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Results of the Survey on Standardization Activity (2019): Situation of Standardization Activities in Business Entities and Other Institutions

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Results of the Survey on Standardization Activity (2019): Situation of Standardization Activities in Business Entities and Other Institutions

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Abstract

This study considers the standardization activities of business entities and other institutions in Japan for 2019. Through a survey, it examines their standardization activities while focusing on organizational characteristics and factors influencing knowledge creation. The survey covers (1) whether or not the institutions conduct standardization activities, as well as their (2) interest in standardization in advanced technology fields, (3) knowledge sources for standardization activities, (4) organizational design for standardization activities, and (5) management system of technical information in standardization activities. Moreover, in the field of advanced technology (artificial intelligence and quantum computing), the survey examines essential items (performance evaluation methods, data formats, ethical aspects, and others) that may need to be standardized.

Keywords: standardization activities, questionnaire survey, knowledge sources, organizational design, artificial intelligence, quantum computing

JEL: O20, O30.

[1)] This study was conducted as part of the Research Institute of Economy, Trade, and Industry (RIETI), Japan. The author appreciates the support of the Technical Regulations, Standards and Conformity Assessment Unit at the Ministry of Economy, Trade, and Industry (METI) and Japanese Standards Association (JSA). The author appreciates the cooperation of the survey respondents.

[2)] This study corresponds to the policies in Chapter 2.1. (6) of the Sixth Science, Technology and Innovation Basic Plan (FY 2021–2025) developed by the Japanese government.

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1. INTRODUCTION

This study considers the standardization activities of companies and other organizations in Japan for 2019.[1,2] Through a questionnaire survey, this study examines their standardization activities while focusing on their organizational characteristics and factors influencing knowledge creation.

The survey covers (1) whether or not the organizations conduct standardization activities, as well as their (2) interest in standardization in advanced technology fields, (3) knowledge sources for standardization activities, (4) organizational design of standardization activities, and (5) management system of technical information in standardization activities. Moreover, in the field of advanced technology (artificial intelligence technology and quantum computing), the survey examines essential items (performance evaluation methods, data formats, ethical aspects, and others) that may need to be standardized. The artificial intelligence and quantum computing-related technologies are considered as key elemental technologies for the future 6G communication platform.

This study explores the (1) organizational structure of standardization, (2) characteristics of standardization in advanced technology fields, (3) characteristics of knowledge creation related to standardization, and (4) current status of information management in standardization activities. As a result, the following findings were obtained compared with previous years' surveys: The degree of implementation of standardization and the rate of progress in organizational development are almost constant. In addition, in the implementation of standardization activities, it became clear that the restrictions on the use of technical information disclosed by standards development organizations (SDOs) are not strict.

2. METHOD AND DATA

2.1. Survey Purpose

The purpose of this study is to gain useful knowledge for managing standardization activities by understanding how and to what extent institutions are engaged in standardization activities as such activities' impact on the institutions' provision of goods

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[1] The survey's title is the "Survey on Standardization Activities" (abbreviated as "SoSA") or "標準化活動調査" in Japanese characters.

[2] In this paper, the expressions *standard's* + *noun* and *standards* + *noun*, both mean "for standardization." Because the expression *standards* + *noun* is acceptable as a convention, the word "standards" is used when referring to the Japanese Industrial Standards Committee (JISC).

and services.

2.2. Survey Subject and Method

This study conducted a stated preference survey related to standardization, which presents the objective observations of respondents, rather than a revealed preference survey. The survey questionnaire was prepared and administered in the Japanese language because the survey targets are located in Japan and their primary language is limited to Japanese.[3] From a practical perspective, a higher response rate was expected with a questionnaire in Japanese.

As for survey subjects, the focus was on (1) business entities and (2) research institutions (e.g., universities). Two similar surveys were conducted in 2017 and 2018 (Tamura, 2019a, 2020).[4,5] In these studies, institutions with sales equivalent to at least 10 billion Japanese yen (one billion US dollars or more) were chosen.[6,7] The current survey comprised about 170 respondents who had responded to at least one of the previous two surveys.

For the means of communication, both postal mail and electronic media were used. The questionnaire was sent by postal mail to companies and other institutions, and respondents could choose to submit their responses by e-mail or postal mail (n.b., this was not a web-based survey).

The survey was sent to individuals in charge of standardization activities, with a note asking that people involved in standardization activities for technology, test and evaluation methods, terminology, and symbols within the institution should answer the survey as much as possible.

2.3. Survey Period

The survey was carried out from April 2021 to July 2021.[8]

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[3] The expressions in English (e.g., industry classification) used in this document are provisional translations at the time of preparation of this paper. The original expressions are in Japanese.

[4] All citations in this article with "Tamura" as the author refer to my past research. Fortuitously, no previous work by other researchers with the same name has been cited.

