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Size Matters in Municipal Digital Transformation: Insights from local government survey in Japan

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Size Matters in Municipal Digital Transformation: Insights from Local Government Survey in Japan

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Abstract

We analyze the current status and challenges of municipal digital transformation (DX) based on data from an original questionnaire survey, showing that progress in DX has so far remained at a low level, with small municipalities lagging behind. Many factors hinder DX; these include lack of expertise, difficulties in internal human resource development, and many written procedures. Smaller municipalities face hardware limitations, such as inadequate IT equipment and security systems. Our empirical results suggest that municipal DX at the introductory stage is expected to improve the quality and efficiency of public services through the digitization of administrative procedures and automation. DX in the later stage, in which municipalities adapt their workflow or organization to the digital environment, is conducive to teleworking, data-driven decision making, evidence-based policy making, and proliferation of DX in the local industry from the perspective of industrial policy.

Keywords: digital society, telework, data-driven decision making, regional industrial policy, municipality size
JEL classification: H70, R50, O33

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1. Introduction[1]

The Japanese government has focused on digitalization as a driving force for its growth strategy. Among the proposed measures, the government designs municipal digital transformation (municipal DX) to transform the administrative operations of local governments with digital technology and build an essential common foundation for a digital society.

The discussion on private corporate strategy often distinguishes digital transformation (DX) from mere digitization, which aims to streamline the operational process. It portrays the integration of digital ICT into corporate management, involving the transformation of organizational structure and corporate culture. Vial (2019) points out that corporate DX strengthens engagement with stakeholders, triggering firms' strategic responses to changing value-creation paths and value propositions.

Similarly, the central government expects local governments to engage in DX not only to raise service delivery efficiency but also to break bureaucratic culture, whereby new ways of communication and information-sharing inspire operational flexibility and interactive engagement with the local community. We take a two-stage view of DX that improves efficiency with digitization in the introduction stage and triggers structural transformation in the next stage. This view derives from Janowski's (2015) model of digital government, which comprises four stages: digitization, transformation, engagement, and contextualization. The distinctions between the stages are as follows: whether digitization just adds to the internal working of the government, or it transforms its functional structure (from digitization to

[1] **Abbreviations:** DX, Digital Transformation; AI, Artificial Intelligence; RPA, Robotic Process Automation; CIO, Chief Information Officer; METI, Ministry of Economy, Trade and Industry; MIC, Ministry of Internal Affairs and Communications; RESAS, Regional Economy Society Analyzing System; RIETI, Research Institute of Economy, Trade and Industry; CISO, Chief Information Security Officer; DDDM, Data-Driven Decision-Making; EBPM, Evidence-Based Policymaking;

transformation); whether the transformation is only internal to the government, or it transforms the relationships with citizens, businesses, and other stakeholders as well (from transformation to engagement); and whether the transformation depends on a particular application context, for example, of a country, location, or sector, or is context-independent with many stakeholders (from engagement to contextualization).

We consider that corporate DX and local government DX will eventually merge into regional DX, as in the engagement and contextualization stages of Janowski's model. Local stakeholders come together to connect, share, and accumulate public and private data to construct a common platform for the government and private sector to look for innovative solutions to relevant issues in the local community. Local governments would exploit available data for data-driven decision-making and evidence-based policymaking. Thus, the second stage of municipal DX is characterized by the local governments' placing value on data and the proliferation of DX on a regional platform.

In this context, the concept of open data has gained widespread support. However, it often falls short of realizing the expected benefit because of the inadequate interaction between the user and supplier of the data to improve data quality (Janssen et al., 2012). Mergel et al. (2019) remark that DX aimed at higher citizen satisfaction requires decapsulation of bureaucratic culture and frequent adjustments in response to information feedback from local residents and firms. Recent studies suggest progress in this direction. Although an early study by Norris and Reddick (2013) found that local e-government services in the US were mainly one way from the government to citizens, Cho et al. (2021) show that the use of online participatory platforms has been increasing, and civic participation in offline activities is also growing.

A growing number of studies have been conducted worldwide on the progress of the public sector's DX and e-government adoption. For example, Velsberg et al. (2021) studied Nordic countries; Pittaway and Montazemi (2020) studied Canada; Kuhlmann and Heuberger (2021)

studied Germany; Epstein (2022) studied the USA; and Bousdekis and Kardaras (2020) studied Greece. This article adds to the literature a Japanese case study of the DX of local governments. We exploit this dataset from a unique survey of local governments. To our knowledge, this is the first comprehensive empirical study of this topic in Japan.

In Section 2, we review Japanese government policy to promote municipal DX. Section 3 presents findings from the data regarding local governments' perceptions, implementation organization, and advances in and obstacles to DX. Section 4 considers the impact of DX on local governments' internal work organization, focusing on the implementation of teleworking, which has become popular owing to activity restrictions under the current sanitary crisis. Section 5 sheds light on local governments' attitudes toward the proliferation of DX in the local economy. We focus on local governments' inclination to use digital information for policymaking. Finally, Section 6 concludes the paper.

2. Japan's policies for the formation of a digital society

In Japan, the government has adopted a gradual approach to form a digital society. In the Basic Act on the Formation of an Advanced Information and Telecommunications Network Society (IT Basic Act), enacted in 2000, the government established fundamental principles and priority measures for forming an advanced information and telecommunications network society. The IT Basic Act stipulates that "necessary measures shall be taken to promote the informatization of public administration, including the expansion of the use of the Internet and other advanced information and telecommunications networks in the affairs of the national and local governments, to improve convenience for citizens and to contribute to simplification, efficiency, and transparency in administrative management."

The Basic Law for the Promotion of Public-Private Data Utilization, enacted in 2016, sets forth the basic policy of shifting paper-document-based administrative procedures online. In December 2020, the cabinet approved the Basic Policy for Reforms toward the Realization of

a Digital Society and the Digital Government Action Plan. This plan set the guiding principles to work with local government to address the following: (1) to offer online administrative procedures[2] using the Myna Portal website as a common platform; (2) to unify information systems for the seventeen core operations of local governments[3] in the common specifications established by the government and integrate them into the Government Cloud (Gov-Cloud), a common platform for the public administrative information systems; (3) to standardize operation processes conforming to the Standard Data Layout and aligning information system equipment to the Local Government Information System Standard[4]; (4) to ensure appropriate information security; (5) to improve operational efficiency through the use of AI (Artificial Intelligence) and RPA (Robotic Process Automation); (6) to use big data processing; (7) to establish an open data platform; (8) to establish the information governance structure in each organization consisting of the elected leader, chief information officer (CIO), and CIO aide; and (9) to prepare the technical staff through appointment of external personnel and training of internal staff.

