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Digitization, Computerization, Networking, Automation, and the Future of Jobs in Japan

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Abstract

In the seminal study, Frey & Osborne reported that 47% of the total employment in the United States is at risk of computerization. Many studies estimate how automation of work influences employment. In Japan, however, there are few studies which investigate the effect of automation and networking on future employment. It is important to discuss this based on facts and evidence.

This paper describes the present situation in Japan on the impact of artificial intelligence (AI) on employment, utilizing a survey study. We first visited Japanese companies and conducted a field survey on the new technologies being introduced. Following this, in August 2017, we conducted a survey study of about 10,000 companies. This paper discusses the output of the survey study.

Keywords: AI, Frey & Osborne, Germany arbeiten4.0, Industrie4.0, Fourth industrial revolution
JEL classification: J00, M10, M11, M12, O30

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1 Introduction

In September 2013, Frey and Osborne [2013], Oxford University, announced that according to their estimation, there was more than 70% risk that 47% of the working population in the US would be replaced by machines within 10 to 20 years. As an announcement of their study, a research boom on "the future of employment" has occurred all over the world. Although the Japanese academia has remained largely unconcerned about such research, the mass media has taken up the figure of 47% and fueled people's anxiety. Is the figure of 47% true? This question motivated us to begin to start addressing this issue. We believe that scientific and calm arguments based on facts are necessary.

In Section 2, we analyze the influence of artificial intelligence (AI), among others, on employment in Japan. To analyze the effect of AI and digital technology innovation on Japanese employment, we visited some Japanese companies and investigated the way that new technology is being introduced in the context of Japanese employment. Next, in August 2017, we conducted a survey questionnaire of around 10,000 companies to grasp the actual situation of the broader Japanese industry. We present the detailed trends and actual situations of the Japanese companies derived based on the questionnaire survey responses. In Section 3, we propose the policy considerations and measures based on the survey research.

We would like to express our thanks to Dr. Aya Hatano (Kochi University of Technology).

2 Actual situation of Japan

2.1 Large manufacturing companies visited

In this section, we share the trends we identified at large Japanese manufacturing companies. Since employment practices, systems, and policies, among others, differ widely from country to country, we expect that the employment environment in Japan corresponding to the introduction of new technology will be different from Germany and the US. To assess this, we visited and interviewed these companies repeatedly. In Japan, since there are only a few large manufacturing companies that have fully introduced new technologies and seen results, we visited each to investigate the actual situation of Japanese companies.

Our survey results reveal the following. The shortage of skilled workers, caused by the population decline, declining birthrate, and the aging population, has been filled by machines. In addition, since the advent of small lot, multi-product production adds to worker burdens, to "empower" workers, new technology has been introduced. As such, workers welcome these new technologies. In the 1990s, Japanese companies made huge investments in mechanization, automation, and labor saving in the factories. Today, many Japanese companies tend to assign work suitable for machines (human) to machines (human). This tendency is called "harmony of man and machine." One company executive emphasized that the company's system concepts were developed based on human activities. Another company executive stated that, "The number of skilled workers has been decreasing rapidly. It is not a matter of whether the investment can be recovered. There is nothing else we can do." This captures the idea that skilled workers are the source of corporate competitiveness. This can be said to be the "Japanese style."

2.2 Analysis of Japanese companies' situations using the survey questionnaire

In order to understand the trend of the entire Japanese industry, the Research Institute of Economy, Trade and Industry (RIETI) conducted a questionnaire survey of around 10,000 companies from August to October 2017. Among these, there were 213 companies that responded to questions on employment changes due to the introduction of new technology.

(1) Outline

The survey questionnaire conducted by RIETI from August to October 2017 was to comprehend the trend of the Internet of things (IoT) in Japanese industries among around 10,000 Japanese companies. The survey items included questions on "impact on employment" and "human resource development."

Survey summary;

Implementation period from August to October 2017
Targeted Japanese companies 10,075
Responses 1372 companies (response rate 13.62%)
By industry:
Manufacturing industry companies 477
Financial and insurance companies 27
Information and communications business companies 103
Construction industry companies 128
Transportation/Postal service companies 49
Wholesale and retail industry companies 196
Other service industry companies 392.

(2) Responses regarding having too many employees

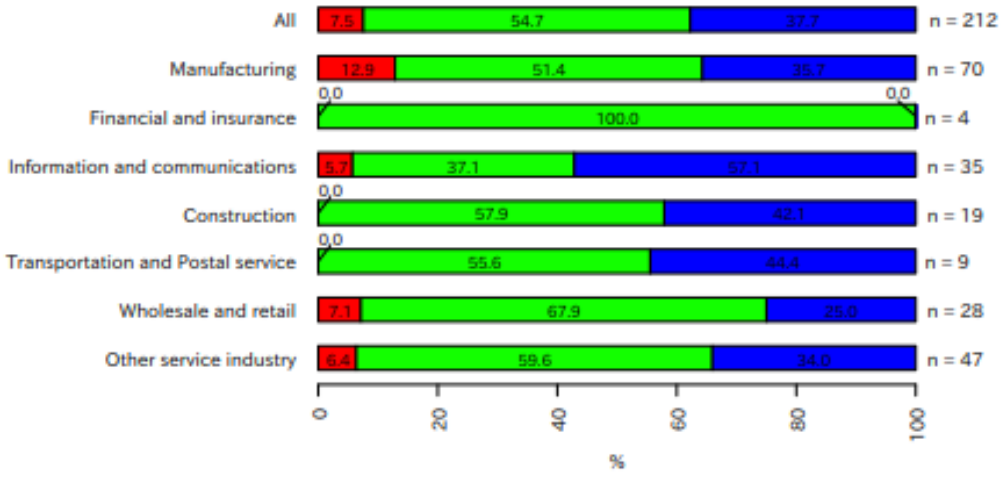
According to these companies, the reduction of employees as a result of IoT implementation in the context of over-employment is different from the reduction of employees when companies face a shortage of employees.

In regards to the question about whether the number of current employees was appropriate, nearly 50% answered appropriate, about 40% answered insufficient, and about 7 to 8% answered excessive. Specifically, the ratio of companies that answered sufficient was higher in the manufacturing industry than in other industries.

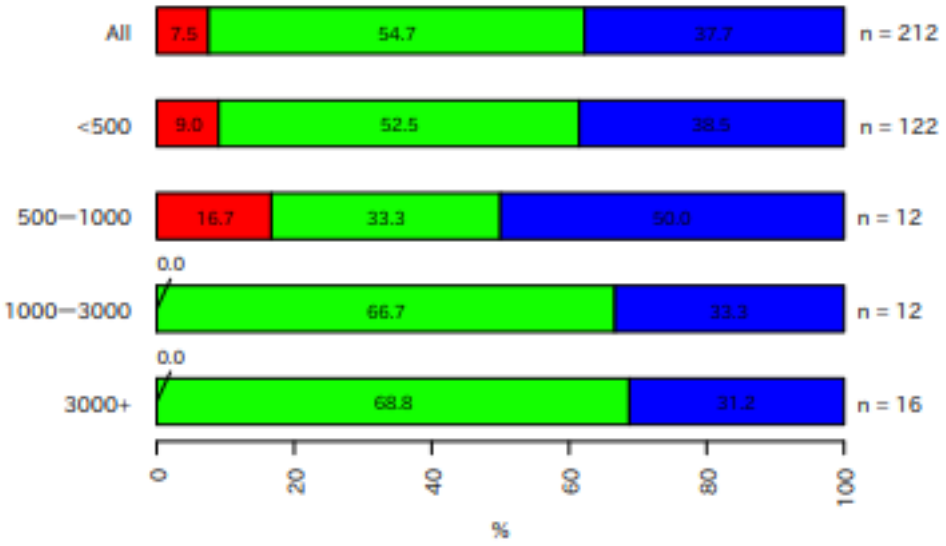
Q25 Which of the following applies to the number of employees in your company?(Industry)

1. Excessive
2. Appropriate
3. Insufficient

"n = num" is the number of the companies which respond to this question



According to the company numbers in Figure 1, the ratio of companies that answered they have a sufficient number of employees was higher among companies that have less than 1000 employees. On the other hand, this ratio was lower among companies with more than 1000 employees.



