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Roadmap Support Measures in DX Promotion

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1. Introduction

Since the mid-1990s, Japan's labor productivity has been the lowest among the seven major industrialized countries and is below the OECD average. According to Fukao (2007), Japan's low economic growth rate is caused by a low investment ratio of information communication technology assets to tangible assets and low investment in intangible assets, such as organizational reform. Atkinson (2018) pointed out that productivity does not increase because small and medium-sized enterprises (SMEs) with low productivity do not exit the market.

To increase labor productivity and maintain the size of the economy, considering the declining birthrate and aging population, Japan must (1) reduce labor input without lowering value added, (2) increase value added without increasing labor input, or (3) reduce labor input while increasing the value added. Defensive digital transformation (DX) is important for implementing (1), whereas "offensive DX" is important for (2).

Digital technologies radically accelerate innovation, disruption, and competitive dynamics in the corporate environment. Organizations must fundamentally transform and restructure to survive in a rapidly changing environment, with technological innovation increasing the pace of environmental change. Therefore, DX goes beyond the digitization of products and services, and companies must redefine their industries and value propositions.

According to the 2022 DX Survey, 68.1% of companies in the US and 54.2% of companies in Japan are implementing DX. However, approximately half of these figures are not company-wide, but target specific sectors. Regarding the DX results, most of them stop at the level of "digitization," which is the digitization of analog and physical data, and "digitalization," which refers to improving productivity by increasing business efficiency. Most companies have not yet reached the level of DX, which is the "creation of new products and services" and "fundamental transformation of business models" that have advanced from "digitalization" (DX White Paper 2023).

According to a 2021 survey by the Ministry of Economy, Trade, and Industry (METI), over 40% of large companies are engaged in DX, whereas only slightly more than 10% of SMEs are. The percentage of companies engaged in DX is approximately 50% in the information and telecommunications, financial, and insurance industries, but only above 20% on average for all industries. Companies located in smaller municipalities are less likely to engage in DX than those located in larger municipalities.

DX has not progressed in Japan for several reasons, including (1) a lack of understanding of what DX means, (2) insufficient budget, (3) concerns about information security and privacy leaks, (4) a lack of human resources to promote and develop DX, (5) busy with existing

businesses, (6) lack of a vision and management strategy for DX, (7) lack of a roadmap, and (8) management's belief that digital technology is not important to the company.

The purpose of this study is to clarify the factors promoting DX based on an analysis of questionnaire data, identify the causal relationships among these factors, and propose a DX roadmap. Existing DX promotion indicators focus on whether a mechanism from a managerial perspective exists. However, it is important to consider the viewpoints of those who are striving to determine whether the system will work or not.

The remainder of this paper is organized as follows. Section 2 addresses the ambiguity of how DX has been defined. Section 3 summarizes previous studies on DX. Section 4 provides an analysis based on previous studies. Section 5 presents a roadmap based on the analysis, and Section 6 summarizes and discusses future prospects.

2. What is DX?

As Vial (2019) explains, definitions DX vary and academics have not reached a consensus. Vial (2019) analyzed 26 papers, finding that business models of process transformation feature prominently in definitions, while organizational factors appear less. Very few of these studies clearly define the culture. In Japan, the most prevalent definition is provided by the METI. Unlike other studies, this definition clearly describes corporate culture and climate.

METI's Definition of DX

The METI defines DX as "the transformation of products, services, and business models, as well as the transformation of operations themselves, organizations, processes, and corporate culture and climate, to establish competitive advantage, based on the needs of customers and society, by utilizing data and digital technologies in response to drastic changes in the business environment."

DX Report 2 also defines the developmental stages of DX as follows:

Digitization

- Digitization of analog/physical data and business flow, partially and locally, by introducing information technology (IT) systems to improve business efficiency
- Examples include digitization of tools, online, paperless, introduction of digital devices, and API linkage

Digitalization

- Digitalization of individual business and manufacturing processes
- Digitalization of specific business processes to create new value and business models

through digital technology

- Examples: “Process digitization” automation and labor saving (Internet of Things monitoring).