[5] These previous survey results are adopted in the ISO research repository (International Organization for Standardization, 2021a, 2021b)

[6] At the time of writing, 1 US dollar was about 100 Japanese yen.

[7] The sales data of the companies were obtained from the Nikkei database. Nikkei is a major financial newspaper in Japan.

[8] The timing of the survey was postponed by about six months to avoid conducting it under restricted conditions, such as the declaration of a state of emergency by the Japanese government for the prevention of the coronavirus infection.

2.4. Survey Scope

Standardization activities can be classified into two types: activities within an institution and activities outside an institution. Implicitly, this survey aimed to collect data mainly on standardization activities within an institution. Theoretically, within-institution activities include a more comprehensive range of activities related to standardization than external-institution activities. A typical example of external institutional standardization activities is the preparation of standards documentation in SDOs.

2.4.1. Meaning of standardization activities

In this survey, standardization was defined as the unification of technical specifications, test and evaluation methods, and terminology and symbols in a specific technical field. Standardization of de jure, de facto, and consortium standards is also included within the scope. However, calibration standards to maintain the measuring instruments' accuracy are excluded. Activities related to certification based on standards (e.g., International Organization for Standardization [ISO] certification, Japanese Industrial Standards [JIS] certification) and those concerning the maintenance and management of certification are also excluded from the scope. Activities aimed at developing technical standards themselves are not classified as standardization activities but as research and development (R&D) activities.

2.4.2. Surveyed personnel

The survey focused on personnel engaged in standardization activities involving the following:

(1) Standard planning, deliberation, and investigation;
(2) Survey activities, such as data acquisition for standard establishment;
(3) Management of established standards; and
(4) Activities related to standardization for education and dissemination (Tamura, 2021a).

3. RESULTS

Approximately 170 subjects were surveyed. A total of 92 responses were received via postal mail or e-mail (as of July 2021). The response rate was roughly 50%, although the number of responses decreased compared with the past two surveys (Tamura, 2019a, 2020).

3.1. Number of Respondents by Industrial Category

Table 1 shows the distribution by industry. Out of the 92 respondents, other manufacturing (e.g., steel and chemical industries), electric machine, and other non-manufacturing industries (e.g., transportation industry) accounted for the highest number of respondents.

Regarding the classification of industries, respondents were asked to choose from among 10 categories: machine industry, electric machine, transportation machine, business machine, other manufacturing, construction, information and telecommunications industry, wholesale and retail, other non-manufacturing, and education/technology licensing organization (TLO).[9] The choice of which industry sector an institution falls into is at the discretion of the respondent.

[Insert Table 1. here]

3.2. R&D Budget Distribution

Table 2 shows the distribution of R&D budgets. The most frequent category was Category 6, which was between 1,000–9,999 million yen (10,000-99,999 thousand US dollars). The share of Category 6 was 33.8%, with 27 respondents. The second was Category 7, amounting to over 10,000 million yen. The third was Category 5, with amounts ranging from 100–999 million yen. This trend in budget allocation is the same as in the findings of the previous two surveys (Tamura, 2019a, 2020).

[Insert Table 2. here]

3.3. Practice of Standardization

Table 3 shows the number of organizations practicing standardization activities. Of the respondents, 67.4% (62 observations) indicated that they practice standardization activities. This figure is almost identical to the previous survey results of 62.4% (78 observations) in 2018 and 60.8% (62 observations) in 2017. In this yearly comparison of the results, the percentage of standardization activities practiced was about 60–70%.

Table 4 shows the presence of standardization activities by industry sector, and Table 5 shows the differences by R&D budget. The industries with higher-than-average values are information and telecommunications, electric machine, and the industries with lower values are wholesale and retail. In relation to R&D budgets, companies with larger research budgets tend to have a higher percentage of standardization activities.[10]

[Insert Table 3. here]

[Insert Table 4. here]

[Insert Table 5. here]

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[9] These classifications are different from the technical classifications of the JIS and ISO standards documents. These classifications are based on the concept of industrial classification, while the JIS and ISO classifications are based on technical differences between the respective standards.

[10] Fisher’s exact test shows a significant difference (5% level) among the industry and budget categories.

3.4. Types of Standardization Activities

As shown in Table 6, in terms of the type of activities conducted, standardization activities related to products and services were the most common at 64.9%, followed by measurement (29.9%) and manufacturing processes (28.6%). Activities related to design and symbols accounted for 10.4% of the standardization activities (multiple responses allowed).

The order of the types was almost the same as in the previous survey results for 2017 and 2018. As the results for 2017–2019 have all shown there is a certain amount of standardization activity related to designs and symbols, it is sufficient to conclude that standardization activities within institutions contain at least some amount of this type of standardization activities.