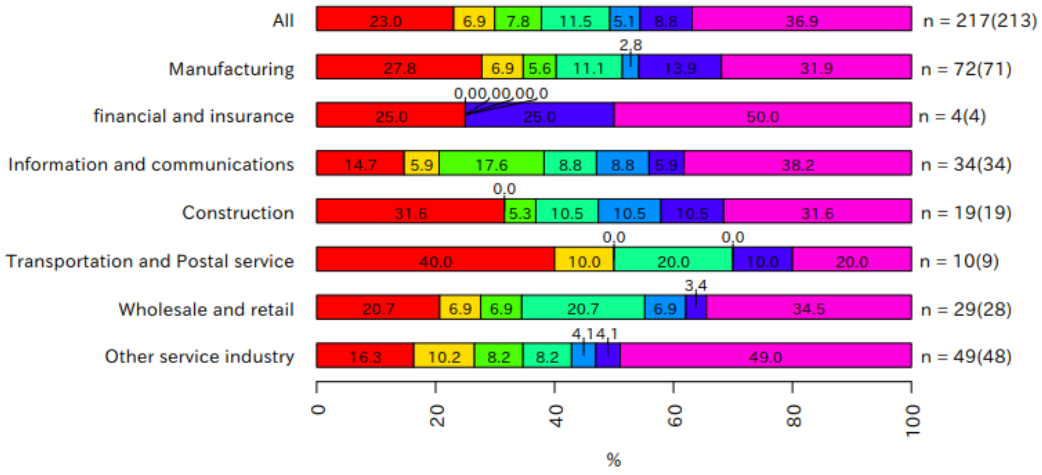
(3) Changes in employment due to new technology introduction

The responses indicated there was an "increase" as well as a "decrease" in employment among the companies due to technology introduction. The following Option 1 is a case where employment decreased due to the introduction of new technology. Options 2 and 3 are cases where employment increased due to the introduction of new technology and are cases where the work volume increased (Option 2) and where the business expanded (Option 3). Option 4 is the case where the number of employees should have increased but where the company suppressed the increase in employees. Option 1, where the number of employees decreased, occurred in the following industries in response order: transportation, postal, construction, and manufacturing. Options 2 and 3, where the number of employees increased, occurred at companies in the following industries: transportation, mailing, and information, and telecommunications. In the finance and insurance industry, there were no companies that increased employment as they all continue to reduce employment.

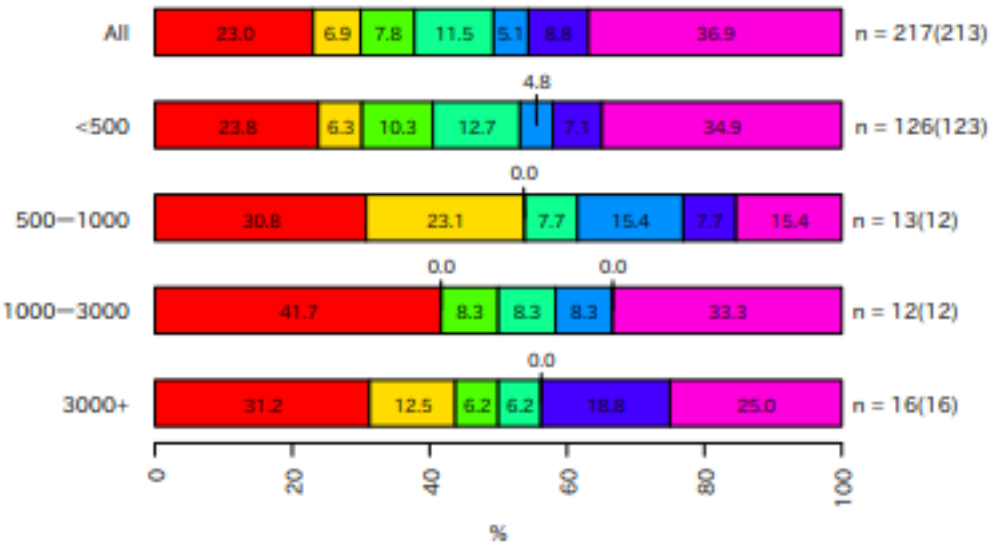
Q26.a How does (will) employment change with the introduction of IoT in your company? (check all that apply)(Industry)

1. Part of the work is replaced by IoT, which is effective in reducing labor costs and the number of employees
2. New work, such as data analysis and system maintenance occurred, and the number of employees increased
3. The business expanded and the number of employees increased
4. The business expanded, but the number of employees did not increase
5. IoT has not been introduced and there is no change in the number of employees due to IoT
6. Other
7. I don't know

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses



Looking at this figure by company size, companies with 1000 or more employees but less than 3000 pushed personnel reduction the most. In companies at this scale, the number of companies that increased employment was extremely small.



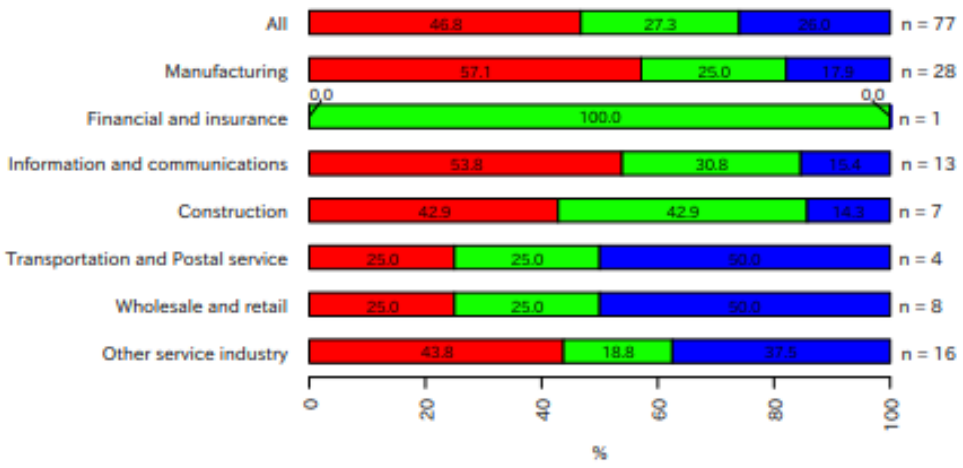
(4) Changes in work volume due to the introduction of new technology

In answer to the question, "Does the number of employees decrease or increase with the introduction of new technology?" the number of companies that answered "increase " was more than the number of companies that answered "decrease" in the manufacturing and information and telecommunication industries.

Q26.b Those who selected (1), (2), (3) in Q 26.a, which of the increase, the leveling, or the decrease is appropriate for the change in the work volume resulting from the introduction of IoT?(Industry)

1. Increased
2. No change
3. Decreased

"n = num" is the number of the companies which respond to this question



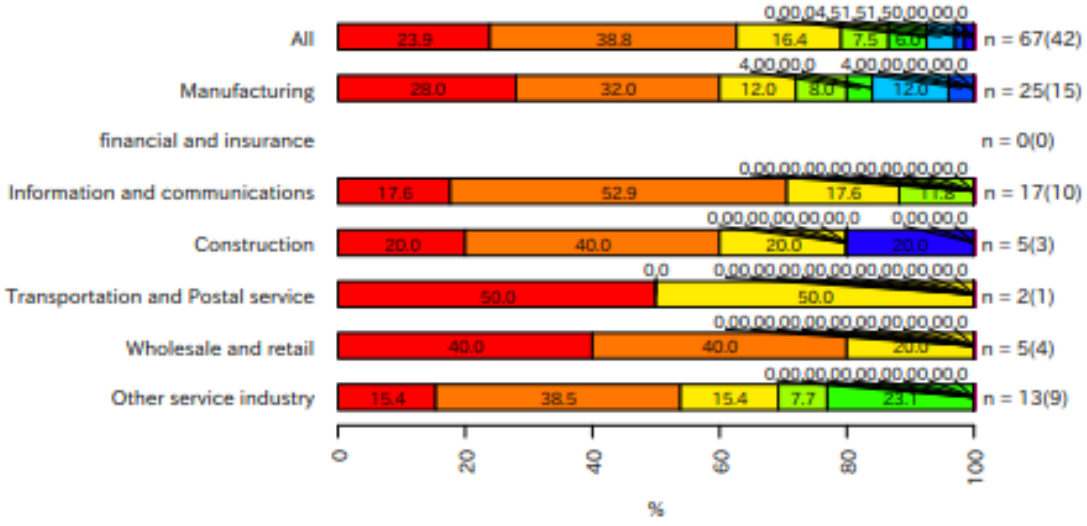
(5) Enterprises that increased the number of employees due to new technology introduction

In terms of the occupations showing an increase in number of employees due to the introduction of new technology, these include: "professional/technical occupation" and, associated with that increase, "management staff" who oversee them and "clerical work," which also increased at the same time. Although this is a phenomenon, which was not predicted in news media, nevertheless, "specialty and technical occupations" cannot exist independently.