The concept of DX gained attention in Japan after the Ministry of Economy, Trade and Industry (METI) issued the *DX Report* (METI, 2018). It predicted the advent of the digital cliff problem by 2025, caused by the end of the support period of the current corporate IT systems

[2] The Digital Government Action Plan stipulates that local governments offer online procedures in 31 services using My Number Card (Myna Card) as the digital identification. They include 15 procedures related to child-rearing; 11 procedures related to elderly nursing care; application for issuance of disaster victim certification; and 4 procedures related to automobile ownership. In addition, an increasing number of municipalities add other online procedures such as employment certification, establishment of firms, relocation of residence, health/medical care, and report of death.

[3] A total of 17 operations: basic resident register, electoral roll management, fixed asset tax, resident income tax, corporate income tax, light motor vehicle tax, national health insurance, national pension, welfare for the physically disabled, medical care for the late-stage elderly, nursing care insurance, child allowance, livelihood protection, health care, school attendance, child welfare allowance, and child rearing support.

[4] To avoid lock-in to a particular vendor, equipment is eligible for purchase or leasing if it uses a common specification that standardizes interfaces so that information can be exchanged between systems from different vendors.

and insufficient up-to-date IT specialists to leverage new information technology. Having the same concern for the local governments, the Ministry of Internal Affairs and Communications (MIC) has formulated the Digital Transformation Promotion Plan for Local Governments (2020). This plan specifies priority targets in line with the Digital Government Action Plan and national government support for local government actions. It also defines provisions for inclusive adaptation of local communities to digital technology. They encompass initiatives for local human capacity building, job creation by supporting the adoption of digital technology in tourism promotion and dismantling barriers for small- and medium-sized enterprises, and the realization of a digitally empowered, safer, and more secure local society.

The Basic Act on the Formation of a Digital Society was enacted in 2021. It outlined basic policies regarding the formation of a digital society, defining the expected roles of national and local governments and private businesses. Under this law, the Digital Agency was established to promote the digitization of administrative organizations across the board at the national level, with the aim of eliminating the adverse effects of inter-ministerial dysfunctional communication.

It is commonly believed that the digital content market exhibits a strong network externality, where the marginal utility of an individual user increases and the marginal cost of an individual provider decreases as the number of participants sharing a data platform grows. Networking capabilities become a critical resource in the digital setting as firms tend to co-create value with a set of digitally connected firms (Verhoef et al., 2021). Thus, METI shifted the pivot of local industrial policy to the formation of digital platforms for matching and collaboration among local industries, government, academia, and financial institutions through the creation of a scheme for accreditation of leading regions and sharing their experiences. The METI provides its own digital resources for this purpose. For example, J-Grants is a portal site from which firms and local governments can apply for industrial subsidy programs. The Regional Economy

Society Analyzing System (RESAS) portal site provides local policy planners with a comprehensive online database and data visualization tools on demographic dynamics, regional macroeconomy, industrial structure and employment, firm activities, consumption, tourism, personal trip flows, healthcare provision, and public finance.

3. Analysis of the current status of municipal DX

3.1 Data

Against the background of the development of national policies described in the previous section, we developed the questionnaire for "Survey on the Promotion of Digital Transformation (DX) by Local Governments" undertaken by the Research Institute of Economy, Trade and Industry (RIETI) to evaluate the current status and challenges of municipal DX. We invited all 1718 municipalities and 47 prefectures throughout Japan. It consists of questions grouped into five blocks: (1) perception of municipal DX, (2) understanding of the objectives of DX, (3) teleworking, (4) support for DX of local industries, and (5) challenges in the promotion of DX in local governments and communities[5]. Questionnaires were mailed (on October 8) to the departments in charge of information policy or digitization promotion. Responses were obtained from 747 municipalities and prefectures, resulting in a response rate of 42% (747/1765)[6].

It should be noted that the survey was conducted almost 10 months after the formal announcement of the Basic Policy on Reforms for the Realization of a Digital Society, Digital Government Action Plan, and Municipal Digital Transformation Promotion Plan in December 2020. Due to the short time, we expected to observe a great variation in local governments'

[5] English translation of the questionnaire is available from the author upon request.

[6] The deadline for responses by mail or electronic file was November 4, but late responses were included in the data. The response rate by municipality population size was as follows: Municipalities with population less than 50,000: 499/1214=41%; Municipalities with populations between 50,000 and 300,000: 172/415 = 41%; Municipalities with population over 300,000: 42/89=47%; Prefectures: 34/47=72%.

actions and perceptions depending on the characteristics of organizations, before it decreased with the passage of time.

3.2 Municipalities' perceptions of DX

Table 1 and 2 concern local governments' perceptions of how residents evaluate their efforts in DX. Hereafter, unless otherwise specified, municipalities with a population of less than 50,000 are referred to as small municipalities, municipalities with a population of 50,000–300,000 as medium municipalities, and municipalities with a population of 300,000 or more as large municipalities[7].

Table 1. Residents' evaluation of whether their municipality is proactive in digital transformation.

Population size	Strongly agree (1)	Somewhat agree (2)	Not sure (3)	Weakly disagree (4)	Strongly disagree (5)	Not answered	Total	Affirmative (1) or (2)	Negative (4) or (5)
Small	2	10	204	126	155	2	499	12	281
	0.40	2.00	40.88	25.25	31.06	0.40	100	2.40	56.31
Medium	1	22	100	32	17	0	172	23	49
	0.58	12.79	58.14	18.6	9.88	0.00	100	13.37	28.48
Large	4	11	51	4	3	3	76	15	7
	5.26	14.47	67.11	5.26	3.95	3.95	100	19.73	9.21
Total	7	43	355	162	175	5	747	50	337
	0.94	5.76	47.52	21.69	23.43	0.67	100	6.70	45.12

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

According to Table 1, only 6.70% of all respondents answered "strongly agree" or "somewhat agree" (grouped as affirmative answer) to the question on their residents' favorable evaluation of municipalities' proactive attitudes toward DX, while 45.12% answered "strongly disagree" or "somewhat disagree" (grouped as negative answers). Table 2 shows that the

[7] The population of 300,000 was one of the conditions for the core-city (*Chukakushi*) status when it was formally established in 1994 to delegate more authority (the criterion was reduced to 200,000 in 2015). The population of 50,000 is one of the conditions for a municipality to become a city under the Local Autonomy Law. Cities handle social welfare services with their own budget, while municipalities in towns and villages delegate such functions to prefectures.

municipalities replying affirmatively about playing a leading role in the DX of local industries was also low at 6.02%, while negative replies accounted for 62.79% of the total.

Table 2. Responses regarding whether municipalities are leading digital transformation in their local industries.