The role of standardization activities for designs and symbols has recently been discussed using Japanese de jure standards document data (Tamura, 2018, 2019b).[11] Designs and symbols will become more important because they play a major role in the information and communication service industry, such as through pictograms. They will also play an important role in constructing social systems (e.g., emergency exit signs) and improving the social brand (International Organization for Standardization, 2019; Tamura, 2020, 2021b).[12] Further, they have helped communicate information non-verbally to cope with the recent coronavirus pandemic (COVID-19) (Tokyo Metropolitan Government, 2020).

[Insert Table 6. here]

3.5. Reasons Not to Practice Standardization Activities

Table 7 shows the reasons why companies do not engage in standardization activities (multiple answers allowed). These reasons are important information for the consideration of policies that support standardization activities.

The most common reason was that standardization activities are not necessary for the products/services offered by the respondents, and that they are using already established standards rather than creating them. These two reasons were attributed to the design of the firms' products and services. The second most common reasons were, respectively, no existing organization and lack of a workforce for standardization activities. These two

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[11] The list of the type of standards is disclosed in an electric data format (Tamura, 2017).

[12] This "emergency exit" design was proposed by Japan and standardized internationally (International Organization for Standardization, 2019). Jin (2015) provides the detailed background on the negotiation process and technical issues.

reasons are classified as managerial reasons, not characteristics of the firms' products or services. In other words, they suggest the need for organizational capacity development.

These results indicate that the standardization activities' degree of implementation is influenced by the nature of the goods and services companies supply and these goods and services' technical novelty.

[Insert Table 7. here]

3.6. Standardization of Advanced Technology

3.6.1. Artificial intelligence technology

Tables 8 and 9 respectively present the attitudes toward advanced artificial intelligence technologies and the difference per industry. In the questionnaire for this study, I did not pursue specifics, but asked about the importance of the term "artificial intelligence" in general. This treatment is because the ISO has not yet decided on a definition for this term.[13, 14] About 35% of respondents answered that the standardization of artificial intelligence technology is "important" or "relatively important." This number is the same as the results from 2018. Further, the results for the last three years namely, 2017, 2018, and 2019 have generally shown that about 30% of the respondents have chosen these two options, indicating a substantial stable need for the standardization of artificial intelligence. The diffusion of this technology is improving by involving standardization.

Standardization has the effect of increasing academic value by promoting the marketization of research results. The same effect can be expected for artificial intelligence technology. This phenomenon can be seen in the case of photocatalysts (Ministry of Education, Culture, Sports, Science and Technology, 2008, p. 102). With the discovery of the "Honda-Fujishima effect" of photocatalysts (Fujishima and Honda, 1972), international standardization of measurement and evaluation of photocatalyst was promoted, and the technology was marketed. As a result, photocatalysis became popular and its academic value increased.

[Insert Table 8. here]

[Insert Table 9. here]

Table 10 shows the technical areas of artificial intelligence technology where standardization is considered important. Herein, the areas of (1) performance evaluation,

[13] International Patent Classification is used to identify artificial-intelligence-related patents (Fujii and Managi, 2018; Tseng and Ting, 2013).

[14] Tamura (2019) classifies Japanese de jure standards (JIS) to form data on artificial-intelligence-related standards and makes them public.

(2) ethical aspects of artificial intelligence, and (3) computational algorithms are considered the most important.

This result indicates that the need for setting benchmarks for the performance evaluation of artificial intelligence technologies continues to be high. Setting standards for performance measurement is considered important to distinguish between different products and services as they become marketable and market competition intensifies. Standardization regarding ethical aspects is important for the social acceptance of artificial intelligence techniques because it prevents the social and legal misuse of this technology. Further, the need for standardization of computational algorithms is an indication that efficient common algorithms are needed to improve the usability of this technology. The development of such artificial intelligence-related standards will lead to public acceptance of artificial intelligence technology.

[Insert Table 10. here]

3.6.2. Quantum computing-related technology

In the questionnaire for this study, I did not pursue specifics, but asked about the importance of the term "quantum computer-related technology." This is because the ISO technology classification does not yet have a category for this technology (International Organization for Standardization, 2015). The percentage of respondents who answered "important" or "relatively important" was about 14% (Table 11). This percentage is lower than the obtained importance of standardization for artificial intelligence technology. Note that about 60% of the respondents selected "not important/will not use such technologies" or "relatively unimportant" for quantum computer-related technologies. This result may reflect the situation wherein quantum computer-related technologies have not yet been used in services and products for the general public. Differences by industry sector are shown in Table 12.

The results of this survey on artificial intelligence and quantum computer-related technologies show the role of standardization in the process of transforming advanced technologies into general purpose technologies (GPT; Lipsey, Carlaw, and Bekar, 2005). Given the results of this study, it appears that quantum computer-related technologies have not yet become GPTs. As technology becomes widespread, the need for standardization increases. In other words, standardization, and technology conversion to GPT are expected to proceed in a reciprocally influential manner. This observation can be seen in both 2019 and last years' results concerning artificial intelligence technology (Table 8).

