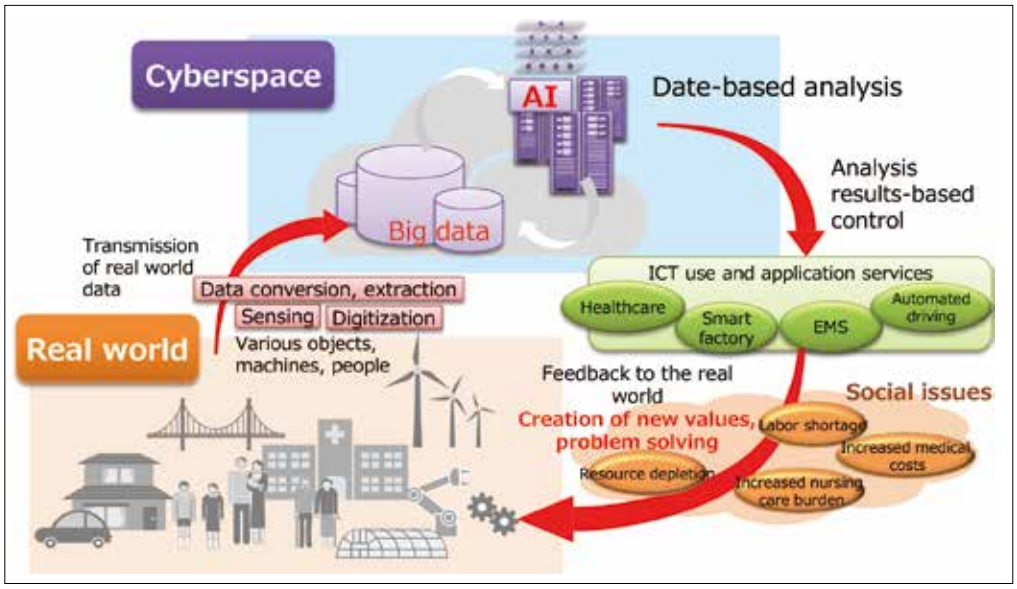
2. ICT-based innovation and economic growth

(1) ICT potential for solving issues facing Japan, such as the declining birth rate and aging population

Due to the aging of Japan's population amid extremely low birth rates, the working-age population started to decline in 1995, and Japan's total population peaked and started to decline in 2008. According to census figures compiled by the Ministry of Internal Affairs and Communications (MIC), Japan's total population in 2015 (excluding cases where age is not reported) was 125.2 million, and the working-age population (ages 15-64) was 75.92 million. The cohort of children aged 14 years and younger has continued to decline since 1982, which only highlights the relentlessly falling birthrates in Japan.

Japan's declining birthrate and aging population coupled with overall declining population will have an adverse effect on both supply and demand sides of Japan's economy, and could impede Japan's prospects for mid-to-long-term economic growth. Yet collecting (IoT) and accumulating (big data) and processing and analyzing (AI) a variety of data will enable us to better grasp current conditions, make predictions and forecasts, and manage equipment and services. This will contribute to economic growth, and should help create new value and solve issues (see Figure 1).

Figure1: New values created by IoT, big data, and AI



(2) ICT contribution to economic growth: specific paths and case example analysis

In light of nation's demographic circumstances, how might ICT contribute to Japan's economic growth? Here we analyzed four basic strategies—two addressing the supply side and two addressing the demand side of the economy—which were then subdivided into eight specific paths to bolster the economy over the next few years until around 2020 (See Figure 2).

The first strategy is to *improve productivity*, which is critically important in societies with decreasing populations. The White Paper underscores the significance of ICT for enhancing the productivity of companies, and here two specific paths contributing to the economy are discussed: *investment related to ICT* and *utilization of ICT*.

The second strategy is to *expand labor force participation and improve quality of labor*, and covers a range of initiatives including telework, exploiting ICT to replace labor, and employing human resources skilled in ICT.

