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Results of a survey on standardization activities: Japanese institutions' standardization activities in 2017 (Implementation, knowledge source, organizational structure, and interest in artificial intelligence) (Revised)

TAMURA, Suguru
RIETI

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Results of a survey on standardization activities: Japanese institutions' standardization activities in 2017 (Practice, knowledge source, organizational structure, and interest in artificial intelligence)

Suguru TAMURA
RIETI (Research Institute of Economy, Trade and Industry)

Abstract

This study discusses the results of a survey on standardization activities to provide valuable information on this topic. Currently, standardization is similar to platform formation in that it serves as a firm's central theme for creating a strategy. Furthermore, the management structure of standardization is of interest to understand the organizational structures of firms better. Data from selected Japanese institutions' standardization activities in 2017 are collected using a questionnaire survey. The survey contains three main categories: (1) degree of standardization activities, (2) knowledge sources for standard formation, and (3) organization of standardization activities. Particular focus is on standardization activities with regard to artificial intelligence. To the best of my knowledge, this comprehensive survey related to standardization activities is the first of its kind.

Keywords: standardization activities, questionnaire survey, knowledge sources, organizational structure, artificial intelligence

JEL: O20, O30.

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Contact: tamura.edu@nifty.com

1. Introduction

This survey is the first of its kind and reveals new information about institutional standardization activities (Tamura, 2019a).[1,2,3] To obtain information about standardization activities, I conducted a questionnaire survey and analyzed the collected data to discuss the results. The results of this study are academically and practically relevant in that data for this research purpose remain scarce and data collection methodologies are underexplored. Although the findings may seem to lack generality and international representativeness because the survey focuses on Japan's standardization activities, they are still important in this regard.

This survey has some advantages over conventional academic and practical surveys. This survey attempts to overcome both practical and academic limitations due to the lack of data collection experience. Moreover, the survey's scope includes both de jure and de facto standards, and, thus, it particularly contributes to the improvement of measurement methodologies.[4] The merit of the survey is that it can observe all standardization activities, as it focuses on the institutions that internally practice de jure and de facto standardization.[5,6] This design is the core idea of this survey.

Data related to standardization activities have not been conventionally collected with a specific framework; hence, data accumulation has not yet improved. One reason for the data scarcity is that standardization activities are not considered scientific activities, and their measurement system has not been adequately developed as a scientific indicator (Godin, 2001). As a result, standardization activities are not properly included within the international innovation measurement system defined in the OECD Frascati and Oslo manuals (OECD, 2002, 2005; Tamura, 2013).[7]

This survey primarily focuses on micro standardization activities at the institutional level. The respondents are asked whether they conduct standardization activities. Moreover, this study explores the relationships between standardization activities and related essential factors (e.g., knowledge sources, the institution's managing structure, and the types of standardization activities practiced). The survey is composed of three main categories: (1) the degree of standardization activities, (2) knowledge sources for standard formation, and (3) internal organizations for standardization activities. These data are useful for capturing relevant insights into management strategy and structure by reflecting each respondent's self-recognition of standardization activities. The data are important in that they capture current standardization activities within organizations. Furthermore, interest in the standardization of AI-related technology is investigated because AI-related standards are currently underdeveloped and still remain largely unexplored in academia.

With respect to the contrast between de jure and de facto standards, governmental and quasi-governmental agencies establish de jure standards. Hence, the bibliographic information for these

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[1] Japan's Industrial Standardization Law, which was revised in 2018, requests that both the public and private sectors engage in standardization activities as desired endeavors. The revised law went into effect in 2019. For this reason, this study, which collects relevant data to this law, is important from the perspective of policy evaluation and policymaking.

[2] To avoid conceptual confusion, I note that the term "institution" refers to a company as a whole. The term "organization" is used to refer to an individual department or office within an institution. An exception to this rule is the SDO, which is described using the term "organization." This usage is because the word "organization" is part of the SDO's name. I also describe the SDO as an "external organization" as opposed to an "internal organization."