[Insert Table 11. here]

[Insert Table 12. here]

Table 13 shows the results of technology areas related to quantum computers that are considered important. As marketization will progress in the future, related standardization will become necessary.

Regarding the need for standardization of quantum computers, the main areas for standardization are (1) performance evaluation methods, (2) terminology, and (3) computational algorithms. Performance evaluation methods make it possible to compare the performance of quantum computers. Standardization of terminology is very important in conveying new technological concepts. When nanotechnology emerged as a new technology, the standardization of basic terminology was implemented (Blind and Gauch, 2009). The need for standardization of computational algorithms is an indication that efficient algorithms are needed to correspond with new hardware technologies.

[Insert Table 13. here]

3.7. Knowledge Sources for Standardization Activities

The important sources of information in standards development are (1) standardization documents and (2) information from SDOs. This trend is almost the same as in the previous two surveys from 2017 and 2018 (Table 14) (Tamura, 2019a, 2020).

This result implies that information in negotiations is important because the development of a standard requires the parties' agreement. In other words, human-to-human communication is important in the creation of knowledge for standardization, even if the communication measure is digitalized in the form of web conferencing. This background indicates that knowledge from bibliographic information alone is insufficient for the formation of technical standards.

[Insert Table 14. here]

3.8. Degrees of Importance of Knowledge Sources for Standardization Activities

To show the level of importance in detail, results of the five-point evaluation are shown in Table 15. The information obtained from both (1) standardization documents and (2) SDO meetings is of high importance (Tables 14 and 15). This result is almost the same as last year's result (Tamura, 2019a, 2020).

Unlike other typical areas of knowledge creation, bibliographic information alone is not sufficient for knowledge creation in standards. Standardization requires the sharing of knowledge among people in SDOs. It has been shown that knowledge creation for standards, patents, and academic research has different mechanisms. I conceptualize this type as "standards-type knowledge" in contrast with patent or patent-type knowledge. Such knowledge requires two-way communication between humans, in addition to textual data, for its creation.

[Insert Table 15. here]

3.9. Protection of R&D Information and Trade Secrets

25% of the responding companies have developed institutional guidelines for standardization activities, while 75% have not (Table 16). Differences by industry sector are also indicated (Table 17).

About 55% of the companies with developed institutional guidelines indicate that they include trade secret protection notices in their guidelines for standardization (Table 18). This result is close to the results of the previous years' surveys that were conducted in 2017 and 2018. Differences by industry sector are also indicated (Table 19).

Table 20 presents the results of information management in SDOs. Here, the responses of "confidentiality of information is required, but NDAs are not required" and "confidentiality is not required" account for about 15% of the respondents who participate in standardization activities. This figure is about twice as high as for respondents who have concluded a non-disclosure agreement (NDA; 6.3%).

[Insert Table 16 here]

[Insert Table 17 here]

[Insert Table 18 here]

[Insert Table 19 here]

[Insert Table 20 here]

3.10. Organizational Designs for Standardization Activities

Regarding the development of an organization to oversee standardization activities, 33 respondents (40.2%) answered that they had developed such an organization (Table 21). The results are close to those of the past two years in 2017 and 2018 (Tamura, 2019a, 2020).

Differences by industry sector are shown in Table 22, and differences by R&D budget are shown in Table 23. The industries with higher-than-average values are information and telecommunications, electric machine, and the industries with lower values are wholesale and retail. In relation to R&D budgets, companies with larger research budgets tend to have a higher percentage of standardization activities.[15]

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[15] Fisher's exact test shows a significant difference (5% level) among budget categories.

[Insert Table 21. here]
[Insert Table 22. here]
[Insert Table 23. here]

Overall, 91.2% (31 cases) of the organizations managing standardization activities are located within the headquarters (Table 24). Compared with last 2018's result, standardization organizations located within headquarters, rather than within business units, have increased. In the past, the standardization activities of companies mainly comprised each business unit's technical quality control activities (Tamur, 2021c). Today, the management system for standardization activities is centralized, indicating that standardization activities have become a company-wide strategy.

[Insert Table 24. here]

The human resource aspect of the standardization organization was examined in detail (Table 25). Regarding the standardization organization's management size, most organizations (22 cases; 62.9% of the total) had less than 10 employees, followed by 10–49 employees (8 cases; 22.9% of the total). It is important to note that the number of employees is counted in full-time equivalents. This measure provides a good reflection of the workload of employees actually engaged in the work.

[Insert Table 25 here]

One way to determine the importance of a department is looking at the level of the individual responsible for controlling that department. Table 26 shows the results of examining the position level of the individual responsible for the standardization department. In 23 cases (74.2%), the department head was also responsible for managing the standardization activities. Managers were found responsible in 6 cases, accounting for 19.4%. Notably, in two cases (about 6.5%), the president or vice president oversees the standardization department. With the control of high-ranking managers, standardization can be implemented as a strategy for the entire organization.