Figure2: ICT paths contributing to the economy

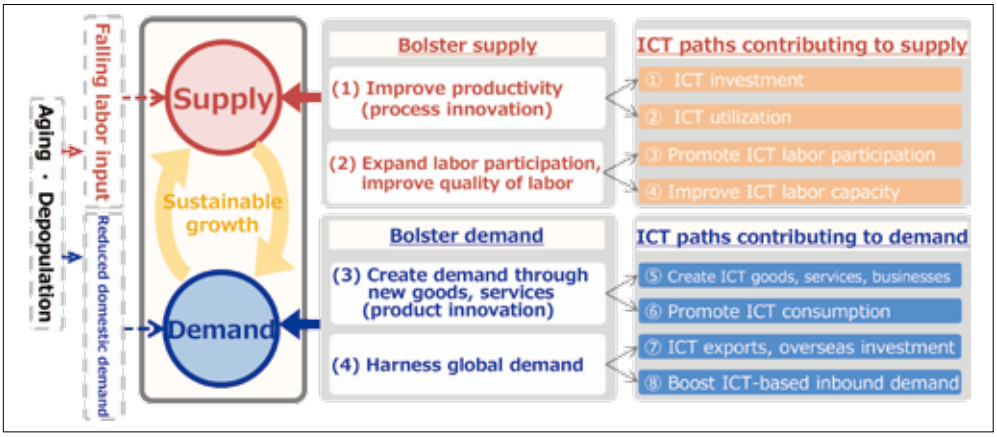
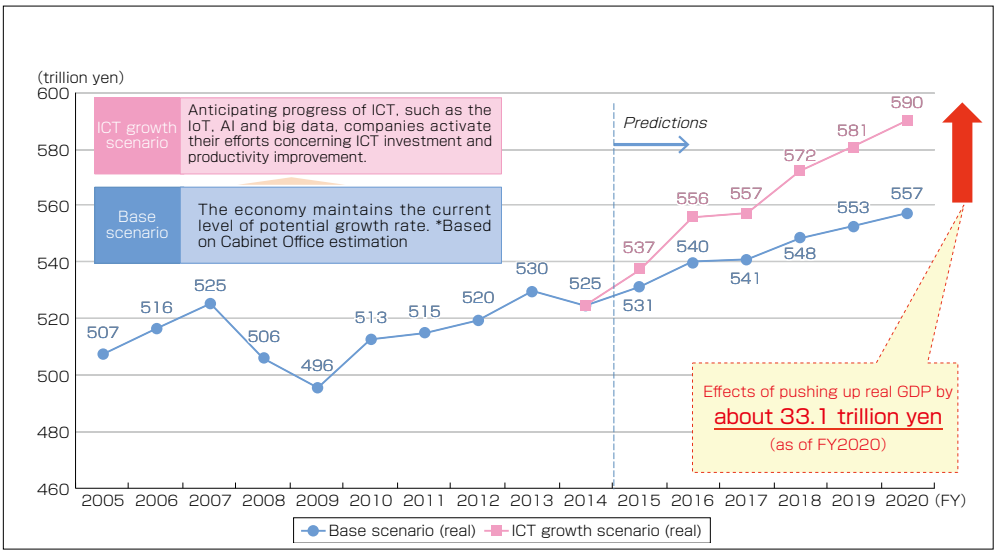


Figure3: Impact of ICT growth on real GDP



In addition to supply side capacity, sustained economic growth also must be supported by robust demand. Therefore, the third strategy is to harness ICT to *create demand for new products and services* featuring examples such as smartphones, telematics insurance, network shopping mixed with various types of statistics and estimates.

And finally, the fourth strategy is to *harness global demand*, which is further broken down into *exports and foreign investment and boosting inbound demand*.

(3) ICT contribution to economic growth: quantitative and comprehensive verification

Estimates of how much real GDP might be increased by investments in IoT, big data, AI, and other ICTs arrived at a figure of ¥33.1 trillion by the year 2020. Broken out by factor, the total factor productivity* contribution should increase, and ICT is expected to boost the total factor productivity contribution (see Figure 3).

(4) Multifaceted ICT contribution to the economy and society

ICT has also helped create considerable non-monetary values that is not captured by existing statistics. The White Paper covers three categories of non-monetary values—*consumer surplus, time saving, and information assets (word of mouth, reviews, etc.)*—and provide examples and quantitative estimates of each category. The paper also estimates the likely future impact of these types of non-monetary values on society.

3. Analysis of ICT industrial trends in the IoT era

(1) ICT industry structural reorganization brought about by IoT

In light of recent advances in Internet and sensor technologies, we are now beginning to see all kinds of devices, facilities, and other things interconnected to the Internet including home appliances, vehicles, buildings, factories, and much more. We can expect to see a vast increase in the number and variety of interconnected devices with the full arrival of the *Internet of Things* (IoT) era. According to projections by IHS Technology, close to 15.4 billion things (*i.e.*, IoT devices) were already connected to the Internet in 2015, and this number is expected to double to approximately 30.4 billion things by the year 2020.