Q26.c.1 Those who selected (1), (2), (3) in Q26.a, please check all applicable items for occupations whose number of employees has increased with the introduction of IoT (check all that apply).(Industry)

1. Administrative vocational worker
2. Professional. Technical occupation worker
3. Clerical worker
4. Sales personnel
5. Service worker
6. Security worker
7. Agriculture, forestry and fishery workers
8. Production process workers
9. Transportation. Machine Operating Personnel
10. Construction or Excavator
11. Transportation, Cleaning, or Personnel in packaging etc.
12. Occupation incapable of classification
13. Others

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses



(6) Companies with a decrease in the number of employees due to new technology introduction

In terms of the occupation that saw a decrease in the number of employees due to the introduction of new technology, this included "clerical work." Among the companies that responded as such, there was a decrease in employees in the finance/insurance industry

where "clerical work" exists in such companies and is naturally composed of only "clerical workers." There was no company where "clerical work" decreased in the "construction industry." Compared to large enterprises, the ratio of companies with a decrease in the number of "clerical workers" was higher among the small and medium enterprises (SMEs).

There were 34 companies that indicated that the number of employees "decreased" as a result of the introduction of new technology.

The number of companies that indicated an "increase" in employees was 43 companies; The number of companies that indicated a "decrease" was 34 companies.

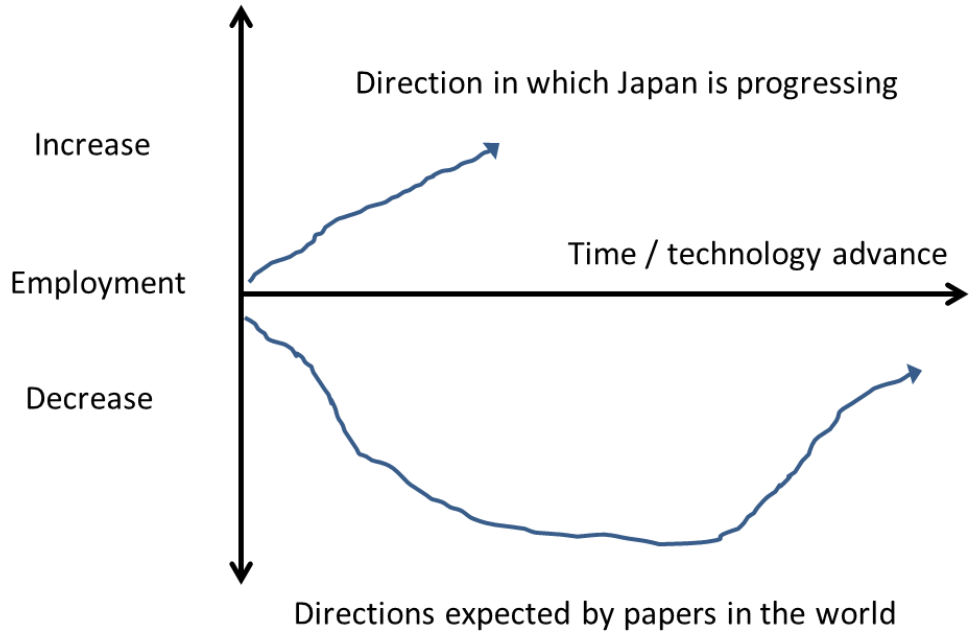
The number that claimed an increase was nine more than those that stated a decrease. From this result, in Japan's industrial world, at least at the present time, there are more companies with an increase in the number of employees due to the introduction of new technology than companies with a decrease in employees due to the introduction of new technology.

Based on the essays and reports published in the world, the expectation has been that at first, employment would be reduced, at least temporarily, as secretarial labor and other routine work would be replaced by machines due to advances in new technologies as well as efficiency and rationalization associated with these. Subsequently, young people with appropriate skills for the new era of technology would emerge and employers would be expected to increase employment. However, from our understanding of the questionnaire results, the situation in Japan contrasts with the expectation of such reports, starting with the fact that employment initially increases. We imagine that the increase in employment in this context is deeply affected by Japanese-style employment.

However, this phenomenon needs further investigation in two respects. First, this trend has only been identified thus far in this questionnaire, which only represents 213 companies that responded to employment questions. If another group of companies is investigated, another trend may appear.

Second, this trend merely expresses recent events. Thus, it is not clear how this may change in the future as time passes. For example, employment may continue to increase as it is or may increase only as human beings are needed at the beginning of new

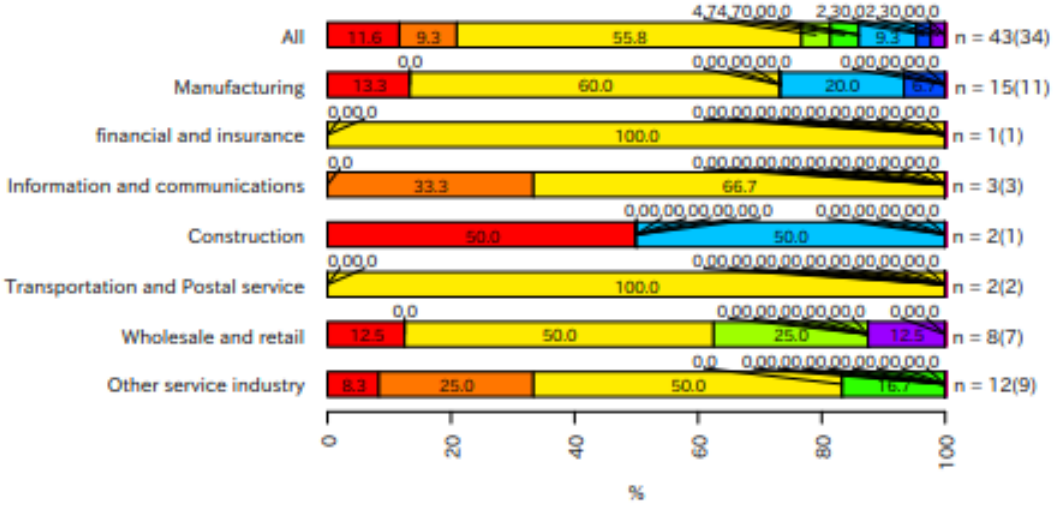
technology introductions, but as the technology takes hold in the company, machines may replace humans; thus, employment may see a decreasing trend. Therefore, in order to grasp the actual situation of Japan, it is important to dynamically understand this by observing fixed points of about every two years through a planned longitudinal survey.



Q26.c.2 Those who selected (1), (2), (3) in Q26.a, please check all applicable items for occupations whose number of employees has decreased with the introduction of IoT (check all that apply).(Industry)

1. Administrative vocational worker
2. Professional. Technical occupation worker
3. Clerical worker
4. Sales personnel
5. Service worker
6. Security worker
7. Agriculture, forestry and fishery workers
8. Production process workers
9. Transportation. Machine Operating Personnel
10. Construction or Excavator
11. Transportation, Cleaning, or Personnel in packaging etc.
12. Occupation incapable of classification
13. Others

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses



(7) The biggest challenge for the future is "human resource development"

Regarding the "challenges for the introduction of IoT and its utilization," the largest number of companies cited "securing human resources." Among the companies citing "securing human resources," "IT technicians" were the most frequently pointed to as the

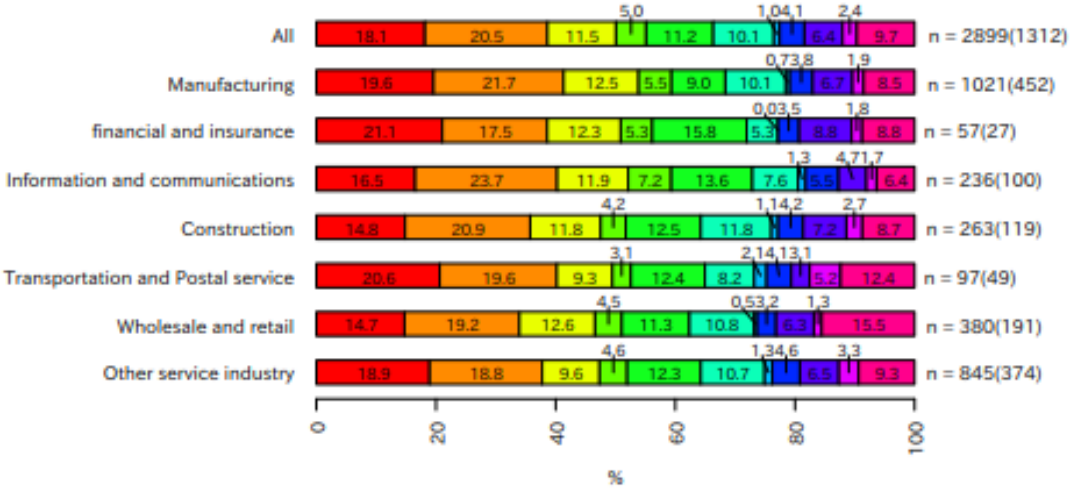
human resources that these companies need. However, looking at this by company size, the ratio of those citing "data analyst" and "AI engineer" increased as the enterprise scale increased. This indicates that the larger companies had more advanced technologies, such as IoT and AI, as well as conventional simple IT technology.