Population size	Strong-ly agree (1)	Some-what agree (2)	Not sure (3)	Some-what disagree (4)	Strongly disagree (5)	Not ans-wered	Total	Affirma-tive (1) or (2)	Negative (4) or (5)
Small	1	8	129	156	204	1	499	9	360
	0.20	1.60	25.85	31.26	40.88	0.20	100	1.80	72.14
Medium	3	7	62	57	43	0	172	10	100
	1.74	4.07	36.05	33.14	25.00	0.00	100	5.81	58.14
Large	9	17	40	8	1	1	76	26	9
	11.84	22.37	52.63	10.53	1.32	1.32	100	34.21	11.85
Total	13	32	231	221	248	2	747	45	469
	1.74	4.28	30.92	29.59	33.20	0.27	100	6.02	62.79

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

In contrast, Table 3 shows that 41.77% of respondents agreed strongly or somewhat to "Do residents expect DX to contribute to solving social issues in the community?" The share of affirmative answers on local expectations was noticeably high, despite the negative self-perception of public evaluation of the local government's DX efforts shown in Table 1 and 2.

Table 3. Responses regarding whether municipality residents expect digital transformation to solve social problems.

Population size	Strong-ly agree (1)	Some-what agree (2)	Not sure (3)	Some-what disagree (4)	Strongly disagree (5)	Not answer-ed	Total	Affirma-tive (1) or (2)	Negative (4) or (5)
Small	22	147	246	57	24	3	499	169	81
	4.41	29.46	49.30	11.42	4.81	0.60	100	33.87	16.23
Medium	26	66	71	7	2	0	172	92	9
	15.12	38.37	41.28	4.07	1.16	0.00	100	53.49	5.23
Large	17	34	21	1	0	3	76	51	1
	22.37	44.74	27.63	1.32	0.00	3.95	100	67.11	1.32
Total	65	247	338	65	26	6	747	312	91
	8.70	33.07	45.25	8.70	3.48	0.80	100	41.77	12.18

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

Table 4 tabulates the three most valuable benefits of DX for respondents. Almost all municipalities, respective of size, selected "improving efficiency of administrative operations" and "promoting convenience of residents." The third most common response was "compliance with national policies of promoting digital government," which seems to be a passive motive for DX.

The answers here confirm generalized recognition of benefits of DX in the first digitization stage of municipal DX discussed in Section 1 (i.e., "improvement of service quality" and "raising the service delivery efficiency"). In contrast, few municipalities pointed to benefits in the third stage of proliferation by approving "enabling data-based policy selection and planning" and "promoting DX of local industry."

These tendencies differ according to the municipality size. Larger municipalities agree on the benefits of data-based policy selection, planning, and promoting the DX of the local industry. Small municipalities are more likely to approve the "reduction of labor costs with automation," another benefit in the first stage. Medium-sized municipalities are situated between the two ends.

Table 4. Benefits of digital transformation respondents consider more important for their municipality.

Population size	Improving efficiency of administrative operations	Reducing labor costs with automation	Improving the convenience for residents	Enabling data-based policy selection and planning	Promoting DX of local industry	Compliance with national policies	No response	Total
Small	476 95.4	170 34.1	468 93.8	67 13.4	36 7.2	227 45.5	16 3.2	499
Medium	166 96.5	43 25.0	163 94.8	39 22.7	14 8.1	82 47.7	2 1.2	172
Large	65 85.5	6 7.9	73 96.1	24 31.6	26 34.2	24 31.6	2 2.6	76

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

According to Table 5, 32.93% of all respondents indicated that DX resulted in a review of workflow and organization, which we stipulated to occur in the second stage of municipal DX. This percentage is markedly different according to population size: 20.64% for small municipalities, 51.16% for medium-sized municipalities, and 72.37% for large municipalities. The ratio of affirmative answers to the sum of affirmative and negative answers (i.e., (1)/ [(1) + (2)] in the last column) was 69.59%, even for small municipalities, compared to 84.62% for medium and 91.67% for large municipalities. Hence, most large and medium-sized municipalities implementing DX also engage in structural transformation, while this ratio falls short of 70% in small municipalities. In other words, more than 30% of small municipalities undertaking DX remain in the first stage without engaging in organizational adjustment, only seeking efficiency gains. It is even more striking that 69.14% of the small municipalities replied that they did not implement DX at all. Section 3.4.3 provides an analysis of the characteristics of municipalities that have not implemented DX.

Table 5. Responses regarding whether one's municipality's digital transformation resulted in review of workflow or organization.

Population size	Yes (1)	No (2)	Not implemented DX (3)	Not answered (9)	Total	Ratio (1)/(1+2)*
Small	103	45	345	6	499	
	20.64	9.02	69.14	1.20	100	69.59%
Medium	88	16	61	7	172	
	51.16	9.30	35.47	4.07	100	84.62%
Large	55	5	12	4	76	
	72.37	6.58	15.79	5.26	100	91.67%
Total	246	66	418	17	747	78.85%

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).
* Ratio (1)/(1+2) is the share of municipalities that reviewed workflow or organization among those that implemented digital transformation.

3.3 Organization to promote DX in local governments

According to Table 6, 48.87% of the respondents either strongly or somewhat agree that the mayors/governors give clear direction to promote DX. The larger the size of municipality, the more clearly the elected leader's will to promote DX is recognized, while 46.29% of the respondents of small municipalities were not sure and 17.24% had a negative impression.

The Municipal DX Promotion Plan adopted by the MIC in December 2020 stipulates that, under the leadership of the elected leader, the DX promotion organization counts on directions by the CIO[8] and the chief information security officer (CISO), who takes care of information security. The plan recommends that local governments appoint an external technology specialist as a CIO aide and maintain a section specialized in administering information systems. The DX promotion organization is required to transect the jurisdictions of administrative and operational groups.

Table 6. Responses to whether the mayor/governor shows a strong will to promote municipal digital transformation.

Population size	Strongly agree (1)	Somewhat agree (2)	Not sure (3)	Somewhat disagree (4)	Strongly disagree (5)	Total	Affirmative (1) or (2)	Negative (4) or (5)
Small	55	127	231	44	42	499	182	86
	11.02	25.45	46.29	8.82	8.42	100	36.47	17.24
Medium	49	68	38	12	5	172	117	17
	28.49	39.53	22.09	6.98	2.91	100	68.02	9.89
Large	50	16	10	0	0	76	66	0
	65.79	21.05	13.16	0	0	100	86.84	0
Total	154	211	279	56	47	747	365	103
	20.62	28.25	37.35	7.5	6.29	100	48.87	13.79

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

[8] De Tuya et al. (2020) state that the CIO is an entity that creates value for both the government and citizens, with the role of leading the available resources and building partnerships not only within the municipality but also externally to bring the necessary technology to core business processes to reach their goals. However, drawing from a U.S. case study, Young (2020) noted that when it comes to building public data platforms, the role of the department-level heads of the respective areas of jurisdiction in each organization is more significant than the leadership of the CIO, who is the head of the organization.