How will this enormous increase in number of things and

* Factors other than production factors (labor, capital) that contribute to increasing added value. Specifically, it includes technology progress, improvement of workers' skills, and improvement in business management efficiency or organizational management efficiency.

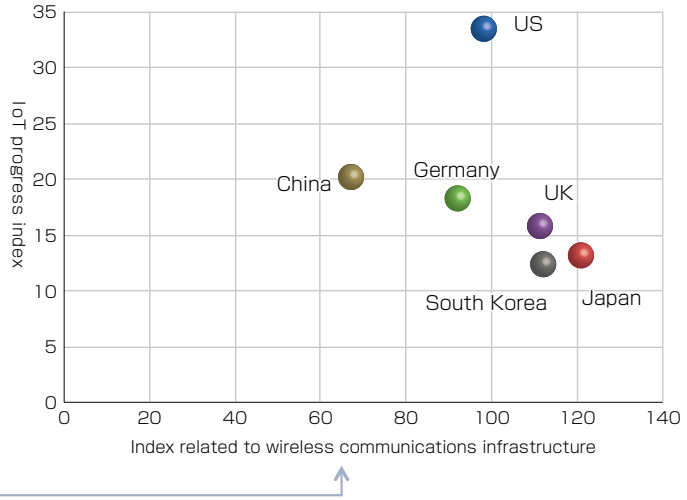
Figure4: International Comparison of IoT Progress

IoT progress index (based on a questionnaire survey of companies)	Weight
Process	
Rate of introducing IoT solutions	0.25
Amount of IoT-related capital investment by companies that have introduced IoT solutions (percentage of total sales)※	0.25
Product	
Rate of providing IoT goods/services	0.25
Amount of sales of IoT goods /services by companies that provide IoT goods/services (percentage of total sales)	0.25

※ Rather than the production cost reduction rate, we used amount of capital investment to align percentage of total sales.

Index related to wireless communications infrastructure (ITU*)	Weight
Mobile-cellular telephone subscriptions per 100 inhabitants	0.5
Active mobile-broadband subscriptions per 100 inhabitants	0.5

*Source: "ICT Development Index," ITC.

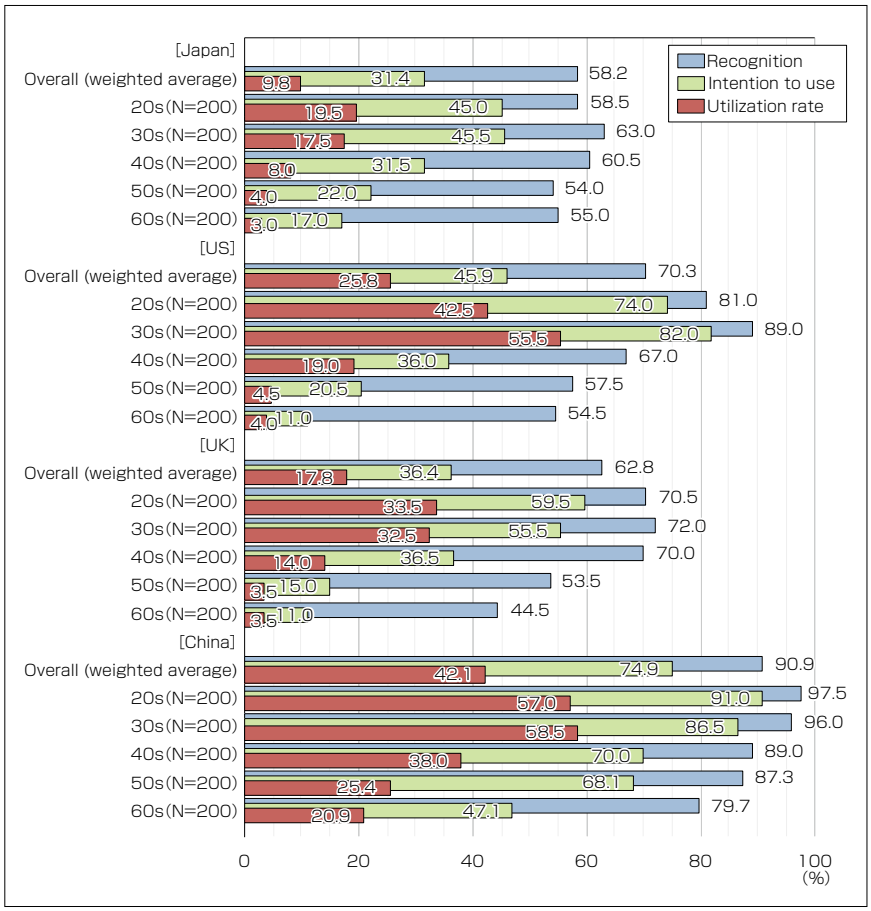


volume of data connected over the Internet change the structure of the current ICT industry and market?