In response to the question, "What is important to promote the future of IoT," the most frequent answer was "training human resources to promote IoT." Furthermore, in response to the question, "Are you facing any obstacles to introduce IoT in your existing products/services," the most frequent answer was the "lack of experts, skilled workers."

Q4.a Which of the following are the issues for introducing and utilizing IoT for your company (check all that apply)?(Industry)

1. Capital investment or Fund
2. Securing personnel
3. Organizationor Change in structure
4. Legacy or System migration
5. Industry or Trends of other companies in same industry
6. Education for general employees, securing literacy
7. Understanding of financial institutions
8. Understanding of parent company, partner, customer
9. Understanding of management level
10. Others
11. There are no particular issues

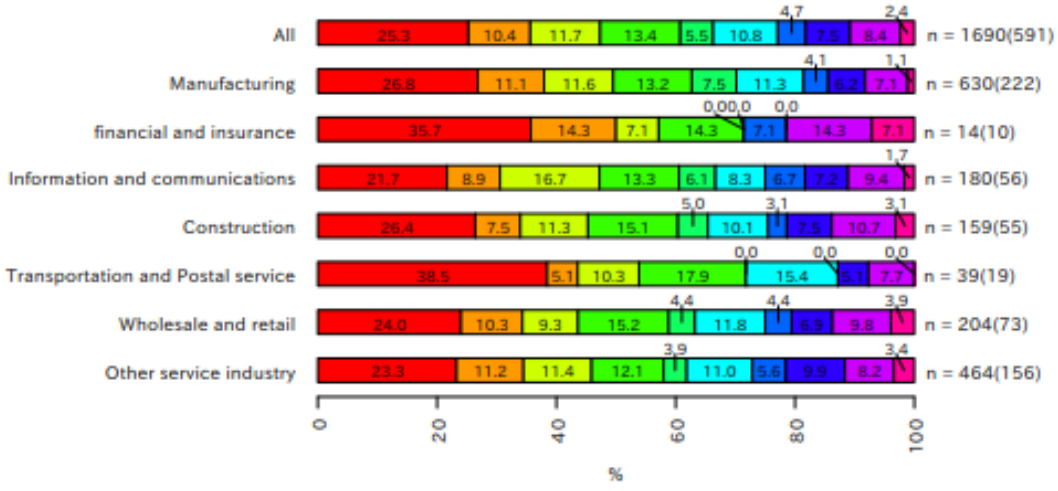
n = num1 (num2) stands for the number of companies which respond to this question and sum of responses

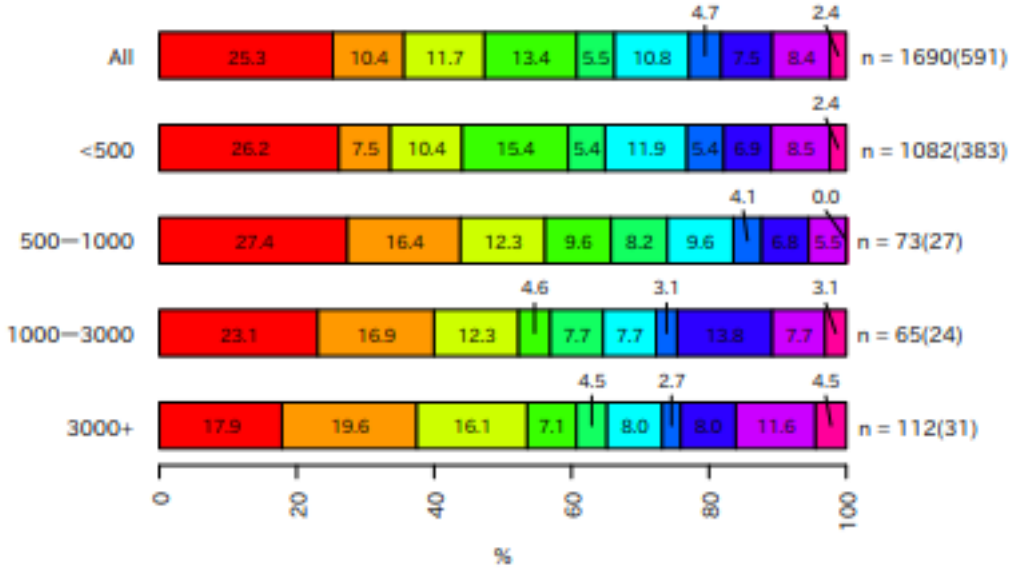

All
Manufacturing
financial and insurance
Information and communications
Construction
Transportation and Postal service
Wholesale and retail
Other service industry
n = 2899(1312)
n = 1021(452)
n = 57(27)
n = 236(100)
n = 263(119)
n = 97(49)
n = 380(191)
n = 845(374)
0
20
40
60
80
100
%

Q4.b Ask to those who selected "(2) Securing personnel" in Q4.a. What kind of talent are the following subjects to be secured?(check all that apply) (Industry)

1. Engineer
2. Data Analyst
3. AI engineer
4. Network technician
5. Robot. Control engineer
6. Database engineer
7. Web. UI designer
8. Business Strategy Analyst
9. Cyber Security Expert
10. Others

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses

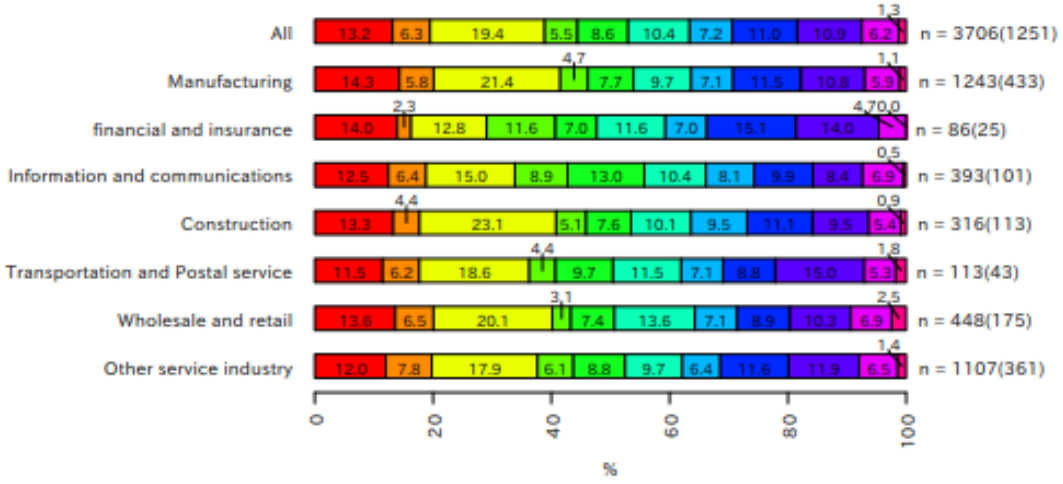


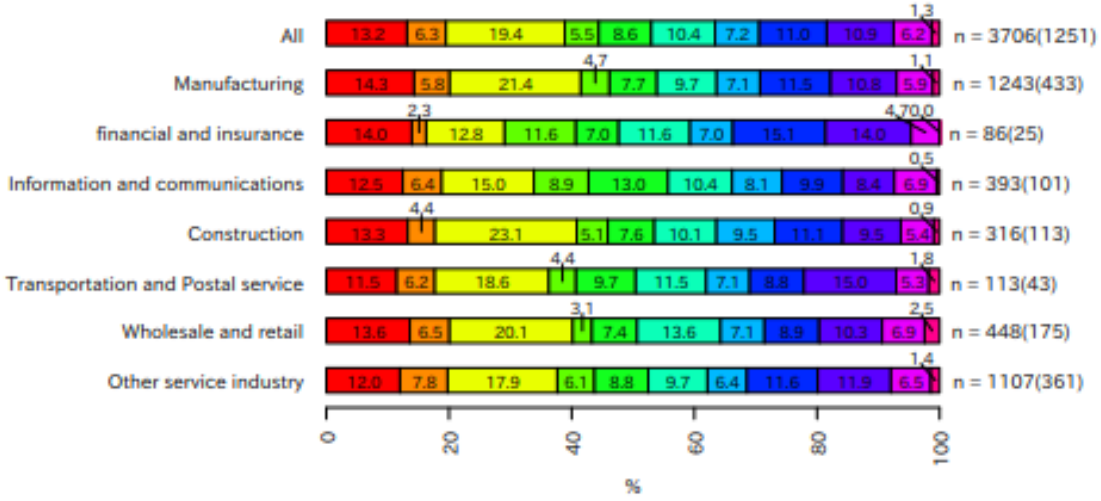

All
25.3
10.4
11.7
13.4
5.5
10.8
4.7
7.5
8.4
2.4
n = 1690(591)
<500
26.2
7.5
10.4
15.4
5.4
11.9
5.4
6.9
8.5
2.4
n = 1082(383)
500−1000
27.4
16.4
12.3
9.6
8.2
9.6
4.1
6.8
5.5
0.0
n = 73(27)
1000−3000
23.1
16.9
12.3
4.6
7.7
7.7
3.1
13.8
7.7
3.1
n = 65(24)
3000+
17.9
19.6
16.1
7.1
4.5
8.0
2.7
8.0
11.6
4.5
n = 112(31)
0
20
40
60
80
100
%