[3] Standardization activities related to patenting activities are measured in the survey of the JPO (Japan Patent Office, 2009). However, this survey measures standardization with a narrower scope than the scope of standardization activities in general.

[4] The concept of de facto standardization activities generally includes consortium standardization activities. In this study, the main focus is on consortium standardization, and for simplicity of expression, the term "de facto standard" is used to mean consortium standards without any supplemental explanation.

[5] A survey of SDOs cannot cover all de facto standardization activities; only consortium standardization activities, which are one part of de facto standardization activities, can be covered by such a survey.

[6] In the survey discussed here, which was conducted in 2018, it is explicitly stated that consortium standardization is the survey's scope, but it is not explicitly stated that all de facto standardization is covered. However, de facto standards are considered to be implicitly included in the scope of the survey as an aspect of consortium standardization.

[7] This discussion is based on Tamura (2010, 2013) and reflects the information at the time of these articles' publication. Please check for the latest information.

standards is monitored and accumulated well, and the information is used for academic and policy purposes. Some databases for de jure standards (e.g., PERINORM and e-JISC) already exist.[8]

In contrast, data related to the formation of de facto standards have not been sufficiently created based on the available information in the market. De facto standards are established as the result of market competition, mainly within an industry. De facto standards therefore have a similar meaning to the market share of products (Yamada and Kurokawa, 2005). A competitive environment in the market is usually monitored based on products' market shares. However, determining the market shares of products and services requires substantial intentional monitoring. Thus, such monitoring is not entirely possible.[9]

Theoretically, de facto standards can change dynamically, and a market can shift between multiple de facto standards and a unique de facto standard because industrial structures are dynamic rather than static. Thus, the formation of standards serves as an indicator of the industrial structure. Understanding activities related to standardization has important implications for competition policy.

In practice, standards are not necessarily established as unified standards, and several standards can coexist in the market. The coexistence of multiple standards typically reflects the industrial structure of an oligopoly market (e.g., in the smartphone market, two de facto standards for operating systems exist: iOS for Apple smartphones and Android OS for Google smartphones). In contrast, in a monopoly market, only one de facto standard exists.

At present, in many cases, standardization (e.g., de facto standardization) is comparable to platform formation in an industrial structure context. Standardizing a networking protocol is a type of platform formation. Once a firm successfully forms its platforms through standardization, it can control the structure of the industry to which it belongs and achieve a leading position (e.g., Google, Amazon, and Facebook).

This survey directly studied institutions that frequently practice R&D activities. In this respect, this survey can gather comprehensive information related to standardization and can observe the direct relation between R&D and standardization.

This survey attempts to cover both upstream and downstream R&D activities by focusing on the degree of standardization activities. The standardization activities considered here mainly consist of drafting standardization documents (i.e., downstream activities) and standardizing the R&D results of technologies for products and services (i.e., upstream activities). Some downstream activities are carried out within institutions, and others are carried out within SDOs. Upstream activities are to plan the standardization of R&D results and are carried out by individual institutions according to their R&D or marketing strategies.

Previous research has mainly gathered data on downstream activities outside of R&D institutions (i.e., activities in SDOs). For example, these data may include the number of formulated standards and the number of participants affiliated with SDO activities (e.g., the ISO and the IEC). Previous research has not collected data within firms. Furthermore, R&D-related data on upstream standardization activities within institutions have not generally been gathered sufficiently and systematically because of the methodological difficulty of observing activities for standardizing R&D results.

This survey includes new technology areas. Efforts to gather standardization information related to advanced technologies are essential for improving the measurement framework for standardization (Tamura, 2019a). Namely, a survey related to emerging technologies (e.g., AI-related technologies) is essential. At present, no technological classification of AI-related standards has been officially

[8] PERINORM and e-JISC are the bibliographic databases for standards. PERINORM is the database of de jure standards utilized by the EU. e-JISC is the database of de jure standards used by Japanese organizations (e.g., the JISC). These databases exclusively include de jure standards and not de facto standards. Moreover, at present, these databases contain only relevant data described in standards documents and not data related to organizational administrations for standardization. Some previous studies on the effective terms of de jure standards used data from these databases for econometric analysis (Blind, 2008; Tamura, 2018, 2019b, 2019c).