The CIO, who is a promoter, and the CISO, who monitors information security requirements, are the main pillars to promote municipal DX. Table 7 indicates that 47.12% of local governments have a CIO and 59.30% have a CISO. More than 60% of medium- and large-sized municipalities have two key positions.

Table 7. Responses regarding whether the positions and departments demanded by the digital transformation guideline have already been established in one's organization.

Population size	Total	Chief Information Officer (CIO)	CIO Aide	CIO Aide is external personnel	DX promotion department	Chief Information Security Officer (CISO)	No applicable position or department
Small	499	194	52	7	122	263	127
	100	38.88	10.42	1.40	24.45	52.71	25.45
Medium	172	108	27	14	91	122	8
	100	62.79	15.70	8.14	52.91	70.93	4.65
Large	76	50	24	14	57	58	5
	100	65.79	31.58	18.42	75.00	76.32	6.58
Total	747	352	103	35	270	443	140
	100	47.12	13.79	4.69	36.14	59.30	18.74

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

The implementation of DX requires specialized knowledge of recent digital technology, which is not usually available within municipal organizations. Thus, the government provides subsidies to appoint outside technical personnel as a CIO aid. However, Table 7 shows that only 13.79% of the municipalities have CIO aides. Even among large municipalities, less than one-third have appointed outside personnel as CIO aides.

3.4 Advances and obstacles regarding municipal DX

3.4.1 Actions taken toward municipal DX

In the Municipal DX Promotion Plan, the target date for providing citizens with full online municipal administrative procedures is set for 2022. This target is based on Article 2-1 of the Digital Procedures Law enacted in December 2018, which had set forth the "digital-first

principle" of "ensuring the adoption of information and communication technology to process a series of administrative procedures and related clerical works handled by administrative agencies and contracted private operators." The progress of local governments in this regard are tabulated in Table 8. According to this table, "digitizing documents" and "putting applications, procedures, and notifications online" are the most advanced, as nearly half of the municipalities responded that they are in the "experimental/partial introduction" or "full-scale implementation" stage.

Table 8. Current status of implementing digital transformation methods.

	No plan to introduce	Planning stage	Experimen-tal/partial introduction	Full-scale implemen tation	Not answered
Document Digitization	154	226	261	101	5
	20.62	30.25	34.94	13.52	0.67
Putting administrative application forms, procedures, and notifications online	53	330	270	88	6
	7.1	44.18	36.14	11.78	0.8
AI chatbots	402	188	74	77	6
	53.82	25.17	9.91	10.31	0.8
Automation of routine tasks with RPA	258	193	152	136	8
	34.54	25.84	20.35	18.21	1.07
Data integration via API	443	226	44	24	10
	59.3	30.25	5.89	3.21	1.34
Use of RESAS for the analysis of local industries	455	123	121	34	14
	60.91	16.47	16.2	4.55	1.87
Support for local SMEs in adopting IoT and AI	545	108	39	46	9
	72.96	14.46	5.22	6.16	1.2

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

Regarding the use of digital tools, 18.2% of respondents answered that "automation of routine tasks with RPA" is in the "full-scale implementation" stage, while 20.4% are in the "experimental/partial introduction" stage. Combining these two responses, nearly half of the

municipalities have introduced RPA. However, approximately 35% answered that they had "no plans to introduce" RPA, indicating that municipalities were polarized about automation. The proportion of municipalities in the implementation stages is even lower in the use of "AI chatbots to reduce call center/window congestion" and "Data integration via API"[9].

To ascertain whether municipalities link municipal DX to regional industrial policy, we asked about the implementation of "analysis of regional industries using RESAS" and "provision of support for local SMEs in adopting IoT and AI." The use of RESAS represents municipalities' attitudes toward data-based policy making, and providing support for local SMEs in adopting IoT and AI implies the intention to diffuse DX at the regional level. Table 8 shows the low interest of municipalities in this aspect: the percentage of municipalities in the implementation stage of these policies was only in the single digits, and the percentage of respondents with "no plan to introduce" was remarkably high[10].

Overall, a high percentage of municipalities are in the process of digitizing documents and introducing online procedures, but few municipalities have implemented automated information processing using digital tools. Very few municipalities connect municipal DX to regional industrial policies.

3.4.2 Obstacles to municipal DX

Table 9 summarizes the answers to questions regarding obstacles to promoting municipal DX. The construction of the list of obstacles follows Manoharan and Ingrams (2018), which classifies the determinants of local-level e-government adoption into three factors: external

[9]Article 2-2 of the Digital Procedures Law states as a basic policy that "administrative agencies should cooperate with each other to share such information using information systems."

[10] It is possible that such responses are due to limited knowledge of local industries among respondents because we requested departments in charge of information policy or digitalization promotion to respond the questionnaire. However, at the very least, they suggest that there is no shared recognition in local government of the link between municipal DX and local industries.

enablers, internal enablers, and barriers. Political competition and citizen adoption are the main external enablers. Employee and organizational capabilities are critical internal enablers. Barriers include lack of technology, finance, information, and elected leaders' political will. The most common agreements ("strongly agree" or "somewhat agree") regarded "difficulty in developing internal human resource" (92.0%) and "lack of expertise[11] to promote digitization of operational processes" (81.7%). Following these, more than 60% of municipalities approve of "difficulty in hiring external personnel," "many procedures require paper documents," and "delayed standardization and uniformization of data formats at the national level." Regardless of municipality size, the lack of human resources and expertise and lack of unification of documents and data formats are the main barriers to advancing DX. Considering that most small municipalities responded that they "have not implemented DX" as shown in Table 5, they are seriously constrained by internal and external human resources and expertise.

About 70% of small municipalities admit that they have a perception of the municipality being too small to benefit from DX, while 35% of medium-sized municipalities and only 1% of large municipalities gave the same reply. There might be a belief that advanced technologies serve only large organizations. A case study in the USA (Epstein, 2022) found that cities with a large population and a higher proportion of broadband Internet access have adopted e-government innovations earlier than others, which implies that size matters in advanced technology adoption. However, because any municipality, large or small alike, is expected to provide a full set of universal public services, DX must be attractive, especially to small

[11] As pointed out by Pittaway and Montazemi (2020), DX requires expertise that enables organizations to coordinate and use resources and capabilities in new ways. The requisite expertise are: (1) to enact a strategy to explore innovative opportunities while pursuing efficiency in existing opportunities; (2) to select the most rewarding innovations in support of improved public service delivery while outsourcing non-core operations; (3) to recruit necessary external resources such as universities to enhance learning capacity; and (4) to restructure IT governance vesting decision power to leading officers while stakeholders monitor gaps in performance.

municipalities, because routine process automation allows them to concentrate scarce human resources on tasks that are particularly needed in the community.

Table 9. Obstacles to municipal digital transformation.