Q15 What do you think is important for future IoT progress?(check all that apply)(Industry)

1. Management who promotes IoT Top leadership. Company vision formulation
2. Financing environment related to IoT
3. Train personnel to promote IoT
4. Cooperation in different industries for creating new business utilizing IoT
5. Solutions utilizing IoT / Products made into IoT. Business creation by services, creation of markets
6. Building a business model utilizing IoT in existing markets
7. Construction of a platform related to IoT.
8. Solving technical problems
9. Infrastructure improvement
10. Institution. Promotion support
11. Others

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses

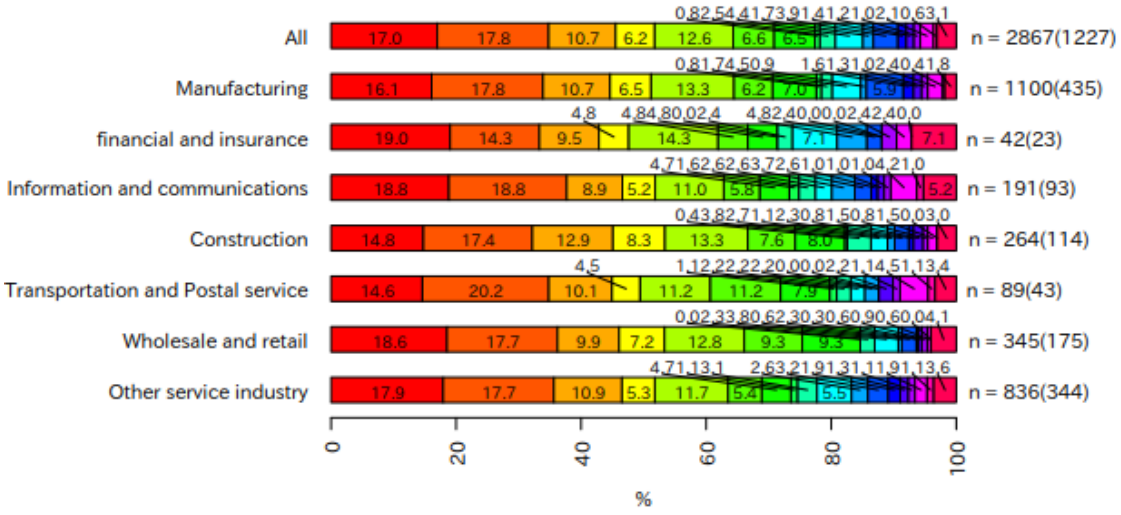




Q17 What is the obstacle to introducing IoT into your existing products / services? (check all that apply)(Industry)

1. Financial merit is unclear
2. Lack of experts, skilled workers
3. It is technically difficult to introduce IoT
4. It is difficult to change within the organization
5. Standards are inadequate
6. Employee motivation
7. The corporate constitution is moral
8. Young company age can not afford
9. Employee's personal information protection
10. Protection of corporate data
11. Legal restrictions
12. Business, fear of leakage of manufacturing know-how etc.
13. Restrictions on Protection of Intellectual Property Rights
14. Intra-company interests
15. Protection of workers
16. Stakeholder interests outside the company
17. Restrictions such as social problems
18. Others

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses



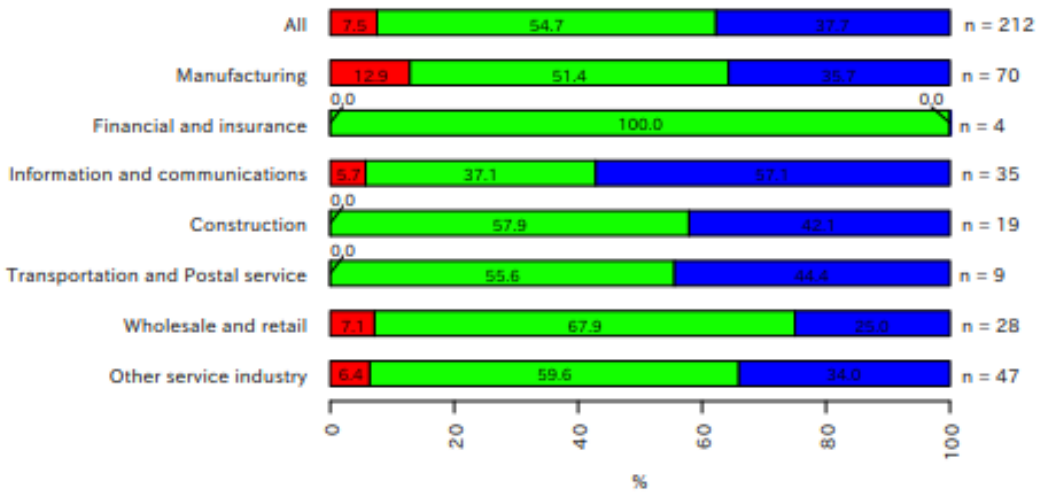
(8) Different corporate behavior based on perceptions of over employment or underemployment

In the questionnaire, company managers were asked to choose whether they perceived "excessive," "appropriate," or "insufficient" employment at their companies (Q25).

Q25 Which of the following applies to the number of employees in your company?(Industry)

1. Excessive
2. Appropriate
3. Insufficient

"n = num" is the number of the companies which respond to this question



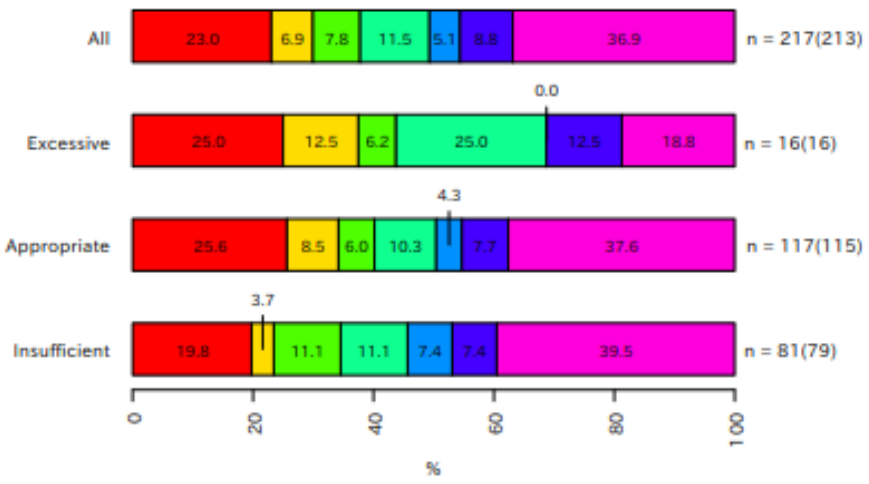
We analyzed the behavioral differences concerning IoT for each of the companies with " excessive," "appropriate," and "insufficient," or companies with a shortage in employment.

The remarkable difference highlighted in the answers to Q26 is that companies with “excessive” employment, in particular, most frequently cited that "the work expanded by introducing IoT but the number of employees did not increase." This is certainly a natural judgment for managers.

Q26.a How does (will) employment change with the introduction of IoT in your company? (check all that apply)(Q25)

1. Part of the work is replaced by IoT, which is effective in reducing labor costs and the number of employees
2. New work, such as data analysis and system maintenance occurred, and the number of employees increased
3. The business expanded and the number of employees increased
4. The business expanded, but the number of employees did not increase
5. IoT has not been introduced and there is no change in the number of employees due to IoT
6. Other
7. I don't know

n = num1 (num2) stands for the number of companies which respond to this question and sum of responses

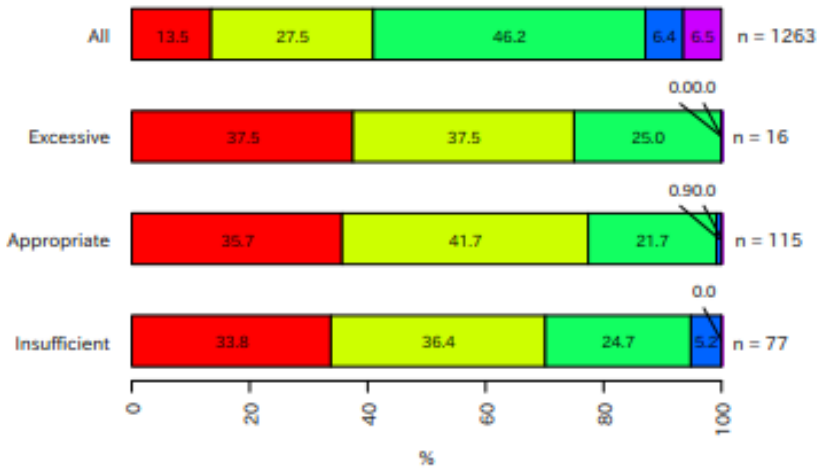


In addition, looking at Q11 and Q12, companies with "excessive" employment are focusing on efficiency improvement and cost reduction rather than new value offerings and innovation regarding IoT introduction. On the other hand, companies with a lack of or insufficient employees appear to be emphasizing new value propositions and innovation rather than efficiency and cost reduction through IoT introductions.