[9] When a de facto standard for electrical equipment is formed, the product market share is around 2% to 3% (Yamada and Kurokawa, 2005). For this analysis, the contents of newspaper articles are used.

established by either international standardization institutions (e.g., the ISO and the IEC) or regional institutions (e.g., the JISC).

2. Methods and Data

In this study, a survey on the standardization activities of Japanese institutions (the SoSA), called "Hyojunka katsudo chosa" in Japanese, was conducted in 2018.[10,11] The survey aimed to collect data regarding firms' standardization activities in 2017 (i.e., activities in the year prior to 2018). The target firms were those with reported sales of over 100 million USD (10 billion yen). The firms were chosen from the Nikkei database.[12,13] The questionnaire was sent to corporations and other institutions via postal mail. The number of survey subjects was approximately 1,600, and about 110 responses were obtained via postal mail. The authentication of standardization activities is not included in the survey's scope.[14,15]

In summary, this survey mainly focuses on collecting data on standardization activities within institutions, and it covers both de facto and de jure standardization activities, as mentioned above. Moreover, it covers domestic and international standardization activities, as both types of standardization activities can be observed by surveying an institution.

3. Results

A total of 104 survey responses were obtained. Table 1. shows the distribution of the industrial categories represented by these respondents. The frequencies do not sum to 104 because eight respondents did not respond to this questionnaire item.[16] The three largest industries are the other manufacturing (i.e., category 5), electric machines (i.e., category 2), other non-manufacturing (i.e., category 9) industries.

[Insert Table 1. here]

Table 2. presents the number of institutions that practice standardization activities. Among the responding institutions, 60.8% (62 observations) practice standardization activities (i.e., category 1).

[Insert Table 2. here]

Table 3. presents the distribution of R&D budgets. The modal budget size is found to be category 6 (10,000–99,999 thousand US dollars).

[Insert Table 3. here]

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[10] This survey was initially conducted under the Japanese title of "Hyojunka katsudo ni kansuru anketo."

[11] This title is "標準化活動調査" in Japanese characters.

[12] Nikkei is a major financial newspaper company in Japan. Firm data are obtained from the Nikkei database.

[13] One US dollar was approximately equal to 100 Japanese yen at the time of this book's writing.

[14] Regarding the definition of standardization in this survey:

1. Standardization means unifying technical specifications, test evaluation methods, and terms and symbols in a certain technical field. The standards described here include those that are defined among companies and those that are defined by SDOs.
2. Personnel engaged in standardization activities perform the above-mentioned standardization activities. Specifically, they handle the following tasks:
   (1) Standard planning, deliberation, and investigation
   (2) Survey activities, such as data acquisition for standard establishment
   (3) Management of established standards
   (4) Activities related to standardization for education and dissemination.

[15] Points to keep in mind regarding the definitions of the survey include:

(Note 1) The standards here include consortium and de jure standards.
(Note 2) The standards here do not include calibration standards to maintain measurement accuracy.
(Note 3) The standardization activities here do not include certifications based on standards (e.g., ISO and JIS certifications) and activities related to the maintenance and management of certifications.
(Note 4) Activities related to the science and technological development of technical standards are considered to be part of R&D activities.

[16] The total frequency may not reach 104 in the subsequent single choice questions because not all respondents answered all questions.

3.1. Types of Standardization Activities

As shown in Table 4., standardization activities related to products and services are the most frequent (84%) among the types of standardization activities being practiced (i.e., category 1). Product processes and measurement are practiced with similar frequencies (47%) (i.e., categories 2 and 3). Moreover, activities related to designs and symbols are practiced by 24% of respondents (i.e., category 4) (multiple answers are allowed).