First, we can expect new markets will emerge even as the existing ICT industry and market continue to expand and develop. Exploiting value added from big data collected by myriad devices, new markets will spring up providing all kinds of new services and applications. Breakthroughs in AI technology also have great promise for analyzing and applying big data derived from IoT, and this too will accelerate the emergence of IoT markets. Second, we can also anticipate competition to heat up among new value-added services and businesses made possible by the availability of big data. Rivalry will not just be among the traditional ICT players, but among new entrants from wholly different businesses and sectors who have found new ways to leverage ICT.

We thus envision an ecosystem taking shape in the form of a new ICT industry as existing ICT infrastructure and new ICT trends based on IoT, big data, and AI interact and affect each other.

Figure5: Recognition, intention to use, and utilization rate of asset management services



(2) Quantitative verification of the market size, etc.

If we classify the ICT industry in the IoT era into four hierarchical layers—*content and applications, platform, network, and devices and components*—it's apparent that the lower two layers (*network* and *devices and components*) have already achieved substantial global penetration. So, although the size of the mobile market is substantial, we should not expect rapid growth of individual-oriented devices like smartphones since the *devices and components* layer of the industry is down.

But now turning to the upper two layers of the industry—*content and applications* and *platform*—the market size for these areas is much smaller than the *network* and *devices and components* described in the previous paragraph, but the growth potential or growth rate is very high. This suggests that, for adding value to the ICT industry in the years ahead,

we should expect to see a shift to upper layers of the ICT industry.

(3) International IoT progress

Based on findings from an international company questionnaire, we first defined two indices—an index of national IoT progress and an index relating to the development of wireless communications infrastructure that serves as a key environmental factor in IoT progress—then assessed the performance of six nations (Japan, the U.S., the U.K., Germany, Korea, and China) based on these indices. We found that a relatively small percentage of companies identified Japan as having infrastructure-related issues that might affect IoT progress compared to other countries, and statistics also revealed that Japan's IoT progress index was low compared to the country's infrastructure development status. This shows that Japan needs better training of human resources, exposure of user companies to IoT use cases, and explicit measures promoting use of IoT (see Figure 4).

4. New products and services in the IoT era

(1) New services in the IoT era

Among new services symbolizing the arrival of the IoT era are fintech and the sharing economy. A user questionnaire was conducted in six countries (Japan, the U.S., the U.K., Germany, Korea, and China) to assess awareness, intention to use, and utilization rate of these new services, and Japan generally scored lower than the other countries (see Figure 5). While new ICT-inspired products and services should contribute to economic growth by creating additional demand, it is apparent that Japanese consumers are currently little aware of these developments and need more information and assurances to relieve anxieties about new technology.

(2) Smartphone penetration and ICT use and application

It is generally assumed that smartphones, other ICT terminals, and social media will provide the foundation for the adoption and spread of the new services mentioned in Section (1) above. Yet survey results among the six countries mentioned earlier revealed that smartphone usage in Japan at 60% was relatively lower than the other countries. Broken out by age, it was found that while 87% of young people in their 20s use smartphones, a far smaller percentage older people above age 50 use smartphones. This cohort is much more inclined to use feature phones.

(3) ICT use and application in the public sector

ICT can help solve societal problems, and the White Paper describes several examples from the public sector, including extensive reliance on ICT during the Kumamoto earthquakes in April 2016.

5. ICT progress and future work styles

(1) ICT progress and employment, working styles

Development of ICT will affect the job market in two ways: it will have an employment substitution effect in which ICT takes the place of jobs that are currently done by people, and it will have a job creation effect by increasing added value and creating new businesses.

First, regarding the way ICT takes the place of current jobs, a preceding study has revealed that ICT can substitute for some routine types of work (*e.g.*, accounting, manufacturing) but not very well for non-routine types of work (*e.g.*, research, sales) and manual jobs. However, we should note that recent advances in AI and robotics is reinforcing the view that machines may take over some non-routine intellectual work and complex manual jobs in the not-too-distant future.