	Affirmative	Not sure	Negative	Not answered
(a)	479	213	53	2
	64.12	28.51	7.1	0.27
(b)	610	102	33	2
	81.66	13.65	4.42	0.27
(c)	512	167	67	1
	68.54	22.36	8.97	0.13
(d)	687	53	7	0
	91.97	7.1	0.94	0
(e)	385	287	68	7
	51.54	38.42	9.1	0.94
(f)	260	374	110	3
	34.81	50.07	14.73	0.4
(g)	336	247	163	1
	44.98	33.07	21.82	0.13
(h)	506	166	74	1
	67.74	22.22	9.91	0.13
(i)	381	147	217	2
	51	19.68	29.05	0.27

(a) Delayed standardization and uniformity of data formats at the national level
(b) Lack of expertise to promote digitalization of operational processes
(c) Difficulties in hiring outside personnel
(d) Difficulties in internal human resource development
(e) Insufficient support and guidance from national and prefectural governments
(f) Lack of interest from residents and businesses
(g) Weak organizational IT facilities and security management
(h) Numerous procedures that require paper documents
(i) Municipality is too small to benefit from digital transformation

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

We also observe that small municipalities are strongly concerned with hardware limitations. About 50% of the respondents of small municipalities consider the “weak organizational IT facilities and security management” as obstacles to DX, however, this percentage was smaller (in the 30% range) for medium- and large-scale municipalities.

3.4.3 Empirical analysis of reasons for not implementing DX

Noting that 56% of all municipalities, mainly small municipalities, responded that they "do not implement DX" (Table 5), this section presents an analysis to extract factors associated with this response. The independent variable for the analysis is a dummy that we set to 1 for municipalities that responded "do not implement DX" as shown in Table 5. The explanatory variables of interest the question come from the question which concerns obstacles to municipal DX, as shown in Table 9. These variables were recorded in an ordered discrete form, as follows: strongly agree=1, somewhat agree=2, not sure=3, somewhat disagree=4, and strongly disagree=5.

Negatively estimated coefficient implies that the stronger perception of each obstacle increases the probability to reply, "not implementing DX." We also included the following control variables that specify municipal characteristics.

- Residents' expectations of municipal DX (Positive perception dummies who answered "strongly agree" or "somewhat agree" to "Do residents expect DX to provide solutions for social problems in the community?")
- The strong will of the elected leader of the municipality (positive perception dummy who answered "strongly agree" or "somewhat agree" to "Does the mayor (governor of prefecture) show strong will to promote municipal DX?)
- Residents' adaptation to digital government (My Number card issuance rate from MIC's Monthly report on My Number Card issuance status: as of December 1, 2021)
- Dummy variable specifying prefectures sample
- Dummy variable controlling for small municipalities with populations of less than 50,000 (from the 2020 Population Census)
- Regional dummy variables dividing Japan into seven regions: Hokkaido, Tohoku, Kanto-Ko-Shin-Etsu, Chubu, Kinki, Chugoku-Shikoku, and Kyushu-Okinawa.

Table 10. Factor analysis of municipalities responding “Not implementing DX” to Q3.

Variables	Dependent variable: Did not implement DX								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Local residents’ expectation [a]	-0.456***	-0.453***	-0.453***	-0.455***	-0.458***	-0.456***	-0.452***	-0.463***	-0.388***
	(0.105)	(0.105)	(0.105)	(0.105)	(0.105)	(0.105)	(0.105)	(0.105)	(0.107)
Strong will of elected leader [a]	-0.537***	-0.535***	-0.529***	-0.533***	-0.547***	-0.547***	-0.541***	-0.546***	-0.516***
	(0.138)	(0.138)	(0.138)	(0.138)	(0.138)	(0.138)	(0.137)	(0.137)	(0.139)
Percentage of Myna card holders [b]	-1.367*	-1.340*	-1.328*	-1.333*	-1.377**	-1.364*	-1.322*	-1.314*	-1.172
	(0.698)	(0.704)	(0.699)	(0.707)	(0.702)	(0.700)	(0.703)	(0.704)	(0.714)
Prefecture	-0.732**	-0.695**	-0.737**	-0.685**	-0.712**	-0.713**	-0.721**	-0.715**	-0.601*
	(0.350)	(0.343)	(0.344)	(0.346)	(0.346)	(0.345)	(0.351)	(0.344)	(0.349)
Population less than 50k [c]	0.689***	0.657***	0.662***	0.673***	0.694***	0.690***	0.653***	0.687***	0.502***
	(0.117)	(0.118)	(0.118)	(0.118)	(0.117)	(0.118)	(0.119)	(0.117)	(0.130)
Obstacles -Data format [d]	0.0666								
	(0.0507)								
−Lack of expertise [d]		-0.120**							
		(0.0576)							
-Difficulty in obtaining external human resource [d]			-0.0778						
			(0.0479)						
-Difficulty in developing internal human resource [d]				-0.162**					
				(0.0736)					
-Insufficient national and prefectural support [d]					-0.0483				
					(0.0437)				
-Lack of interest from local residents & businesses [d]						-0.00768			
						(0.0491)			
-Weak IT facilities and security management [d]							-0.106**		
							(0.0474)		
-Many written procedures required [d]								-0.0862*	
								(0.0517)	
-Municipality is too small to benefit from DX [d]									-0.151***
									(0.0436)
Constant term	0.318	0.688**	0.632**	0.715**	0.584*	0.481	0.754**	0.637**	0.878***
	(0.310)	(0.313)	(0.312)	(0.319)	(0.315)	(0.319)	(0.324)	(0.314)	(0.322)
Regional Dummy [e]	YES	YES	YES	YES	YES	YES	YES	YES	YES
Number of samples	747	747	747	747	747	747	747	747	747

Robust standard errors are indicated in parentheses. *** p<0.01, ** p<0.05, * p<0.1. [a] Dummy variable for affirmative responses =1. [b] As of December 1, 2021. https://www.soumu.go.jp/kojinbango_car d/kofujokyo_06.html. See footnote 2 for Myna card [c] Population data are from 2020 Population Census(MIC) [d] Ordered discrete variables consisting of strongly agree=1, somewhat agree=2, not sure=3, somewhat disagree=4, and strongly disagree=5. [e] Regional dummies to distinguish seven regions: Hokkaido, Tohoku, Kanto-Ko-Shin-Etsu, Chubu, Kinki, Chugoku-Shikoku, and Kyushu-Okinawa.

We estimated a probit model with robust standard errors. Since the responses on obstacles are likely to be correlated with each other, we included them individually in the explanatory variable. Table 10 presents the results of the model estimations. All control variables employed here have a statistically significant effect and meet the expected sign condition. Municipal awareness of residents' expectations for municipal DX, political leadership, and residents' adaptation to digital government reduces the probability of municipalities responding, "Not implementing DX." Table 10 also confirms that small municipalities tend to report that they have not implemented DX. None of the regional dummies were significant; therefore, we can say that there were no differences across regions.