First, the survey results reveal that activities related to the formation of design and symbol standards are substantially practiced. The actual standardization activities related to designs and symbols within institutions have not been sufficiently surveyed previously. As supplemental information, the role of such design and symbol standardization activities has become the subject of recent debate through the use of de jure standards bibliometrics data in Japan (Tamura, 2018, 2019b). Previously, standardization activities related to products, manufacturing processes, and measurement were mainly recognized as playing central roles, whereas those related to design and symbols (e.g., graphical representations) have received insufficient attention and observation.

[Insert Table 4. here]

3.2. Reasons for Not Practicing Standardization Activities

Clarifying the background for that standardization activities cannot be implemented is essential for policymaking. Table 5. presents several reasons that firms may not practice standardization activities. Corporations' decisions to practice standardization activities appear to be affected mainly by firms' products and service characteristics (Table 5.). The most commonly chosen option is that the product manufactured by the institution does not require standardization (i.e., category 1). Another commonly chosen option is that the institution may follow standards rather than create them (i.e., category 7). These reasons are associated with the goods and services that a firm provides. The respondents' answers seemingly imply that the need for standardization activities is primarily affected by the designs of products and services.

The lack of an internal organization to manage standardization activities (i.e., category 2) is seemingly another critical reason for not practicing such activities. Internal organizations for standardization are still developing and have not been fully improved. This result shows that the further development of organizations within institutions is still necessary to conduct adequate standardization activities. As supplementary information, such organizations' establishment is reported to be steadily improving in the example firms considered in case studies (Tamura, 2012).

In addition, this result indicates the difficulty of setting up internal organizations to manage standardization activities without policy support. It is worth noting that the respondents to this survey were mainly large companies with sales above a certain level. These firms have seemingly sufficient management resources in terms of their institutional capabilities. In this regard, these companies' systems are considered to be well-developed overall. Even in such institutions, however, internal organizations for standardization activities may not be firmly established, indicating insufficient knowledge and ability to set up such organizations.

The results reveal the difficulty in allocating workers to standardization activities. A shortage of human resources (i.e., category 4) is noted as another reason for not practicing standardization activities. The supply of human resources in this field is constrained because standardization activities are labor-intensive. In addition, the required knowledge and skills for standardization activities are often not conventionally acquired.

[Insert Table 5. here]

3.3. AI Technology

Attitudes toward standardization activities in the field of an emerging advanced technology (i.e., AI technology) are shown in Table 6. The technical scope of AI depended on the respondents' understanding when they answered this questionnaire item. In the questionnaire, I referred to AI in general terms. At present, a definition of AI technologies is not explicitly provided in the ISO and IEC classifications. As supplementary information, the technological classification of AI in patent

categories is almost specified (Fujii and Managi, 2018; Tseng and Ting, 2013).[17]

About 33% of respondents view the standardization of AI technologies as "important" or "relatively important" (i.e., categories 1 and 2). This number indicates a substantial need for the standardization of AI. By contrast, about 44% of respondents "do not deal with technology" or view AI as "unimportant" (i.e., category 5). One reason for the large number of responses in category 5 is that the industries surveyed are diverse, and some industries may not yet have a need for AI technology.

AI technology has not seemingly developed fully into a general-purpose technology at this time (Lipsey, Carlaw, and Bekar, 2005). As this technology develops into a general-purpose technology in the future, the vital need for standardization will seemingly become apparent. This finding emphasizes that current AI technologies are still undergoing a process of diffusion throughout the economy. The formation of standards often develops after a market has been substantially formed. In this respect, standardization may play a limited role in the initial stage of new technology diffusion. In particular, in the case of AI, distinguishing between existing technologies and AI technology is difficult because AI technology mainly improves the speed or accuracy of goods and services and does not affect their external appearance. Owing to AI's technical characteristics, its standardization is likely to be necessary only in limited areas in the early stages of AI technology diffusion.

Potential specific standardized aspects of AI technologies can include, for example, methods to measure its efficiency or accuracy (i.e., performance measurements), related terminologies (i.e., the unification of terms and definitions), and ethical aspects of its applications. These fundamental standards are essential in this early stage to improve the technology's diffusion and social acceptability.