Digital Transformation

- Digitalization of operations and manufacturing processes across an organization, and transformation of business and business models for “customer-driven value creation”
- Transformation of products and business models according to the needs of customers and society
- Transformation of corporate organization, business processes, and corporate culture
- Establishing a competitive advantage

Figure 1 shows a word cloud of the contents and titles of the top 72 DX-related books sold on Amazon in Japan as of January 2024. The data were obtained from the Kinokuniya website. For simplified table of contents, data were sourced from the publisher’s website. Of the 72 books, seven include culture in the table of contents and nine included a roadmap. Many books that present a roadmap describe the developmental stages shown in DX Report 2[1]. These vague descriptions are believed to be the result of the inability to present a detailed roadmap attributed the different situations of each industry and company.

Therefore, an attempt to proceed with DX based on these books would likely begin by introducing digital technology without considering organizational or cultural factors.

[1] Furushima (2022) indicated factors such as the timing of vision and data analysis. However, organizational and cultural factors are not explicitly considered.

Figure 1. Word cloud of Japanese DX books

DX Report 2 presents a roadmap of short-term measures (developing a DX promotion system, formulating a DX strategy, and monitoring the DX promotion status) and medium-to-long-term measures (further accelerating industrial transformation, forming digital platforms, and securing DX human resources). METI presents the DX Framework as a DX success pattern that should be referred to at the “DX strategy formulation” stage. However, this explanation does not indicate which factors should be prioritized.

To grasp the status of DX promotion, METI has created DX promotion indices, conducts a survey of these indices every year, analyzes all the indices uniformly, and publishes the average values. The index comprises 9 main indicators, 26 qualitative indicators, and 22 quantitative indicators. Each indicator is rated on a 6-point scale as follows: “none,” “established in one department,” “partially implemented,” “company-wide implementation,” “established,” and “global level.” Nonaka (2020) conducted a factor analysis of these data and concluded that the main qualitative indicator is a valid common factor among the sub-quantitative indicators. However, the causal relationships among individual indicators (factors) were not included in that analysis.

3. Previous Studies on DX

3-1 Theoretical Basis of DX

Studies highlighting the importance of organizational change in informatization can be traced back to Bresnahan, Brynjolfsson, and Hitt (2002). Their analysis showed that informatization without organizational change (decentralization) is ineffective.

According to Vial (2019), dynamic capability (DC) is the theoretical underpinning of DX. Capability is the ability to deliver value, and is a combination of management resources (people, goods, money, intellectual property, and IT) and operations (processes, know-how, and organization). Management resources can be imitated; however, operations are path-dependent and, therefore, difficult to imitate. Even if a company imitates other companies and incorporates digital assets as management resources, it will be unable to gain a competitive advantage unless it can sufficiently reform its operations in response to a drastically changing business environment. If a company has sufficient DC, it can sense rapid environmental changes (opportunities and threats); seize the opportunities they offer; reuse existing resources, routines, and knowledge; and systematically reorganize and transform the elements of its business model.

Teece (2007), an advocate of DC, posited that existing firms may fail to invest in opportunities even if they perceive them, because path dependence tends to favor more incremental competencies and avoid radical innovations that destroy competencies. Therefore, firms begin to experiment with agility to seize new opportunities. Teece et al. (2016) defined agility as an organization's ability to efficiently and effectively reallocate and redirect resources in response to internal and external conditions to create value and protect (and capture) high-value profitable activities[2].

In Kato and O'Reilly's (2020) concept of ambidextrous management, DC refers to a company's ability to identify opportunities and threats and respond to them using its assets (people, organizational architecture, and management resources). The conditions for a successful ambidextrous strategy are (1) clear strategic intent, (2) management involvement and support, (3) ambidextrous organizational design, and (4) the existence of a common identity (vision, values, and culture). In ambidextrous management, top leaders' roles are

[2] (1) customer agility (e.g., co-creating user experiences), (2) partner agility (e.g., aligning the external partner ecosystem), and (3) operational agility to improve financial performance (e.g., achieving speed, accuracy, and cost efficiency).

important to (1) present strategic intent, (2) reconcile tensions among departments, (3) provide support thorough discussions among departments, (4) deal with contradictions between exploration and exploitation, and (5) adopt evaluation criteria.