Advances in ICT are also having a major impact on the way people work. Going beyond telework that allows people to work from home or anywhere without commuting into a central place of work, the sharing economy and digital fabrication have become widespread, which give individuals who are not affiliated with larger organizations more opportunities for on-demand type work. These new work arrangements allow people to choose more flexible employment that is better suited to their own circumstances, and should help restore the work-life balance in people's lives.

Figure6: Appeal of new ways of working (Japan and US)

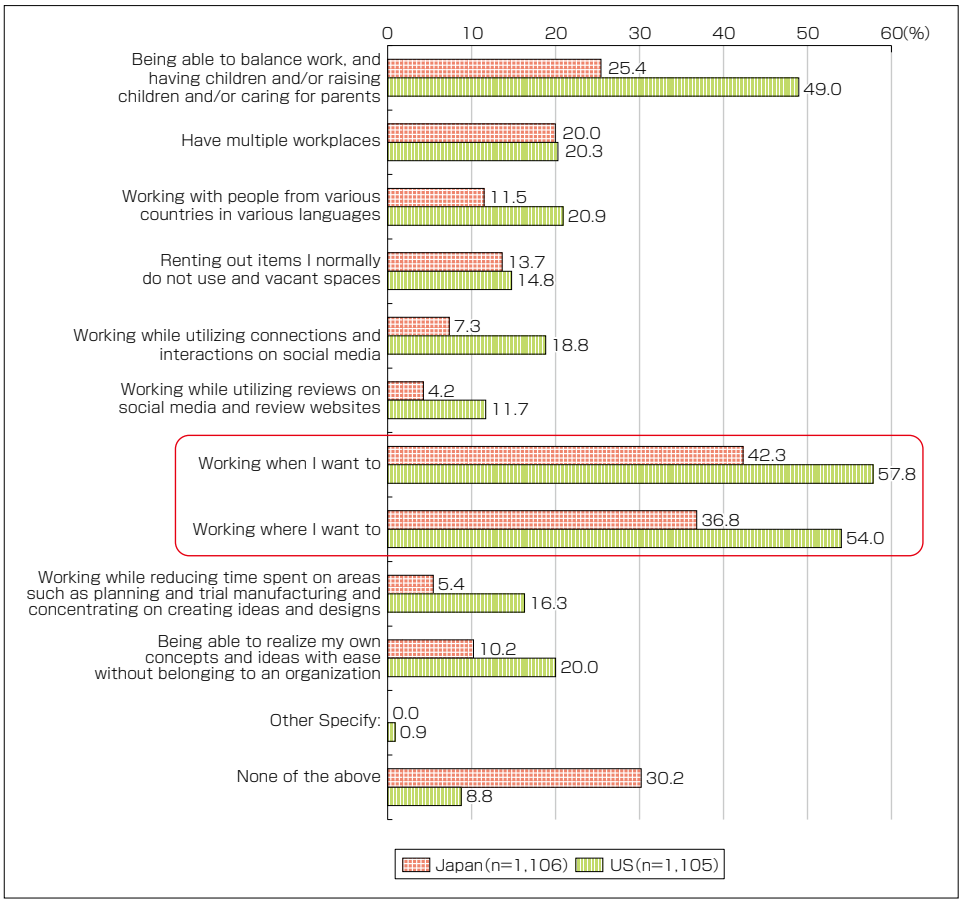
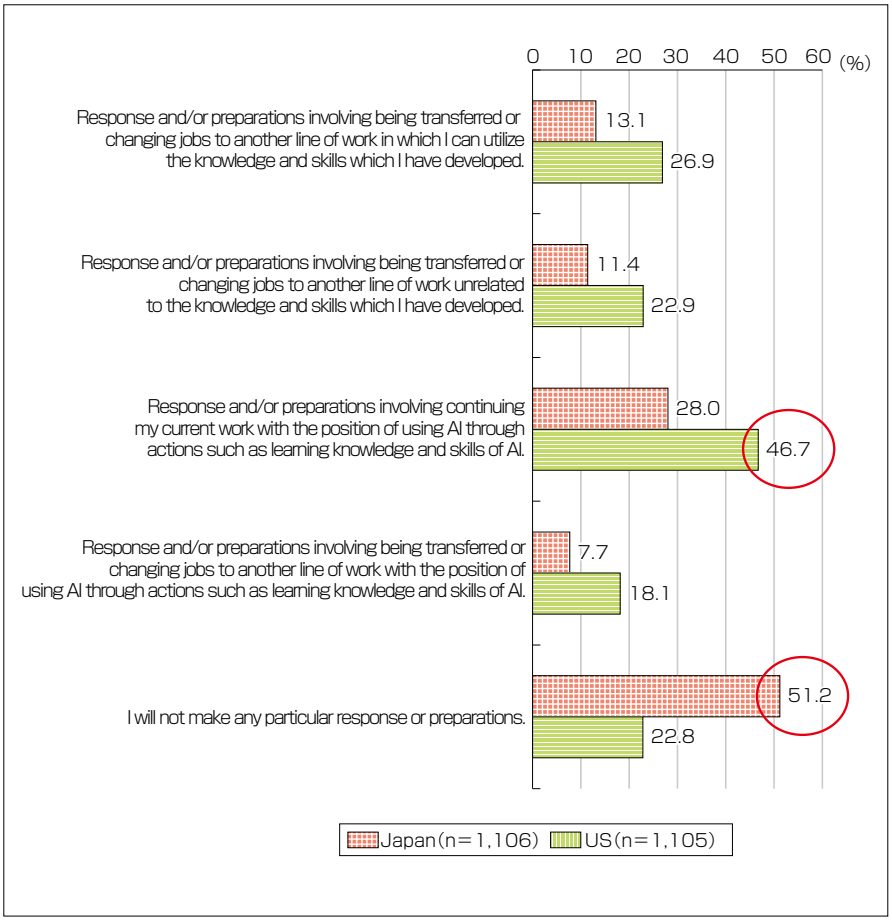