The social application of AI technology is still developing, and the areas in which the technology is applied are still limited. The diffusion of new ideas, such as AI, in society is difficult (Rogers, 2003). When new technologies are introduced, communication difficulties arise because appropriate expressions do not yet exist; consequently, the public acceptance of these technologies is delayed. Various standardization activities have been conducted in the past to address this situation (e.g., for nanotechnology; Blind and Gauch, 2009).

[Insert Table 6. here]

3.4. Sources of Information on Standardization Activities

Among the information sources, SDO information is mostly used, followed by standardization documents, patent information, and academic articles, in descending order (Table 7.). This result indicates the importance of SDO activities as an information source. Simultaneously, this result demonstrates the importance of controlling SDO activities in terms of trade secret protection so that participating firms can maintain their technological advantages (Tamura, 2015). In SDO activities, technical information can flow from one institution to another either intentionally or unintentionally. Careless information provision in an SDO meeting can lead to information leakages to a firm's competitors.

Among the items, design rights are used as a knowledge source at a notable frequency.[18] Although detailed background studies are necessary to deeply understand the observed facts, the information may be primarily used for the development of standards related to designs and symbols, such as pictograms. Until now, the importance of design rights in standards formation has not been thoroughly discussed in terms of standardization. As supplementary information, it is commonly known the patent information has been used for standardization. This usage is also indicated in Table 7.

[Insert Table 7. here]

3.5. Degree of Importance of Data Sources for Standardization Activities

Information on SDO meetings and standardization documents are highly valued as "important" or "relatively important" data sources (Table 8.). Table 8. provides more detailed results (i.e., a five-point scale evaluation) than Table 7. does. These results imply that the information gained from standardization activities is important information for forming knowledge about standards. In other

[17] The IPC is used for AI-related patent analysis (Fujii and Managi, 2018; Tseng and Ting, 2013).

[18] In the context of this survey item, design rights information includes legal design rights of IP.

words, the results imply that standardization requires knowledge exchanges in non-textual forms.

The formation of knowledge related to standards seemingly follows different creation models and mechanisms from those of other knowledge creation systems (e.g., patents and academic articles). This difference is because standardization is formed through the agreement of related parties.[19] The study results show that the establishment of standards requires not only textual information but also knowledge transitions through direct human interplay.

Direct non-textual knowledge exchanges among people seem largely essential to the formation of standards knowledge. This situation seems to differ from the general perception that information processing technologies, such as information extraction, can sufficiently generate new knowledge without human interaction if only textual information is available. In research for knowledge creation, scholars and policymakers are gradually placing lower values on knowledge transitions through direct human interplay, which are not officially documented and cannot be read in textual records.[20] In this light, various works of research focus more on bibliographical and textual analyses to create new knowledge based on the precondition that digitized data are widely available. Despite this current trend, the results show the importance of two-way direct information exchanges between people for knowledge creation.

Models and mechanisms that consider the high stickiness of information on standards can explain the reason it is difficult to transfer this knowledge through textual information (Tamura, 2014). It is not easy to transfer information on standards unless it is combined with background information for consensus building.

In terms of policy implications, this result indicates the substantial need for measures to prevent unintentional technology information leakages in standardization activities. This necessity is because non-textual information is essential for the formation of technical standards.

[Insert Table 8.]

3.6. Protection of Trade and R&D Secrets in Standardization Activities

The survey results underscore the necessity of preparing to protect trade secrets during standardization activities. From the observed facts, it can be concluded that the formation of management guidelines for standardization activities and trade secret protection is an important policy measure. Of the respondents, 27% said that they stipulate institutional management guidelines for standardization activities, whereas 73% said that they do not (Table 9.). Furthermore, among the firms that stipulate standardization management guidelines, approximately 67% said that trade secret protection notices are included in these guidelines (Table 10.).