[Insert Table 26. here]

3.11. Organizational Integration

When asked if the patent organization and standardization organization belong to the same company, 31.4% of the respondents answered yes (Table 27). This trend is almost the same as 2017 and 2018's results. Meanwhile, in 24 cases (about 68.6%), the standardization organization and patent organization existed separately. In these institutions, patent and standards management is carried out in different departments. Regarding location, the department tends to be located in the headquarters if the standards management and patent management functions are in the same department (Table 28). These cases are examples of the integration of standardization management operations into the head office functions.

[Insert Table 27. here]

[Insert Table 28. here]

4. CONCLUSION AND POLICY IMPLICATIONS

This study aimed to obtain information on standardization as an organizational activity, which is valuable information for academic and practical purposes was obtained.

First, the data to date indicated that the percentage of companies conducting standardization activities, a key indicator of standardization, was about 60%. In addition, the percentage of companies that have developed a standardization organization is about 30%. This outcome can be considered an approximate benchmark figure.

Second, in terms of organizational structure, the management of standardization activities has become part of the headquarters function. This result is consistent with the results of a Japanese company's case study (Tamura, 2012). Further, the results indicate that standardization activities have become a company-wide strategy rather than a management task for business units. This development may indicate that corporate organizations are responding to changes in the external environment where networkability is becoming more important for product design (Chandler, 1962; Hirata et al., 2001; Sasaki et al., 2001; Tamura, 2012).

Third, in advanced technologies, differences in the need for standardization were found between artificial intelligence and quantum computing. These differences may reflect the fact that in artificial intelligence technology, there has been some extent of marketization of products and services using this technology, whereas in quantum computing, the marketization of products is not yet common. Currently, quantum computing-related technologies are not considered as consumer products; they are considered as mainly hardware infrastructure for central processing. Nevertheless, as services for use become available commonly in the future, the need for standardization in related peripheral technology areas may increase.

Finally, as in the last years' outcome in 2017 and 2018, the results of this survey on important knowledge sources for standardization activities suggest that the knowledge creation mechanism of standardization is different from other knowledge creation systems (i.e., academic research and patents). This outcome means that direct communication is still essential for knowledge creation in standardization, despite the advances in information processing technology. In a generalized sense, some types of knowledge cannot be created by digital information alone; standards are an example of such knowledge types. I conceptualized this type as "standards-type knowledge" in contrast with patent knowledge in the academic consideration of this study.

As a policy implication, it is important to support the establishment of standards for advanced science and technology to promote the diffusion of these technologies, on the basis that there is a high need for standardization in fundamental fields.

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Tables:

Table 1. Industrial categories

No.	**Category**	**n**	**%**
1	Machine	4	4.3
2	Electric machine	16	17.4
3	Transportation machine	5	5.4
4	Business machine	1	1.1
5	Other manufacturing	36	39.1
6	Construction	7	7.6
7	Information and telecommunications	2	2.2
8	Wholesale and retail	3	3.3
9	Other non-manufacturing	11	12.0
10	Education / TLO	7	7.6
	Total	92	100.0

Note: Due to rounding, the simple sum of the percentages may not equal 100%.

Table 2. Budget allocation for R&D

No.	Budget		n	%
	(thousand US dollar)	Reference: (million yen)		
1	0	0	1	1.3
2	<100	<10	5	6.3
3	100–499	10–49	3	3.8
4	500–999	50–99	1	1.3
5	1,000–9,999	100–999	17	21.3
6	10,000–99,999	1,000–9,999	27	33.8
7	100,000<	10,000<	24	30.0
8	Unknown	Unknown	2	2.5
	Total		80	100.0

Note 1: One US dollar was equal to approximately 100 Japanese yen.
Note 2: Due to rounding, the simple sum of the percentages may not equal 100%.

Table 3. Practice of standardization activities

No.		**n**	**%**
1	Yes	62 (78)	67.4 (62.4)
2	No	30 (47)	32.6 (37.6)
	Total	92 (125)	100.0 (100.0)

Note: Figures in parentheses represent the results for the previous year, 2018 (Tamura, 2020) .