Q11 Were you effective in reducing costs, such as compression and improvement in operational efficiency by utilizing IT and IoT at your company?(Q25)

1. There was an effect
2. It was somewhat effective
3. Neither is it
4. It was not very effective.
5. There was no effect at all

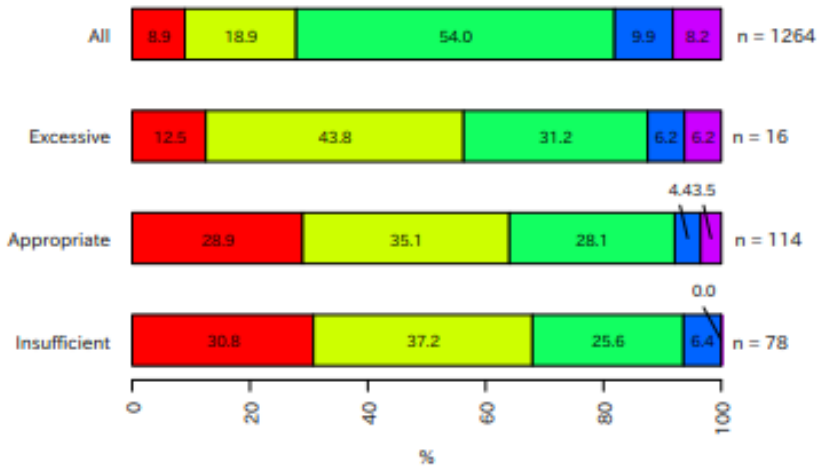
"n = num" is the number of the companies which respond to this question



Q12 Were you effective in providing new value and creating innovation, such as providing new products and services by utilizing IT and IoT at your company?(Q25)

1. There was an effect
2. It was somewhat effective
3. Neither is it
4. It was not very effective.
5. There was no effect at all

"n = num" is the number of the companies which respond to this question



2.3 IoT Progress and Change in Employment

(1) Degree IoT progress

Next, we analyze the relationship between degree of IoT progress and employment. Regarding the utilization of IoT, we measure an enterprise's IoT progress by two questions (Table 1). In response to Question 1, companies that answered as (1) "utilizing" were given a five-point scale, companies that answered as (2) "somewhat utilizing" were given a four-point scale, companies that answered as (3) "neither" were given a three-point scale, companies that answered as (4) " do not utilize them much" were given a two-point scale, and companies that answered as (5) " do not utilize at all" were given a one-point scale (Score 1).

Likewise, regarding question 2, companies that answered (1) as "connecting" were given a five-point scale, companies that answered (2) "somewhat connecting" were given a four-point scale, companies that answered as (3) "neither" were given a three-point scale, companies that answered as (4) " do not connect much" were given a two-point scale, and companies that answered as (5) " do not connect at

all" were given a one-point scale (Score 1).

Table 1 Questions on IoT Progress

Question 1	Do you utilize data in analyzing and forecasting performance, actual results, inventory disposal, etc., using IT and IoT at your company?
Question 2	Are you engaged in providing new value and creating innovation by connecting IT and IoT between organizations and companies?

Table 2 summarizes the results by company size. For answers to questions 1 and 2 (scores 1 and 2), large companies had higher scores than SMEs. From these results, it appears that large enterprises are making better use of IoT in both data analysis and value creation compared to SMEs.

Table 2 Average IoT Progress Score by Company Size

	All	Large Company	SME
Score 1	3.022 (n = 1325)	3.437 (n = 410)	2.836 (n = 915)
Score 2	2.675 (n = 1327)	3.116 (n = 413)	2.476 (n = 914)

Tables 3 and 4 summarize the average score by industry and business size. As shown in Table 3, with respect to score 1, in large enterprises, the scores of the financial/insurance and the information communication industries were high. Among SMEs, the scores in the finance/insurance industry that had been high for large enterprises were low here, but in the information communication industry, the scores were high. In all industries, we confirmed that the scores of large companies were higher than those of SMEs.

As shown in Table 4, for large enterprises, there are similar trends for score 1 and for score 2. However, in the finance/insurance industry, score 2 is higher among SMEs than in the other industries.

Table 3 Average IoT Progress by Industry, Score 1

	ALL	Manufacturing	Financial and insurance	Information and communications	Construction	Transportation and Postal service	Wholesale and retail	Other service industry
Large	3.437	3.519	4.462	3.818	3.296	3.375	3.500	3.287

company	(n = 406)	(n = 108)	(n = 13)	(n = 22)	(n = 27)	(n = 8)	(n = 50)	(n = 178)
SME	2.836 (n = 898)	2.910 (n = 310)	2.556 (n = 9)	3.192 (n = 78)	2.802 (n = 91)	2.811 (n = 37)	2.584 (n = 125)	2.786 (n = 248)

Table 4 Average IoT Progress by Industry, Score 2

	ALL	Manufacturing	Financial and insurance	Information and communications	Construction	Transportation and Postal service	Wholesale and retail	Other service industry
Large company	3.116 (n = 409)	3.119 (n = 109)	4.000 (n = 14)	3.783 (n = 23)	2.889 (n = 27)	2.875 (n = 8)	3.314 (n = 51)	2.977 (n = 177)
SME	2.476 (n = 897)	2.397 (n = 310)	2.556 (n = 9)	3.462 (n = 78)	2.396 (n = 91)	2.405 (n = 37)	2.112 (n = 125)	2.478 (n = 247)

(2) Relationship between IoT progress and change in employment

Next, we analyze the relationship between the progress of IoT and the change in employment. Here, with reference to Washio et al. [2016], we summarized for each score, the percentage of companies where the number of employees increased, comparing the last closing period with the two previous periods (Fig. 1, Fig. 2).

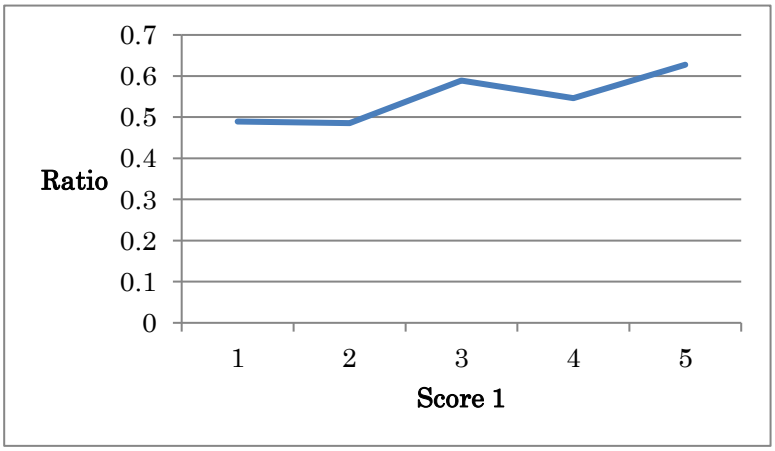


Fig. 1 Ratio of companies with an increase in employment: score 1 (n = 1325)

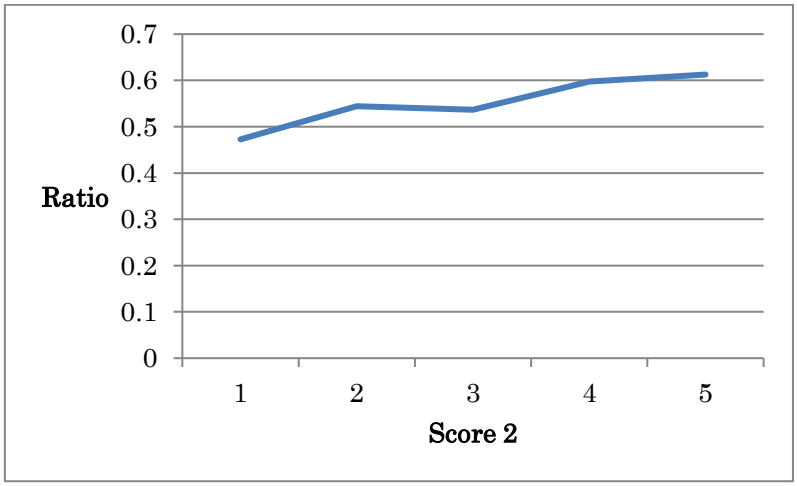


Fig. 2 Ratio of companies with an increase in employment: score 2 (n = 1327)

As shown in Fig. 1 and Fig. 2, there are higher scores among companies where the number of employees increased, although it is a gentle rise. Figs. 3 and 4 summarize the results by company size. Regarding score 1, although it is moderate, this shows that the higher the score, the higher the proportion of companies where employment has increased. On the other hand, with regard to score 2, overall, this shows that there is a tendency for companies with higher employment to have a higher score because the scores are higher for SMEs, but there is no clear trend for large companies.