[Insert Table 9. here]

[Insert Table 10. here]

Firms participating in standardization activities need to consider not only the collection of information but also concerns about trade secret leakages (Tamura, 2015). The results seemingly reflect the fact that standards formation requires consensus, especially for de jure and consortium standards. Institutions' standardization activities are divided into internal and external activities. With internal activities, the risk of trade secret leakages is low, whereas, with external activities, the risk of unintended leakages is high. Thus, previous research shows that firms with high R&D orientations and patenting-filing firms tend not to participate in standardization activities and do not view such activities as necessary, whereas patent-preparing firms tend to participate in standardization activities and file more patents (Gandal, Gantman, and Genesove, 2007; Tamura, 2015; Zi and Blind, 2015).

3.7. Organizational Structure of Standardization Activities

About 39% of the respondents claimed they have an internal organization for standardization management, whereas about 61% claimed not to have a specific internal organization (Table 11.).

[19] This statement holds for de jure and consortium standards only.

[20] Here, "direct human interplay" includes interplay through web meetings and other communication methods. Namely, interactive bidirectional communication is essential to the creation of standards knowledge.

Although it is difficult to determine whether this number is high, it seems that institutional development is progressing in an environment in which standardization activities are considered important.

[Insert Table 11. here]

Table 12. presents the responses regarding the location of the internal organization related to standardization activities. About 81% of respondents indicate that standardization activities are organized within their headquarters. Only about 16% indicate that they are organized within a business unit. The survey results on organizational positioning are consistent with a previous study on Japanese electric machine corporations (Tamura, 2012). The observed results on internal standardization organizations are consistent with prior research on the relationship between internal standardization organizations and strategies (Tamura, 2012). A prior case study of the development of internal standardization organizations in the Japanese electric machine industry (i.e., NEC, Hitachi, and Fujitsu) shows that internal standardization organizations have changed from departmental to headquarters organizations (Tamura, 2012).

The position of internal standardization organizations is changing from individual to central control departments because of the increasing importance of standardization strategies. In this way, standardization activities are changing from department-level activities to institution-level activities. In the 20th and 21st centuries, activities related to standards have shifted from focusing on calibration standards to focusing on corporate strategies related to product design. This shift in the role of standards is also the underlying background for the institutional change. Firms should adjust their strategies to changes in the external environment, and institutional structures should develop to respond to these institutional strategy transformations.

This optimization of the institutional structure is necessary because implementing new strategies within an existing institutional structure is usually costlier. These costs are incurred because new strategies often involve the implementation of new operations that have not been optimized within the existing institutional structure. This implementation may even be impossible if the incurred cost is high. On this point, a strategy requires an adjusted institutional structure for implementation (Chandler, 1962). Related to internal IP organizations in Japan, the relationship between institutional strategies and structures is discussed in terms of the relationship between firms' patent strategies and their institutional structures (Granstrand, 2000; Hirata et al., 2001). In this research, institutions applying for patents change their structures and roles in response to the external environment (Chandler, 1962; Hirata et al., 2001; Sasaki et al., 2001).

[Insert Table 12. here]

The survey examined the human resources aspects of internal standardization organizations in detail. The modal size (i.e., the number of employees) of the internal management organization for standardization is less than ten employees, followed by 10–49 employees (Table 13.). About 77% of the respondents indicate that the department head is in charge of the head of the internal standardization organization (Table 14.). This category is the most frequent case.

[Insert Table 13. here]

[Insert Table 14. here]

3.8. Organizational Integration

About 34% of respondents indicated that standardization and patenting activities management belong to the same department (Table 15.). The integrated management of patents and standardization can be interpreted as one of the objectives of establishing a standardization management department within the headquarters. This result is consistent with the structural development model related to the integration of patent and standardization activities (Tamura, 2012). This merger in strategies results in the merger of standardization and patent organizations.

In addition, all respondents with integrated patent and standard organizations indicated that the integrated organization belongs to the institution's headquarters. No respondent indicated that an integrated patent and standardization organization belonged to a business unit (Table 16.). These

internal organizations' placements within companies' headquarters indicate that the unification of patents and standards is a strategy that spans an entire institution.

[Insert Table 15. here]

[Insert Table 16. here]

4. Conclusion and Policy Implications

This study considers standardization activities based on survey results. The results capture previously unknown information on standardization activities.