An increasing number of empirical studies have tested the hypothesis. Dragičević et al. (2022) synthesize the literature on individual ambidexterity, DX, and DC to develop a framework that considers the role of ambidexterity learning in building organizational DX capacity. Their study indicates that recognizing and supporting management ambidexterity is an important factor in successful DX.

A two-way relationship exists between DX and organizational agility. AlNuaimi et al. (2022) demonstrate that DX leadership and organizational agility have positive effects on DX, whereas DX leadership affects organizational agility. They also show that organizational agility mediates the relationship between DX leadership and DX. However, the moderating effects of digital strategy on the relationships between DX leadership, DX, organizational agility, and DX are not significant. Ciampi et al. (2022) use a sample of 171 peer-reviewed articles to analyze the factors affecting organizational agility. They found the roles of big data analysis capabilities, digitalization at the supply chain level, and information technology capabilities as driving forces.

3-2 Organizational Culture

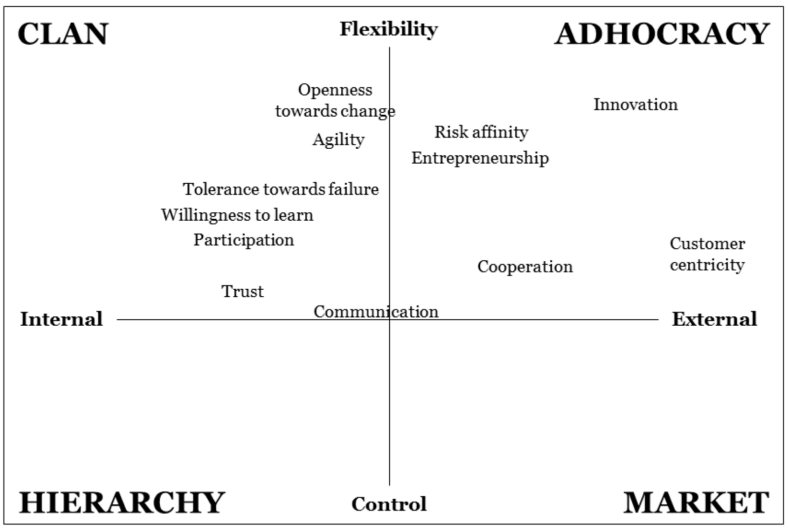
Organizational culture is critical for the success of DX. The concept of culture includes implicit elements, such as beliefs and norms, and explicit elements, such as structures and practices. In Schein's (2016) three-level model, culture comprises both elements. In a corporate environment, organizational values form the basis of organizational culture. Organizational values can be defined as the shared beliefs of organizational members regarding what is considered desirable. Ideals and norms influence behavior by setting expectations and boundaries for what is appropriate. Most studies on DX treat cultures as having a single set of values and generalized attributes. To date, few studies have adopted an empirical approach to comprehensively analyze whether organizational values support DX.

Friedrich-Baasner et al. (2018) analyzed the factors influencing cloud service adoption (employee intention to use) in German SMEs. The adoption of digital services is the process of aligning organizational goals, values, and cultures with employees using digital technologies. Therefore, understanding DX and judging its success from an employee's perspective is important. They theorized and tested the relationship between digital culture, employee

experience in DX, and DX co-governance, and found that cultural characteristics[3] have a significant impact on employee experience.

Hartl also conducted a relevant series of studies analyzing the importance of culture in DX research. Hartl and Hess (2017) identified 12 cultural values associated with DX through an exploratory Delphi study conducted with 25 researchers and industry experts[4]. All organizational values were categorized into clan and adhocracy cultures[5]. The overall distribution of organizational values in the upper half of the framework in Figure 2 and the top position of the cultural value of openness in DX suggest an organizational culture that emphasizes flexibility. Therefore, the target organizational culture to promote DX should include both clan and adhocratic cultural values.

Hartl and Hess (2017) indicated that the following cultural values are important for DX: Values in parentheses are the rankings.