Regarding the association between the perceptions of obstacles to DX and the response of not implementing DX in Table 10, "Lack of expertise," "Difficulty in internal human resource development," "Difficulty in obtaining external human resource," "Weak organizational IT facilities and security management," "Many paper-based procedures required," and "Municipality is too small to benefit from DX" are estimated with a statistically significant negative sign, supporting that these factors are perceived as obstacles to DX. The obstacles to municipal DX found here are similar to those found by Kuhlmann and Heuberger (2021) in the case of Germany. They pointed out fragmented decision making and the lack of standardization across administrative levels and units, legal obstacles from handwriting requirements and data protection regulations, bureaucratic interfaces with citizens with limited online applications, and resource-related constraints, such as the lack of finance and IT experts.

4. DX and implementation of telework

4.1 Status of telework implementation

Interest in teleworking (telecommuting) did not suddenly emerge following the COVID-19 pandemic. The benefits of teleworking have been discussed in both the public and private sectors in the context of strengthening business continuity in preparation for natural disasters

and embracing diversity in working styles. However, previous studies have questioned the productivity of working from home. In the case of Japan, surveys on employees and firms found employees were less productive when working from home compared to working in the office (Morikawa, 2022). The MIC (2021) reports that teleworking in municipal governments was almost nonexistent prior to the COVID-19 pandemic.

The MIC requested that municipal governments introduce teleworking in April 2020 as part of infection prevention measures. However, our survey results show that teleworking in municipalities remains insignificant. Our survey showed that the average telework rate (the share of workers implementing teleworking) was approximately 3.1%. Small municipalities had the lowest rate (1.7%), followed by medium-sized (5.0%) and large municipalities (10.3%). Notably, 77.4% of the small municipalities reported a telework rate of zero. The low level of implementation suggests that local governments continue to view teleworking as a poor alternative to office work.

Table 11 summarizes the results of the responses to the question on the perception of obstacles to introducing/expanding teleworking. This shows that 84.1% of all municipalities agreed on the need for face-to-face interaction to attend to residents and businesses. The high proportion is the same regardless of municipality size, reflecting the nature of the work of local governments dedicated to attending to diverse and idiosyncratic needs in the local community. The response indicating the need for direct dialogue among the staff was also high, at around 40%, regardless of municipality size. This suggests that municipal government workers frequently face irregular issues that compel them to engage in discussions with colleagues.

Small municipalities were more likely to point out problems with the hardware environment, such as weak network security and inability to connect remotely to the organizational LAN. They also tended to point out IT and work environment issues at home, implying insufficient technical support while working from home. Regarding institutional aspects, very few

municipalities affirmed the restrictions of the rules and regulations that mandate office work, but about 20% of the municipalities agreed that the current labor management and evaluation practices are not adequate for teleworking.

Table 11. Perceptions of obstacles to telework

	Total	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Small	499	417	185	165	198	207	119	28	138
		83.6	37.1	33.1	39.7	41.5	23.8	5.6	27.7
Medium	172	153	78	27	30	61	37	11	42
		89.0	45.3	15.7	17.4	35.5	21.5	6.4	24.4
Small	76	58	30	9	10	21	17	4	15
		76.3	39.5	11.8	13.2	27.6	22.4	5.3	19.7
All local governments	747	628	293	201	238	289	173	43	195
		84.1	39.2	26.9	31.9	38.7	23.2	5.8	26.1

(1) Nature of the work (need for face-to-face interaction with visitors), (2) Nature of the work (need for face-to-face interaction among staff), (3) Concerns about network security, (4) Inability to remotely connect to the Local Government Wide Area Network or the municipal LAN, (5) Inadequate IT and working environment at staff's home, (6) Staff is not familiar with telework tools, (7) Regulations requiring in-work, and (8) The labor management system is not adapted to telework.
The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

4.2 Empirical analysis of obstacles to telework

This section analyzes the perception of obstacles to teleworking to explain the variation in the telework rate of municipal employees. In addition to the nine items in Table 11, we added the response to "Did your municipality's DX result in a review of workflow or organization?", tabulated in Table 5, as the explanatory variable of interest. In a previous study (Fujita et al., 2021), it was argued that combining working in the office and from home can generate a superior result to a single working style of either of these if they complement and do not substitute each other. If the implementation of DX has adapted workflow and organization to the digital environment, such complementarity would have been enhanced. We expected that an affirmative response to whether DX resulted in a review of workflow or organization would be associated with a higher telework rate. We also included dummy variables to identify small municipalities and prefectures to control for these samples.

We conducted this analysis in two ways. We first conducted a probit analysis with the dependent variable of a dummy indicating municipalities that reported a 0% telework rate or not teleworking at all. Second, we regressed the telework rate on the perceptions of obstacles. Note that because the telework rate is non-negative censored data, regression analysis was performed with a Tobit model, which is suitable for analyzing this type of data.

Table 12. Results of analysis of explanatory factors for telework rates.

Variable	Probit Zero telework	Tobit. Telework Rate
Need for face-to-face interaction with the public	-0.361*	2.768
	(0.202)	(2.442)
Need for face-to-face interaction among staff	-0.108	1.434
	(0.119)	(1.352)
Concerns about network security	0.678***	-7.382***
	(0.155)	(1.923)
Cannot remotely access the Local Government Wide Area Network or the municipal LAN	0.592***	-6.708***
	(0.138)	(1.706)
Inadequate IT and working environment at staff's home	-0.0325	-0.0115
	(0.128)	(1.457)
Staff is not familiar with telework tools	-0.397***	3.287**
	(0.138)	(1.534)
Regulations requiring in-office work	0.163	-1.254
	(0.239)	(2.836)
Labor management system is not adapted to telework	0.302**	-2.897*
	(0.131)	(1.557)
No specific reasons	-0.461	11.74***
	(0.343)	(3.669)
DX resulting in reviewing workflow and organization	-0.622***	7.216***
	(0.125)	(1.407)
Population less than 50,000	1.050***	-7.977***
	(0.128)	(1.449)
Prefectures	-0.868*	10.95***
	(0.495)	(3.284)
Constant term	-0.111	-3.607
	(0.238)	(2.836)
Number of samples	704	704

The figures in parentheses are the standard errors. Non-responses were excluded from this study.

The results are presented in Table 12. It is noteworthy that DX is negatively associated with the response to no teleworking, which is consistent with expectations. This suggests that teleworking will be promoted as DX progresses to change the working style. Of the factors

considered as obstacles to teleworking reported in Table 11, two factors derived from hardware problems, “concerns about network security” and “inability to realize remote connection to the local government wide area network or the organizational LAN,” are statistically significant in pushing down the telework rate. They were also positively correlated with the response to no teleworking. As Table 11 showed, it was mainly small municipalities that pointed out the hardware issue; we can infer that teleworking can be promoted through support for the development of information infrastructure in small municipalities from the national and prefectural governments.