First, the formation of knowledge related to standards is found to follow a different creation model and mechanism from those used by other knowledge creation systems (e.g., patents and academic articles) in that standardization is mainly achieved through the agreement of related parties. Information from participation in SDO activities and information from standardization documents both have essential value as sources of knowledge for standardization.[21]

Concerning policy implications, the results indicate the need for measures to prevent unintentional technology information leakages in standardization activities (Tamura, 2015; Zi and Blind) to control the leakages of technical information in non-textual forms.

Second, the establishment of standardization organizations has been achieved to a certain degree. Furthermore, competent standardization management organizations are likely to be established within an institution's headquarters. These results imply that, from the perspective of institutional design, standardization activities are a strategy for entire corporations. This finding indicates that standardization organizations have come to play the role of optimizing a company's overall strategy. This development is consistent with improvements predicted by theory and academic research (Chandler, 1962; Hirata et al., 2001; Sasaki et al., 2001; Tamura, 2012). In addition, the integration of standardization and patent organizations is observed. This result suggests that comprehensively controlling the information related to those two activities has become essential from both legal and business perspectives (Tamura, 2016, 2019b).

Third, management guidelines for standardization activities seem to be an effective way to mitigate the risk related to knowledge outflow. The survey results show that guidelines for protecting trade secrets are being prepared to a certain degree. Controlling the cost of trade secret outflow is an important management issue for institutions. Thus, management guidelines must be stipulated to increase the benefits from standardization activities by controlling the outflow and increasing the inflow of technology information. It is essential to recognize that SDO activities are both an opportunity to gain information and a source of information leakage risk. Previously, the need for such guidelines was discussed in case studies (Tamura, 2012, 2015).

Finally, the need for standardization activities for AI seems to be in an initial stage in that the diffusion of AI technology has just started. According to the 2017 survey, the need for such standardization activities still seems to be in its infancy.[22]

[21] This result suggests that two-way communication among participants in SDO meetings is important for effective information transfers. This result is consistent with the explanation that information related to standardization activities is stickier (in short, information transfer costs, including information coding costs, are high) (Tamura, 2014).

[22] One other possible reason for this result is the inability to monitor standardization formation related to AI technologies owing to the lack of well-developed monitoring methods. One possible reason for this difficulty is the lack of a classification code for AI-related technologies in the current standards classification system (International Organization for Standardization, 2015).

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Tables:

Table 1. Industrial categories

No.	Category	n	%
1	Machine	9	9.4
2	Electric machine	15	15.6
3	Transportation machine	4	4.2
4	Business machine	0	0.0
5	Other manufacturing	49	51.0
6	Information and telecommunications	2	2.1
7	Wholesale and retail	1	1.0
8	Finance	1	1.0
9	Other non-manufacturing	11	11.5
10	Education/TLO	4	4.2
	Total	96	100.0

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

Table 2. Practice of standardization activities

No.		n	%
1	Yes	62	60.8
2	No	40	39.2
	Total	102	100.0

Table 3. Budget allocations for R&D

No.	Budget		n	%
	(thousand US dollar)	Reference :(million yen)		
1	0	0	7	8.0
2	< 100	< 10	3	3.4
3	100–499	10–49	3	3.4
4	500–999	50–99	5	5.7
5	1,000–9,999	100–999	16	18.4
6	10,000–99,999	1,000–9,999	30	34.5
7	100,000 <	10,000 <	20	23.0
8	Unknown	Unknown	3	3.4
	Total		87	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 4. Types of standardization activities being practiced

No.		n	%
1	Standardization activities related to products and services	52	83.9
2	Standardization activities related to the manufacturing process of products and services	29	46.8
3	Standardization activities related to measurement	29	46.8
4	Standardization activities related to designs and symbols	15	24.2
	(Total)	(125)	

Note: The total number of responses (125) is not equivalent to the number of respondents (62) because multiple answers are allowed for this question. The percentage column shows n/62 × 100.