Table 4. Practice of standardization activities by industry

No.	Category	Yes	No	Total
		Percentage	Percentage	Percentage
1	Machine	75.0%	25.0%	4.3%
2	Electric machine	100.0%	0.0%	17.4%
3	Transportation machine	80.0%	20.0%	5.4%
4	Business machine	100.0%	0.0%	1.1%
5	Other manufacturing	72.2%	27.8%	39.1%
6	Construction	28.6%	71.4%	7.6%
7	Information and telecommunications	100.0%	0.0%	2.2%
8	Wholesale and retail	0.0%	100.0%	3.3%
9	Other non-manufacturing	54.5%	45.5%	12.0%
10	Education / TLO	28.6%	71.4%	7.6%
	Total	67.4%	32.6%	100.0%

Table 5. Practice of standardization activities by R&D budget

No.	Budget		Yes	No	Total
	(thousand US dollar)	Reference :(million yen)	Percentage	Percentage	Percentage
1	0	0	0.0%	100.0%	1.3%
2	<100	<10	60.0%	40.0%	6.3%
3	100–499	10–49	100.0%	0.0%	3.8%
4	500–999	50–99	0.0%	100.0%	1.3%
5	1,000–9,999	100–999	41.2%	58.8%	21.3%
6	10,000–99,999	1,000–9,999	70.4%	29.6%	33.8%
7	100,000<	10,000<	91.7%	8.3%	30.0%
8	Unknown	Unknown	100.0%	0.0%	2.5%
			70.0%	30.0%	100.0%

Table 6. Types of standardization activities being practiced

No.		n	%
1	Standardization activities related to products and services	50	64.9
2	Standardization activities related to the manufacturing process of products and services	22	28.6
3	Standardization activities related to the measurement	23	29.9
4	Standardization activities related to design and symbol	8	10.4
5	Do not practice	23	29.9
	(Total)	(126)	

Note: The total number of responses (126) is not equivalent to the number of respondents (77) because multiple answers are allowed for this question. The percentage column shows n/77 × 100.

Table 7. Reasons standardization activities are not practiced

No.		n	%
1	Standardization activities are not needed for marketing own products and services.	12	42.9
2	No established organization for standardization activities.	4	14.3
3	The management capacity for standardization activities is scarce.	1	3.6
4	Labor force for the standardization activities is scarce.	4	14.3
5	Existence of outflow risk of technology information and related trade secret.	2	7.1
6	The cost of practicing the standardization activities is higher than the benefit gained from the activities.	1	3.6
7	Using already established standards rather than formulating standards.	12	42.9
	(Total)	(36)	

Note: The total number of responses (36) is not equivalent to the number of respondents (28) because multiple answers are allowed for this question. The percentage column shows n/28 × 100.

Table 8. Importance of standardization for AI-related technology

No.		n	%
1	Not important/do not deal with the technology	23	37.7
2	Relatively not important	4	6.6
3	Neutral	13	21.3
4	Relatively important	10	16.4
5	Important	11	18.0
	Total	61	100.0

Table 9. The importance of standardization for AI-related technology by industry

No.	Category	1.Not important/do not deal with the technology	2.Relatively not important	3.Neutral	4.Relatively important	5.Important	Total
		Percentage	Percentage	Percentage	Percentage	Percentage	Percentage
1	Machine	0.0%	0.0%	100.0%	0.0%	0.0%	3.3%
2	Electric machine	20.0%	6.7%	13.3%	33.3%	26.7%	24.6%
3	Transportation machine	25.0%	0.0%	25.0%	50.0%	0.0%	6.6%
4	Business machine	100.0%	0.0%	0.0%	0.0%	0.0%	1.6%
5	Other manufacturing	57.7%	11.5%	15.4%	7.7%	7.7%	42.6%
6	Construction	0.0%	0.0%	66.7%	0.0%	33.3%	4.9%
7	Information and telecommunications	0.0%	0.0%	0.0%	50.0%	50.0%	3.3%
8	Wholesale and retail	100.0%	0.0%	0.0%	0.0%	0.0%	1.6%
9	Other non-manufacturing	20.0%	0.0%	40.0%	0.0%	40.0%	8.2%
10	Education / TLO	50.0%	0.0%	0.0%	0.0%	50.0%	3.3%
	Total	37.7%	6.6%	21.3%	16.4%	18.0%	100.0%

Table 10. Standardization items considered important to AI-related technologies

No.	Category	n	%
1	Related to computational algorithms.	18	51.4
2	Related to the form of data used in computation.	16	45.7
3	Related to the encryption of data used in computation.	10	28.6
4	Related to hardware, such as arithmetic elements, used in calculations.	6	17.1
5	Related to the transmission of data associated with computations (but excluding those related to encryption).	9	25.7
6	Related to the measurement and evaluation of performance accuracy of computation results.	22	62.9
7	Related to the measurement and evaluation of energy-saving performance in operations.	5	14.3
8	Related to the terminology used to describe artificial intelligence-related technologies.	12	34.3
9	Related to ethical aspects of use and exploitation.	18	51.4
10	Other.	4	11.4
	(Total)	(120)	

Note: The total number of responses (107) is not equivalent to the number of respondents (35) because multiple answers are allowed for this question. The percentage column shows n/35 × 100.