[3] (1) collectivism as collaboration, communication, and participation; (2) power distance as openness and trust; (3) uncertainty tolerance as risk affinity and tolerance for failure; (4) long-term orientation as agility, customer centricity, and innovation; and (5) commitment and entrepreneurial tolerance.

[4] Hess et al. (2016) defined DX as IT-induced organizational change through digitization of products, services, core processes, customer contacts, and business models.

[5] The competing values framework (CVF) developed by Quinn and Rohrbaugh (1983) can be applied to understand organizational effectiveness. It includes four categories for classification based on the degree of internal and external orientation, flexibility and adaptability: clan, adhocracy, market, and hierarchy.

Figure 2. Culture and values in DX Source: Hartl and Hess (2017)

Extroverted: Development of new products and processes (to support aggressive DX)

(2) **Customer centricity**: Organizational orientation toward activities that meet customer needs. Products and processes are designed with a focus on customer needs and continuously adapt to these changes to give organizational members a sense of urgency toward digitalization, which is lacking within the organization.
(3) **Innovation**: The pursuit of improvement and growth through innovation.
(7) **Entrepreneurship**: The organization's intention to empower its members to act proactively and independently and assume responsibility.

Flexibility

(1) **Openness toward change**: The organization's openness to new ideas and readiness to accept, implement, and facilitate change.
(4) **Agility**: An organization's willingness to work, act, restructure, and respond to change with flexibility and adaptability.

Introverted

(5) **Willingness to learn**: The organization's continuous pursuit of progress through the acquisition of new skills and knowledge
(6) **Trust**: Trust in the organization and leadership and among members, as well as trust in the organization's external partners.
(9) **Communication**: the organization's intention to build internal and external networks to share knowledge and information.

Psychological safety[6]

(8) **Tolerance toward failure**: The organization's tolerant attitude toward reasonable mistakes and support for learning from them.
(10) **Risk affinity**: the organization's willingness to take risks and make decisions under uncertainty.

Culture change drivers (Hartl, 2019)

[6] Edmondson (2018)

(11) **Participation**: Organizational support for open, non-hierarchical discussions and democratization of decision-making processes.

(12) **Cooperation**: The organization's willingness to prepare for teamwork, cross-functional collaboration, and cooperation with external partners.

Clan culture is characterized by an internal focus and concern for people. Organizations that advance DX can benefit from maintaining a clan culture because they promote the willingness to learn and emphasize trust. Mutual trust between organizations and their members is key to an increasingly digital work environment. Telework and flextime are becoming more prevalent. However, such flexibility requires organizational trust in members' commitment to the organization's cause. Organizations with a clan culture also create an environment that is tolerant of failure, which is a prerequisite for innovation. By combining a risk-tolerant environment with a unique set of values that encourage members to take risks, the built environment supports exploration, innovation, and, ultimately, DX success.

Following a case study approach, Hartl (2019) examined the digital culture change programs of 11 companies. The results show that digital cultural change is characterized by a disruptive and constantly changing external environment and the increasing importance and enhanced application of digital technologies. Although digital cultural change is initiated using a top-down approach with a clear vision of the desired outcomes (elements of a planned approach), employees must adapt it bottom-up. According to Hartl and Hess (2017), customer-centric values, innovative and entrepreneurial thinking, and learning culture are important for cultural change. Participation has also been highlighted as an important success factor in digital cultural changes. Specific measures included (1) physical relocation to new office facilities to decouple from previous routines, and (2) consistent application of technology throughout the change process, such as using internal social networking sites.

Abhari et al. (2021) defined digital culture as a set of beliefs, values, and assumptions that employees share regarding digital technology. The following five characteristics of organizational culture influence digital culture: collectivism, power distance, uncertainty tolerance, long-term orientation, and tolerance. Depending on the digital culture, digital technology may support or hinder employee behavior. Abhari et al. (2021) further noted that digital technology has the potential to change organizational culture in terms of long-term orientation, which is characterized by customer centricity, responsiveness, innovativeness, and the willingness to learn after new digital tools and technologies are introduced. Miyamori and Miyabayashi (2019) mentioned the need to make changes based on Japanese cultural characteristics as most current management theories have been created in an individualistic

society with small power differentials and high uncertainty.