Table 5. Reasons standardization activities are not practiced

No.		n	%
1	Standardization activities are not needed for marketing own products and services.	21	55.3
2	No established organization for standardization activities.	7	18.4
3	The management capacity for standardization activities is scarce.	2	5.3
4	Labor force for the standardization activities is scarce.	4	10.5
5	Existence of outflow risk of technology information and related trade secret.	3	7.9
6	The cost of practicing the standardization activities is higher than the benefit gained from the activities.	4	10.5
7	Using already established standards rather than formulating standards.	17	44.7
	(Total)	(58)	

Note: The total number of responses (58) is not equivalent to the number of respondents (38) because multiple answers are allowed for this question. The percentage column shows n/38 × 100.

Table 6. Importance of standardization for AI-related technology

No.		n	%
1	Important	14	18.7
2	Relatively important	11	14.7
3	Neutral	12	16.0
4	Relatively not important	5	6.7
5	Not important/do not deal with the technology	33	44.0
	Total	75	100.0

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

Table 7. Use of data sources for standardization activities

No.	Data source		Use		Total
			Yes	No	
1	Academic article	n	31	27	58
		%	53.4	46.6	100.0
2	Patent information	n	31	26	57
		%	54.4	45.6	100.0
3	Standardization document	n	40	17	57
		%	70.2	29.8	100.0
4	Design right information	n	14	42	56
		%	25.0	75.0	100.0
5	Information obtained from the SDO meetings including the participants	n	43	15	58
		%	74.1	25.9	100.0
6	Other sources	n	2	18	20
		%	10.0	90.0	100.0

Table 8. Importance of data sources for standardization activities

No.	Data source		Importance					Total
			Important	Relatively important	Neutral	Relatively not important	Not important	
1	Academic article	n	11	13	16	1	5	46
		%	23.9	28.3	34.8	2.2	10.9	100.0
2	Patent information	n	7	18	13	3	2	43
		%	16.3	41.9	30.2	7.0	4.7	100.0
3	Standardization document	n	18	19	9	1	1	48
		%	37.5	39.6	18.8	2.1	2.1	100.0
4	Design right information	n	3	9	13	4	3	32
		%	9.4	28.1	40.6	12.5	9.4	100.0
5	Information obtained from the SDO meetings including the participants	n	19	17	11	0	1	48
		%	39.6	35.4	22.9	0.0	2.1	100.0
6	Other sources	n	1	2	4	0	1	8
		%	12.5	25.0	50.0	0.0	12.5	100.0

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

Table 9. Stipulation of institutional guidelines for management of standardization activities

No.		n	%
1	Stipulated	21	26.6
2	Not stipulated	58	73.4
	Total	79	100.0

Table 10. Inclusion of trade secret protection and technology leakage countermeasures in the standardization activity management guidelines

No.		n	%
1	Included	14	66.7
2	Not included	7	33.3
	Total	21	100.0

Table 11. Establishment of organizations for standardization activities

No.		n	%
1	Yes	32	39.0
2	No	50	61.0
	Total	82	100.0

Table 12. Structure of organizations for standardization activities

No.		n	%
1	Within headquarters	26	81.3
2	Within business unit	5	15.6
3	Other	1	3.1
	Total	32	100.0

Table 13. Number of employees in the standards management department

No.		n	%
1	0	0	0.0
2	< 10	14	50.0
3	10–49	9	32.1
4	50–99	1	3.6
5	100–499	1	3.6
6	500 <	0	0.0
7	Unknown	3	10.7
	Total	28	100.0

Table 14. Level of the standards management department's supervisor

No.		n	%
1	Non-management	0	0.0
2	Management	5	16.1
3	Department head	24	77.4
4	President, Vice president	2	6.5
	Total	31	100.0

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

Table 15. Standardization organization's inclusion in patent organization

No.		n	%
1	Yes	11	34.4
2	No	21	65.6
	Total	32	100.0

Table 16. Organizational location of patent and standards management

No.		n	%
1	Within headquarters	11	100.0
2	Within business unit	0	0.0
3	Other	0	0.0
	Total	11	100.0