Table 11. Importance of standardization for quantum computing-related technologies

No.		**n**	**%**
1	Not important/do not deal with the technology	34	56.7
2	Relatively not important	4	6.7
3	Neutral	14	23.3
4	Relatively important	1	1.7
5	Important	7	11.7
	Total	60	100.0

Table 12. The importance of standardization for quantum computing-related technologies by industry

No.	Category	1.Not important/do not deal with the technology	2.Relatively not important	3.Neutral	4.Relatively important	5.Important	Total
		Percentage	Percentage	Percentage	Percentage	Percentage	Percentage
1	Machine	0.0%	0.0%	100.0%	0.0%	0.0%	3.3%
2	Electric machine	46.7%	0.0%	20.0%	6.7%	26.7%	25.0%
3	Transportation machine	75.0%	0.0%	25.0%	0.0%	0.0%	6.7%
4	Business machine	100.0%	0.0%	0.0%	0.0%	0.0%	1.7%
5	Other manufacturing	69.2%	11.5%	15.4%	0.0%	3.8%	43.3%
6	Construction	100.0%	0.0%	0.0%	0.0%	0.0%	3.3%
7	Information and telecommunications	50.0%	50.0%	0.0%	0.0%	0.0%	3.3%
8	Wholesale and retail	0.0%	0.0%	100.0%	0.0%	0.0%	1.7%
9	Other non-manufacturing	20.0%	0.0%	40.0%	0.0%	40.0%	8.3%
10	Education / TLO	50.0%	0.0%	50.0%	0.0%	0.0%	3.3%
	Total	56.7%	6.7%	23.3%	1.7%	11.7%	100.0%

Table 13. Standardization items considered important to quantum computing-related technologies

No.	Category	n	%
1	Related to computational algorithms.	11	47.8
2	Related to the form of data used in computation.	8	34.8
3	Related to the encryption of data used in computation.	7	30.4
4	Related to hardware, such as arithmetic elements, used in calculations.	9	39.1
5	Related to the transmission of data associated with computations (but excluding those related to encryption).	8	34.8
6	Related to the measurement and evaluation of the performance accuracy of computation results.	14	60.9
7	Related to the measurement and evaluation of energy-saving performance in operations.	6	26.1
8	Related to the terminology used to describe quantum computer-related technologies.	11	47.8
9	Related to ethical aspects of use and exploitation.	9	39.1
10	Other.	1	4.3
	(Total)	(84)	

Note: The total number of responses (84) is not equivalent to the number of respondents (23) because multiple answers are allowed for this question. The percentage column shows $N/23 \times 100$.

Table 14. Importance of data sources for standardization activities (1)

Data source		Importance		Total
		Use	Not use	
Academic article	n	33	21	54
	%	61.1	38.9	100.0
Patent information	n	35	19	54
	%	64.8	35.2	100.0
Standardization document	n	49	6	55
	%	89.1	10.9	100.0
Design right information	n	17	35	52
	%	32.7	67.3	100.0
Information obtained from the SDO meetings including the participants	n	47	9	56
	%	83.9	16.1	100.0
Other sources	n	2	11	13
	%	15.4	84.6	100.0

Table 15. Importance of data sources for standardization activities (2)

Data source		Importance					Total
		Important	Relatively important	Neutral	Relatively not important	Not important	
Academic article	n	11	20	10	3	2	46
	%	23.9	43.5	21.7	6.5	4.3	100.0
Patent information	n	10	18	14	3	3	48
	%	20.8	37.5	29.2	6.3	6.3	100.0
Standardization document	n	23	22	6	1	0	52
	%	44.2	42.3	11.5	1.9	0.0	100.0
Design right information	n	1	11	14	6	7	39
	%	2.6	28.2	35.9	15.4	17.9	100.0
Information obtained from the SDO meetings including the participants	n	19	27	4	0	1	51
	%	37.3	52.9	7.8	0.0	2.0	100.0
Other sources	n	2	0	5	0	0	7
	%	28.6	0.0	71.4	0.0	0.0	100.0

Note: Due to rounding, the simple sum of the percentages may not equal 100%.

Table 16. Stipulation of institutional guidelines for management of standardization activities

No.		**n**	**%**
1	Stipulated	20 (32)	25.0 (30.2)
2	Not stipulated	60 (74)	75.0 (69.8)
	Total	80 (106)	100.0 (100.0)

Note: Figures in parentheses represent the results for the previous year, 2018 (Tamura, 2020) .