Figure7: Future response and/or preparations for penetration of AI



However, we polled Japanese and American workers regarding the appeal of these new work arrangements—telework, sharing economy, digital fabrication, and so on—and found that the Japanese were much less interested than their American counterparts. This led us to surmise that workers in Japan are less interested in pursuing alternative patterns or modes of working (see Figure 6).

(2) Present and future of artificial intelligence (AI)

Artificial intelligence (AI) is a relatively new phenomenon, for the term was first coined by John McCarthy, a computer scientist at an international conference at Dartmouth College in 1956. Generally, the term AI is applied to "science and technology concerned with machines or computer programs that perform tasks that normally require human intelligence," but among academics there is some variation in the definition. This might be attributed to the fact that "there is no commonly accepted definition of *intelligence or mental capacity* to begin with," so this makes it rather difficult to define AI.

Deep learning-based AI will open up a wider range of application areas by improving identification and prediction accuracy, and by merging different technologies this should provide sufficient functionality for practical use.

(3) Influence of AI progress on employment, etc.

There is general consensus that as AI becomes increasingly widespread, it will have the following effects on employment: it is generally thought that AI generates operational efficiencies, improve productivity, create new modes of work and new businesses, and fundamentally alter the volume of tasks that is the basis of employment.

We would expect that the volume of tasks associated with occupations introduced by AI will decrease as a result of improved efficiency and productivity of AI. But at the same time, AI has new work and employment effects, and we can anticipate an increase in the volume of tasks associated with new jobs associated with the deployment and spread of AI and new jobs used by AI that will be created. The ideal would be a society in which the volume of newly created tasks exceeds the volume of tasks that is lost, and clearly the creation of new jobs and businesses is a highly significant role of AI in the years ahead.

(4) Changes in the required skills and the types of human resources and education sought

There are various steps involved in exploiting AI, so we can expect that a wide range of human resources and capabilities will be needed when AI becomes commonplace and widely used.

What do Japanese and American workers think about how they respond and prepare for the future when AI becomes pervasive?

We found that many U.S. workers were fully committed to "acquire AI knowhow and skills so they would be well positioned to use AI to continue doing their jobs and work," and believed it was important to look ahead and prepare to exploit AI in their jobs and work of the future. Among the Japanese workers, we found that more than half the respondents said they "didn't plan to do anything special to respond or prepare for the advent of AI," yet were concerned that others might step up and exploit AI as it becomes widely disseminated (see Figure 7).

There can be little doubt that AI will become widely disseminated in our lives and in our work in the not-too-distant future. It is thus apparent that any nation that ignores AI does so at its peril, for ignoring AI will certainly have a detrimental effect on employment. A proactive stance is required to take full advantage of AI. This involves correct understanding of AI, training of professional resources who can engage in practical use of AI, more managers who can make sound decisions regarding deployment and use of AI, strong motivation and independence to achieve things by exploiting AI, creativity to develop novel new ways of incorporating AI in our daily lives and work, and so on. With a keen awareness of the issues at stake, we have witnessed a very rapid rollout of initiatives by the government and some forward-looking companies, and we can step up government-private cooperation in the future.