Finally, replying that “labor management practices are not adapted to teleworking” is associated with a lower telework rate. This result suggests the need to review the existing labor management systems. According to the MIC (2021), there are no established alternatives to regularized attendance and presence check systems for teleworkers, and middle-level managers are puzzled by the difficulty in evaluating the performance of teleworking staff.

5. Proliferation of DX in local economy

5.1 Municipal DX and regional industrial policy

Table 13 reports that 73.36% of the local governments recognized that DX in the local industry is more than an individual firm’s issue, but it is a common interest in the regional industry. Because digital technology typically involves network externalities, whereby an increasing number of participants produce more content, information, and services in innovative ways, the exploitation of regional cooperation may lead to attempts to proliferate a region-wide platform. However, cooperation cannot easily be established because of a lack of trust. Local governments come in to play the role of platform builders, catalysts, or partners (Thompson & Venters, 2021). When examined by municipality size, about 95% of large municipalities showed positive recognition of regional industrial DX as a regional industrial policy issue, while this percentage dropped to 67% for small municipalities and 32% were negative. Hence,

the perception of capturing DX as a regional industrial policy issue declines with a smaller population size.

Table 13. Responses to whether regional industry digital transformation is a regional policy issue that goes beyond individual companies.

	Agree	Disagree	Not answered	Total
Small	334	161	4	499
	66.93	32.26	0.80	100
Medium	142	30	0	172
	82.56	17.44	0	100
Large	72	3	1	76
	94.74	3.95	1.32	100
All local governments	548	194	5	747
	73.36	25.97	0.67	100

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

Table 14. Important measures to encourage individual companies to promote digital transformation at local industry level (multiple responses allowed).

	Total	[A]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Small	499	334	83	89	99	19	33	41	6	2
	100	66.93	16.63	17.84	19.84	3.81	6.61	8.22	1.2	0.4
Medium	172	142	32	30	36	2	26	17	5	0
	100	82.56	18.6	17.44	20.93	1.16	15.12	9.88	2.91	0.00
Large	76	72	6	9	37	1	5	13	3	0
	100	94.74	7.89	11.84	48.68	1.32	6.58	17.11	3.95	0.00
All local governments	747	548	121	128	172	22	64	71	14	2
	100	73.36	16.2	17.14	23.03	2.95	8.57	9.5	1.87	0.27

[A] Yes to DX of local industry is an issue of regional industrial policy; (1) Educational activities through seminars and other means; (2) Sharing experiences in leading regions; (3) Support for digital technology human resource development; (4) Support for recruiting external human resources; (5) Promotion of open data; (6) Building platforms to encourage collaboration among diverse participants; (7) Others; (8) Not answered

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

According to Table 14, which summarizes the responses to the question on which policy local governments would emphasize in promoting local industry DX, “support for digital technology human resource development” was indicated as the most important, regardless of municipality size. Medium and small local governments placed a similar percentage of importance on “sharing the experience of leading regions” and “educational activities through seminars and other means,” while large municipalities did not emphasize such general

measures. They are more interested in creating regional platforms to induce the participation of local stakeholders.

As tabulated in Table 15, we asked what local governments expected the central and prefectural governments to do to encourage municipal DX. Responses were concentrated on (3) digital technology human resource development in local governments and (2) national leadership in aligning municipal information systems in a uniform standard. These measures are considered essential to support local government DX regardless of municipality size.

Table 15. Measures that should be implemented or strengthened to promote digital transformation in the local community (up to 5 multiple responses allowed).

	Total	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Small	499	154	290	373	94	149	142	158	247	17	4
	100	30.86	58.12	74.75	18.84	29.86	28.46	31.66	49.50	3.41	0.80
Medium	172	71	112	132	63	42	42	63	50	13	0
	100	41.28	65.12	76.74	36.63	24.42	24.42	36.63	29.07	7.56	0.00
Large	76	32	51	60	43	23	31	33	29	8	0
	100	42.11	67.11	78.95	56.58	30.26	40.79	43.42	38.16	10.53	0.00
All local governments	747	257	453	565	200	214	215	254	326	38	4
	100	34.40	60.64	75.64	26.77	28.65	28.78	34.00	43.64	5.09	0.54

(1)Awareness-raising; (2) National leadership in aligning municipal information systems in a uniform standard; (3) Digital technology human resource development in municipalities; (4) Promotion of open data; (5) Sending experts to offer DX expertise; (6) Development of local digital infrastructure (optical fiber, 5G lines); (7) Grants and loans for local firms that develop new businesses through DX; (8) Arrangement of inter-municipal collaboration for scale economy (9); Others; (10) No response

The upper row in each column contains the number of responses, and the lower row, the percentage of each population size category (%).

Small municipalities particularly urge support for inter-municipal coalitions, recognizing that the benefits of DX are too small for each small-sized organization. Large local governments are more interested in (4) the promotion of open data, (6) the development of local digital infrastructure (optical fiber, 5G lines), and (7) subsidies and loans for local companies that develop new DX-related businesses. We can infer that size matters in shifting attention to these concrete measures for the proliferation of regional platforms for DX.

5.2 Empirical analysis of determinants of data-driven decision making

In this section, we analyze the association between the implementation of municipal DX and municipality orientation for data-driven decision-making (DDDM) and evidence-based policymaking (EBPM). In this regard, we consider local governments' use of RESAS, an online database provided by the METI and the Digital Garden City Nation Project Secretariat of the Cabinet Secretariat to support a variety of regional development efforts. It is a unique digital tool for local governments to formulate plans and evaluate the progress of policies using finely detailed data and a wide variety of visualization tools. We expect that local governments with a DDDM/EBPM orientation will actively use RESAS.

We analyzed the association between advances in municipal DX and DDDM/EBPM orientation. We evaluated the use of RESAS from the answers to the question on "Analysis of local industry using RESAS." We obtained multiple answers: "no plans to introduce," "planning stage," "experimental/partial introduction," and "full-scale implementation." These were taken as an ordered discrete variable with four categories to show that more advanced use of RESAS means a higher DDDM/EBPM orientation. Table 8 reported that only 20.8% of respondents answered affirmatively, either "experimental/partial introduction or "full-scale implementation," while 61.0% answered "no plans to introduce." We deployed the use of RESAS as a dependent variable for the ordered logit model to identify the characteristics of municipalities with a higher DDDM/EBPM orientation.

We deployed three independent variables of core interest, representing advances in municipal DX. The first variable derives from "Did your municipality's DX result in review of workflow or organization?" whose affirmative answers indicate that the DX implemented in the municipality has advanced organizational optimization. Second, the dependent variable given by the affirmative answers to "Do you think that DX in regional industries is not only an issue for individual companies, but also an issue for regional industrial policy?" represents the municipalities' willingness to proliferate DX in the local industry. Third, the dependent variable

corresponding to the selection of "enabling data-based policy selection and planning to address local issues" as important benefits of DX gauges the municipalities' recognition of the value of data in administrative procedures.