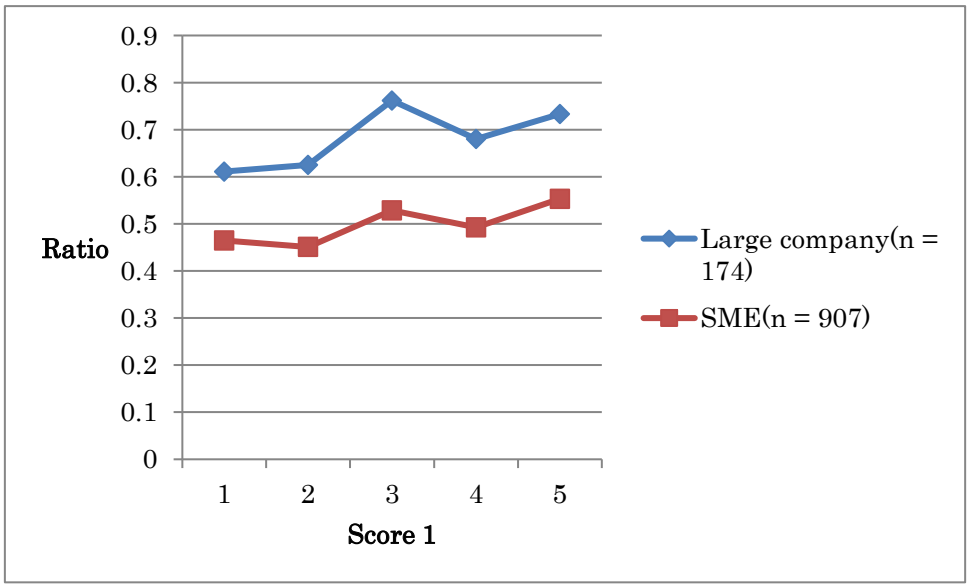


Fig. 3 Ratio of companies that have increased employment: score 1 by company size

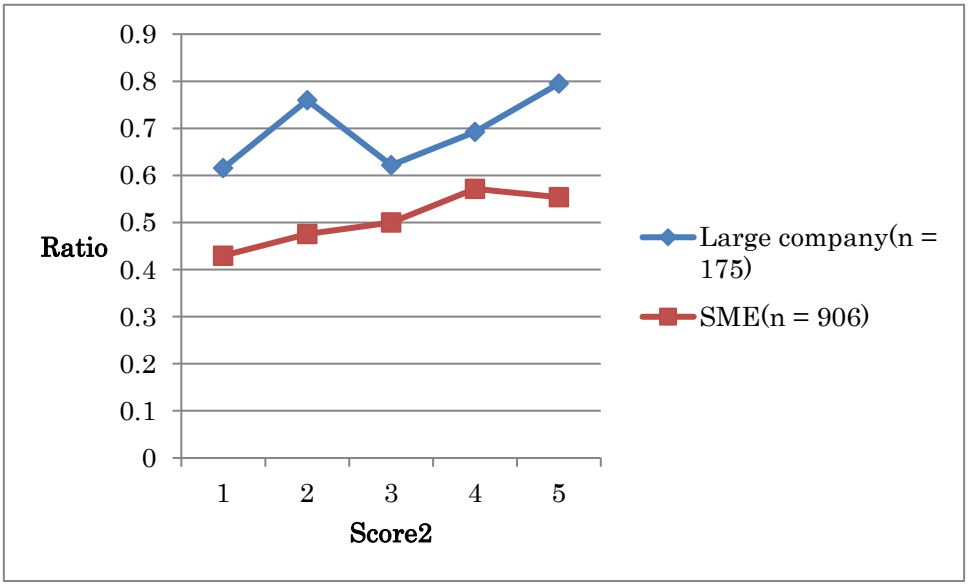


Fig. 4 Ratio of companies that increased employment: score 2 by company size

Figs. 5 and 6 also summarize the results by industry type.

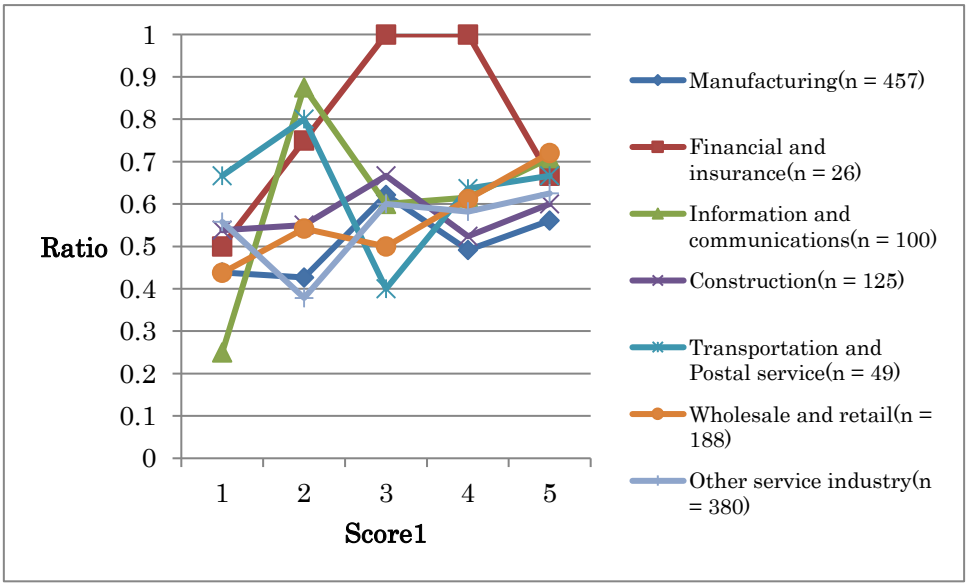


Fig. 5 Percentage of companies that increased employment: score 1 by industry

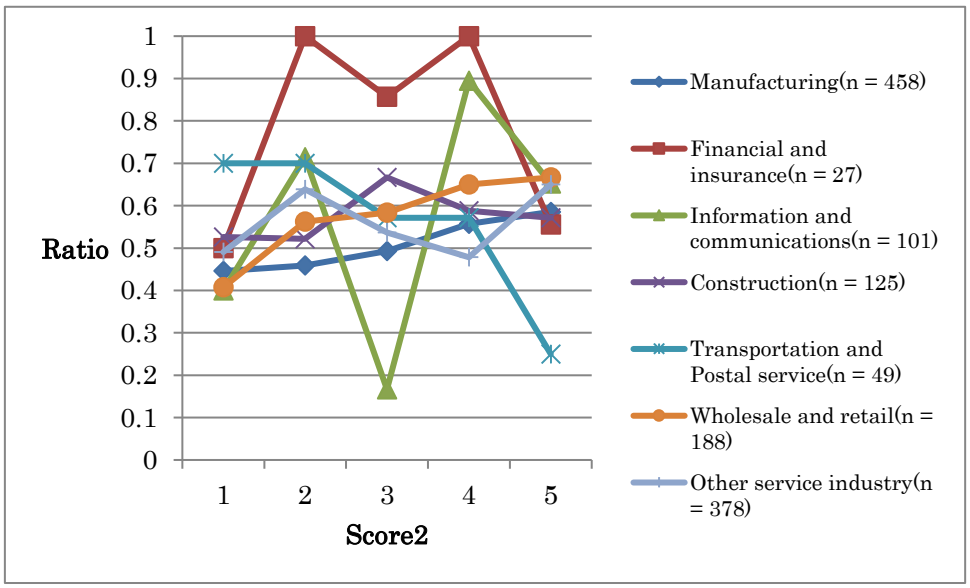


Fig. 6 Percentage of companies that increased employment: score 2 by industry

As shown in Fig. 5 and Fig. 6, the proportion of companies with increased employment aligned with their scores differs according to industry. In addition, unlike in the overall company analysis, here, even if the score increased, the proportion of companies with increased employees did not necessarily increase.