Table 17. Stipulations of institutional guidelines for standardization activities and the management of standardization activities by industry

No.	Category	Yes	No	Total
1	Machine	0.0%	100.0%	3.8%
2	Electric machine	50.0%	50.0%	17.5%
3	Transportation machine	40.0%	60.0%	6.3%
4	Business machine	0.0%	100.0%	1.3%
5	Other manufacturing	25.0%	75.0%	40.0%
6	Construction	0.0%	100.0%	7.5%
7	Information and telecommunications	100.0%	0.0%	1.3%
8	Wholesale and retail	33.3%	66.7%	3.8%
9	Other non-manufacturing	0.0%	100.0%	11.3%
10	Education / TLO	16.7%	83.3%	7.5%
	Total	25.0%	75.0%	100.0%

Table 18. Inclusion of trade secret and technology outflow protections in management guideline of standardization activities

No.		**n**	**%**
1	Included	12 (21)	54.5 (67.7)
2	Not included	10 (10)	45.5 (32.3)
	Total	22 (31)	100.0 (100.0)

Note: Figures in parentheses represent the results for the previous year, 2018 (Tamura, 2020).

Table 19. Inclusion of trade secrets and technology outflow protections in the institutions' standardization activities guideline and the management of standardization activities by industry

No.	Category	Yes	No	Total
1	Machine	0.0%	0.0%	0.0%
2	Electric machine	62.5%	37.5%	36.4%
3	Transportation machine	100.0%	0.0%	9.1%
4	Business machine	0.0%	0.0%	0.0%
5	Other manufacturing	50.0%	50.0%	36.4%
6	Construction	0.0%	100.0%	4.5%
7	Information and telecommunications	100.0%	0.0%	4.5%
8	Wholesale and retail	0.0%	100.0%	4.5%
9	Other non-manufacturing	0.0%	0.0%	0.0%
10	Education / TLO	0.0%	100.0%	4.5%
	Total	54.5%	45.5%	100.0%

Table 20. Entering into a non-disclosure agreement (NDA) with a SDO when participating in the activities of such an organization

No.		**n**	**%**
1	Confidentiality is not required by the rules of SDOs.	9	14.4
2	NDAs are signed with standards development organizations.	4	6.3
3	Confidentiality is required by standard-setting organizations, but NDAs are not.	10	15.6
4	Not participating in the activities of SDOs.	18	28.1
5	unknown	23	35.9
	Total	64	

Table 21. Establishment of organizations for standardization activities

No.		n	%
1	Yes	33 (46)	40.2 (42.6)
2	No	49 (62)	59.8 (57.4)
	Total	82 (108)	100.0 (100.0)

Note: Figures in parentheses represent the results for the previous year, 2018 (Tamura, 2020).

Table 22. Establishment of organizations for standardization activities by industry

No.	Category	Yes	No	Total
1	Machine	33.3%	66.7%	3.7%
2	Electric machine	68.8%	31.3%	19.5%
3	Transportation machine	60.0%	40.0%	6.1%
4	Business machine	0.0%	100.0%	1.2%
5	Other manufacturing	29.0%	71.0%	37.8%
6	Construction	28.6%	71.4%	8.5%
7	Information and telecommunications	100.0%	0.0%	2.4%
8	Wholesale and retail	0.0%	100.0%	3.7%
9	Other non-manufacturing	44.4%	55.6%	11.0%
10	Education / TLO	20.0%	80.0%	6.1%
	Total	40.2%	59.8%	100.0%

Table 23. Establishment of organizations for standardization activities by R&D budget

No.	Budget (thousand US dollar)	Reference :(million yen)	Yes	No	Total
1	0	0	0.0%	100.0%	1.3%
2	<100	<10	40.0%	60.0%	6.6%
3	100–499	10–49	33.3%	66.7%	3.9%
4	500–999	50–99	0.0%	100.0%	1.3%
5	1,000–9,999	100–999	18.8%	81.3%	21.1%
6	10,000–99,999	1,000–9,999	23.1%	76.9%	34.2%
7	100,000<	10,000<	81.8%	18.2%	28.9%
8	Unknown	Unknown	50.0%	50.0%	2.6%
			40.8%	59.2%	100.0%

Table 24. Structure of organizations for standardization activities

No.		n	%
1	Within headquarters	31	91.2
2	Within business unit	1	2.9
3	Other	2	5.9
	Total	34	100.0

Note: Due to rounding, the simple sum of the percentages may not equal 100%.

Table 25. Number of employees for standards management organization

No.		n	%
1	0	1	2.9
2	<10	22	62.9
3	10–49	8	22.9
4	50–99	1	2.9
5	100–499	0	0.0
6	500<	0	0.0
7	Unknown	3	8.6
	Total	35	100.0

Table 26. Supervisor level for standards management organization

No.		n	%
1	Non-management	0	0.0
2	Management	6	19.4
3	Department head	23	74.2
4	President, Vice president	2	6.5
	Total	(31)	100.0

Note: This results indicate the highest position in the respondent's organization.

Table 27. Standardization organization being part of patent organization

No.		**n**	**%**
1	Yes	11	31.4
2	No	24	68.6
	Total	35	100.0

Table 28. Organizational location where patent and standards management organization is located

No.		n	%
1	Within headquarters	9	75.0
2	Within business unit	2	16.7
3	Other	1	8.3
	Total	12	100.0