Table 16. Ordinal logit analysis of factors contributing to the adoption and implementation of regional industry analysis using RESAS.

	Introduction/implementation of RESAS for the analysis of regional industry [c]					
	Coefficients		Marginal effect			
	(1)	(2)	No plan to introduce	Planning stage	Experimental /partial intro-duction	full-scale implemen -tation
DX resulting in organizational review [a]	0.299	0.326*	-0.074*	0.028*	0.037*	0.01
	(0.187)	(0.192)	(0.044)	(0.017)	(0.022)	(0.006)
DX of local industry is an issue of regional industrial policy [a]	0.400**	0.374*	-0.086*	0.033*	0.042*	0.011*
	(0.204)	(0.206)	(0.047)	(0.018)	(0.023)	(0.006)
Enabling data-based policy selection and planning [a]	0.760***	0.715***	-0.163***	0.062***	0.08***	0.021***
	(0.192)	(0.194)	(0.044)	(0.018)	(0.022)	(0.007)
Population (natural log)	0.142**	0.186**	-0.043**	0.016**	0.021**	0.005**
	(0.0707)	(0.0735)	(0.017)	(0.007)	(0.008)	(0.002)
Strong will of elected leader [a]	0.638***	0.583***	-0.133***	0.051***	0.065***	0.017**
	(0.203)	(0.207)	(0.047)	(0.019)	(0.024)	(0.007)
Primary industry's employment share [b]	-1.000	-3.205	0.733	-0.278	-0.36	-0.095
	(3.216)	(3.487)	(0.797)	(0.304)	(0.391)	(0.104)
Hokkaido		0.637*	-0.145*	0.054*	0.072*	0.019
		(0.369)	(0.084)	(0.03)	(0.043)	(0.013)
Tohoku		0.574*	-0.13*	0.049*	0.064*	0.017
		(0.326)	(0.073)	(0.028)	(0.036)	(0.01)
Kanto-Ko-Shin-Etsu		-0.116	0.023	-0.01	-0.01	-0.002
		(0.298)	(0.06)	(0.027)	(0.027)	(0.006)
Chubu		0.508*	-0.114*	0.044*	0.055*	0.014*
		(0.289)	(0.063)	(0.025)	(0.031)	(0.008)
Chugoku-Shikoku		-0.174	0.034	-0.016	-0.015	-0.004
		(0.369)	(0.072)	(0.033)	(0.032)	(0.007)
Kyushu-Okinawa		0.750**	-0.173**	0.062**	0.087**	0.024**
		(0.307)	(0.069)	(0.026)	(0.035)	(0.011)
/cut1	2.623***	3.309***				
	(0.717)	(0.787)				
/cut2	3.579***	4.286***				
	(0.723)	(0.794)				
/cut3	5.444***	6.167***				
	(0.749)	(0.820)				

[a] Dummy variable equal to one for affirmative answers. [b]2014 Economic Census for Business Frame(MIC).
[c] Ordered discrete variable with no plans to introduce = 1, planning stage = 2, experimental/partial introduction = 3, full-scale implementation = 4
Number of samples: 686 (excluding non-respondent and prefecture samples). Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To control for municipality characteristics, we included population size, the dummy of the elected leader's strong will to promote DX, and the ratio of primary industry workers, as well as regional dummies to distinguish the seven regions (with the Kinki region as the reference).

As shown in Table 16, the coefficients of the three core independent variables were estimated to be statistically significant and positive, supporting the hypothesis that they are factors that lead to more active use of RESAS. The results for the control variables of population size and political leadership are also in line with expectations. Statistically significant positive coefficients for the regional dummies are estimated for Hokkaido, Tohoku, Chubu, and Kyushu/Okinawa. It should be noted that RESAS is used more actively in rural areas than in Kanto and Kinki, which are more urbanized. The marginal effects confirm that these variables are less likely to influence the response of "no plans to introduce," but are more likely to influence those of "planning stage," "demonstration/partial introduction," and "full-scale implementation."

6. Summary of findings and policy recommendations

DX is expected to contribute to improving the quality and efficiency of the service provision of local governments. Moreover, DX will induce innovative changes in communication and decision-making processes, which will transform workflows in local government offices and the policy-making process.

To our knowledge, our study is the first to evaluate the current status and challenges of municipal DX by exploiting unique data from a questionnaire survey of Japanese local governments originally conducted in October 2021. We found that the progress in DX has remained at a low level, with small municipalities in particular lagging behind. Observing the progress in stages, the survey showed that approximately 70% of small municipalities did not implement DX, and among those implementing DX, approximately 30% remained in the introductory stage of digitization without engaging in organizational transformation adapted to

digital technology. We also found that most small municipalities lack the notion of data-based policymaking and proliferation of DX in the local industry as benefits of municipal DX, which are more commonly pointed out by medium and large municipalities.

Our novel findings are based on empirical analyses that use econometric models. First, we detected an association between not implementing DX and municipalities' perceptions, such as "lack of expertise," "difficulty in internal human resource development," "difficulty in obtaining external human resource," "weak organizational IT facilities and security management," "many procedures requiring paper documents," and "municipality is too small to benefit from DX." The obstacles regarding expertise, human resources, and hardware and the self-recognition of being too small mainly concern small municipalities.

Second, we found that, as DX evolves to the later stage of structural transformation, local governments promote teleworking. Generally, a high valuation of face-to-face interactions with citizens and colleagues at work reduces teleworking. Small municipalities pointed out problems with the hardware environment, such as weak network security and the inability to connect remotely to the organizational LAN. Regarding institutional aspects, we found that local governments consider labor management and evaluation practices inadequate for teleworking.

Third, we analyzed municipalities' use of RESAS as a proxy for DDDM/EBPM orientation. We found that municipalities that advance DX in later stages with structural transformation tend to value the data in administrative procedures, as evidenced by the more active use of RESAS. Such municipalities also tend to proliferate their DX in the local industry.

In summary, our empirical results suggest that municipal DX at an introductory stage is expected to improve the quality and efficiency of public services through the digitization of administrative procedures and automation. In the later stage, DX, in which municipalities adapt workflow or organization to the digital environment, is conducive to teleworking,

DDDM/EBMP, and the proliferation of DX in the local industry from the perspective of industrial policy. We learned that municipal DX is not just a tool for enhancing organizational efficiency but has the potential to innovate local policies.

However, small municipalities face significant hurdles. They are constrained by insufficient ICT human resources, expertise, and hardware capacity for DX, for which they require assistance from the government. We also found a need for partnerships among small municipalities for DX because they perceive that size matters when it comes to benefiting from DX. In this respect, the government is expected to provide an incentive and framework for organizing partnerships.

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