(3) Analysis of the relationship between IoT progress and increase in employment using a logit model

Following Washio et al. [2016], we statistically verify the relationship between the degree of IoT progress and the employment increase using a logit model. The variable to be explained is the company employment increase, which is a dummy variable that equals one if employment increases, and 0 otherwise.

In this study, we refer to Washio et al. [2016], Biagi and Falk [2017], and others; accordingly, we add sales, capital, and income before tax for the closing settlement period with two dummies (1 if increasing, 0 otherwise), and the logarithmic number of employees as explanatory variables of this model. We impose sum-to-zero constraints on the industrial dummy. The correlation coefficient between score 1 and score 2 is 0.654. Since the correlation is high, a logit model is created for scores 1 and 2.

The results of the logit model are summarized in Tables 5 and 6. As shown in Table 5, the sales increase dummy, the pre-tax net income increase dummy, and the logarithmic employee number have a positive

effect at the 1% level on the increase in employees. The capital increase dummy is positive at the 5% level. However, the score 1 results are not statistically significant with respect to an increase in employees. On the other hand, as Table 6 shows, score 2 results are positive at the 5% level.

Table 5 Results of logit model: score 1

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	−3.808	0.337	−11.297	0.000	*
Score1	0.089	0.058	1.536	0.124	
Increase in sales	1.326	0.165	8.049	0.000	*
Increase in capital	0.708	0.315	2.248	0.025	*
Increase in income before tax	1.553	0.207	7.492	0.000	*
Logarithmic number of employees	0.284	0.056	5.048	0.000	*
Manufacturing	−0.168	0.163	−1.027	0.305	
Financial and insurance	0.681	0.509	1.337	0.181	
Information and communications	0.096	0.273	0.351	0.725	
Construction	−0.334	0.246	−1.357	0.175	
Transportation and Postal service	0.273	0.342	0.797	0.425	
Wholesale and retail	−0.219	0.222	−0.986	0.324	
Other service industry	−0.329	0.183	−1.801	0.072	
Number of samples	1055				
Pseudo R-squared	0.284				
Log-likelihood	−488.281				

Table 6 Results of logit model: score 2

	Estimate	Std. Error	z value	Pr(>|z|)	star
(Intercept)	−3.838	0.338	−11.365	0.000	*
Score1	0.121	0.061	1.980	0.048	*
Increase in sales	1.325	0.165	8.028	0.000	*
Increase in capital	0.724	0.314	2.302	0.021	*
Increase in income before tax	1.578	0.209	7.535	0.000	*
Logarithmic number of employees	0.274	0.056	4.873	0.000	*
Manufacturing	−0.145	0.163	−0.889	0.374	
Financial and insurance	0.695	0.502	1.385	0.166	
Information and communications	0.017	0.278	0.060	0.952	

Construction	−0.309	0.246	−1.256	0.209	
Transportation and Postal service	0.286	0.342	0.838	0.402	
Wholesale and retail	−0.212	0.222	−0.952	0.341	
Other service industry	−0.332	0.183	−1.819	0.069	
Number of samples	1054				
Pseudo R-squared	0.286				
Log-likelihood	−487.064				

2.4 Conclusion

Since September 2013, when Fray and Osborne announced their estimate on "the future of employment," hundreds of papers have been published all over the world on the topic. However, as far as we know, there are no studies that have conducted a broad company questionnaire survey and investigated the present day situation. In that sense, this survey questionnaire is the first to do so. Furthermore, this study provides important information that disseminates to the world at large the facts around such social phenomena in Japan.

However, although the results of this survey come from a questionnaire targeting 10,000 companies, it represents the situation of a subset of 213 companies that responded to the questions concerning employment. Thus, it is uncertain whether this can be generalized to reveal a trend for all of Japan.

In Japan, as in the case of the estimate made by the IAB of the German government's Social Labor Department, we first have to estimate the situation in the whole country; we then need to survey the actual situation with a sampling questionnaire, and then conduct a case study. This three-stage analysis is generally considered the standard method of analysis. In the future, it would be important to construct a complete analytical framework as described to perform further research on the phenomena discussed here.

3 Deriving Social Policies

3.1 Social policy derived from survey analysis results

From the results of the broad survey and our field survey in Japan as well as the results of other papers around the world, we now discuss the measures and issues that should be considered in the

future.

① Training staff to lead the new era of the Fourth Industrial Revolution to win the global competition. For example, in Germany, young people who graduate from the Munich University of Technology and the Munich University Master of Science in Information Sciences will eventually become executives and lead companies into the future.

② Train personnel to do jobs that can only be done by humans. Judgment and routine tasks based on the extension of the past precedent such as past "learning" judgment will be replaced by AI; thus, we need for the future: (1) human resources who can create unprecedented things and new creative work; (2) human resources who can make full use of digital equipment, analyze data, support scientific management, (3) human resources with communication skills/interpersonal skills, (4) human resources who have AI technology skills to keep AI up to date. In an era of major reform, we cannot discuss the future alone based on past precedents and experiences. Since judgment and routine tasks, which are the extension of the past precedent such as past "learning" judgment, are work that can be substituted for with AI, there is a need to open up a new unknown era by leaving it to the machines to identify how humans are needed.

③ Japan has had a history of cherishing skilled workers in the field and the new system that is currently being introduced into firms represents content that makes the most of employees. The new system is basically "visualization," and skilled workers are still responsible for looking at data and thinking about countermeasures. However, in the workplace, the work on the extension of the past precedent, such as past "learning," looking at measured data and making judgments, will sooner or later be replaced by AI. The day when many of the tasks of skilled workers are replaced by machines is coming soon. In Germany, what to do with a skilled worker who has been supporting manufacturing is regarded as a serious problem. Germany has recognized the need to re-educate and re-train workers so that they can work with new technologies. This then can protect the employment of old technology workers when new technologies are introduced. Even in Japan, we still have to think about what to do when AI substitutes for employees in places where fully motivated skilled workers are still active.

④ According to the questionnaire survey results, we discovered that there is an ongoing reduction in back-office workers in banking. In this industry, employment does not increase but rather is always being decreased. Indeed, megabanks have recently announced a large number of personnel cuts. The reduction of the "routine work clerks" expected by many studies in the world, is notable since routine work clerks account for a large percentage of employees; thus, their reemployment is a big issue.

⑤ As the IMF pointed out, IT investment is the biggest factor creating economic disparity, however, at the same time, innovation is the source of corporate competitiveness; therefore,

stopping innovation to prevent disparity is misguided. While trying to innovate through IT investment, we need to think about how to redistribute wealth by taxes in order to reduce these gaps. Looking at the trends before and after income redistribution using the Gini coefficient in each country, the US has a large disparity before income redistribution but the redistribution function is weak and the disparity expands over time. Germany has a large disparity before redistribution but the redistribution function is strong and the disparity shrinks; however, the disparity is expanding in the time series. In Japan, although the gap hardly changes over time, redistribution hardly functions, and the disparity surpasses Germany and remains intact.

4 Conclusions

The problem of "the future of employment" is very similar to the problem of population decline, the declining birthrate, and aging. Japan's rapidly declining population, its declining birthrate, and its aging have been predicted with considerably high accuracy from as much as 30 to 40 years ago. The experts have insisted that we should take action while there is still a financial margin. However, such voices are drowned out until the crisis is in front of our eyes and the Japanese take action. According to numerous survey analyses, this future can be expected to some extent, and the necessary measures are very clear. Before we face the real crisis, if we do not address this issue seriously now, as a ship in the night, Japan will sink.

In the past, many workers were overworked in the civil engineering field but today, construction machinery has freed up humans from heavy labor in that industry. The advent of machines, such as automobiles, airplanes, personal computers, and smartphones, has surpassed human capabilities and enriched people’s lives. In fact, humans have enriched their lives by controlling and using dangerous elements such as fire for centuries. This art is called "technology" and such human activity will continue in the future.

References

Ministry of Economy, Trade and Industry Trade Policy Bureau (2017). White paper on international trade, Japan, 2017.

Washio. S, Noguchi. M, Iizuka. N, & Shinozaki, A, (2016). An empirical study of ICT utilization for improving business performance and job creation: Evidence from logit model analysis based on company survey data, *InfoCom Review, 67,* 17-33. (In Japanese)

Biagi, F, & Falk, M (2017). The Impact of ICT and E-Commerce Activities on

Employment in Europe. *Ration Working Paper*, No. 293, The Ratio Institute.

Frey, C. B., & Osborne, M. A. (2013). The future of employment: how susceptible are jobs to computerization? Oxford University Programme on the Impacts of Future Technology, Technological Forecasting and Social Change, *114,* issue C, 254-280 2013.