3-3 DX Roadmap

Many companies lack a clear roadmap for redesigning their existing processes to fit digital technologies. A comprehensive perspective that includes heterogeneous and complex processes from different domains, such as strategy, human resources, process management, and IT, is necessary to lead DX.

Bumann and Marc (2019) investigated 18 digital maturity models and frameworks for DX and identify strategy [7], organization [8], culture [9], technology, customers, and people (employees) as the most important topics. Some models use certain topics as the main dimensions, whereas others use them indirectly or only as sub-dimensions.

Warner and Wäger (2019) analyzed case studies on DX in seven established companies in traditional industries headquartered in Germany and proposed a process model consisting of micro-foundations to identify factors that drive or hinder DC in DX. They considered DX as a continuous process of using new digital technologies that capture organizational agility as a mechanism for the strategic renewal of (1) business models, (2) collaborative approaches, and (3) culture.

Gökalp and Martinez (2021) developed a DX capability/maturity assessment model in which the most important aspect of DX is organizational strategy, comprising four processes: strategic governance, information and technology, digital process transformation, and

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[7] The digital strategies of successfully transformed organizations are not only well documented but also well communicated within the organization. Sufficient resources should be available and the strategy should be regularly updated and tested. New trends (e.g., technologies and customer behaviors) must be actively and systematically investigated and evaluated.

[8] Cross-functional teams (e.g., developers, IT professionals, designers, and product owners) need to come together in an organizational structure known as the "digital factory," working in agile sprints and using methodologies such as design thinking to build something new in an organization.

[9] The organizational cultures of digitally mature companies share characteristics such as rapid experimentation, risk appetite, and investment in people. Establishing such a culture requires a strong and ongoing commitment from the board of directors and senior management to support the digital strategy. Therefore, strong digital leaders who can facilitate the development of innovative digital solutions are needed.

workforce management (Table 1). They explained the need to incorporate cultural changes into workforce management before initiating the transformation process. In this model, at Level 4, quantitative methods are applied to the real-time data collected for a product, service, or process.

Few studies have explored the DX from the viewpoint of informatics scholars; however, many studies employ the perspective of organizational researchers. Kotter (2021), a leading organizational transformation researcher, showed that his discussion of organizational transformation can be applied directly to DX. He posited that organizational change requires the following eight steps: (1) raising awareness of the crisis, (2) building a collaborative team to promote change, (3) creating a vision and strategy, (4) communicating the vision for change, (5) encouraging employee initiative, (6) achieving short-term results, (7) using the results to promote further change, and (8) embedding new methods in corporate culture.

According to Rogers (2023), the roadmap is as follows: (1) defining a shared vision; (2) identifying problems; (3) creating new businesses; (4) managing growth; and (5) growing technology, human resources, and culture.

From a practical standpoint, Furushima (2022) divided the DX roadmap into the pre-DX and DX phases. In the pre-DX phase, the roadmap moves from strategic policy (vision, customer experience, and value) to the mechanism (KPI, data, AI, development, and execution), whereas in the DX phase, the roadmap moves from data analysis to automation. The DX phase follows a roadmap that flows from data analysis to automation, and then to optimization. Compared with that of Furushima's (2022), Gökalp and Martinez's (2021) roadmap introduces data analysis much later.

3-4 My Research Results to Date

This section provides an overview of the research conducted in the previous stages of this study. Watanabe (2021) analyzed the relationship between the key factors of DX and aggressive IT management issues by applying text mining to integrated reports. The analysis results showed that (1) most of the introductions of DX issues described technological aspects, but only 6 out of 35 companies clearly described corporate culture or corporate climate change; (2) in the integrated reports, companies explained technological aspects, but only a few clearly described corporate culture or corporate climate change; and (3) some companies mentioned DC, psychological safety, and design thinking. Co-occurrence network analysis based on the case documents of the 35 companies in the DX Issue 2020 revealed that the network consists of keywords corresponding to the main parts of the METI definition, whereas corporate culture and climate do not appear frequently.

Watanabe (2022) conducted a survey of employees and use a covariance structure analysis to examine the relationships among DX-related variables (Figure 3). The results showed that (1) DX factors are positively correlated with firm performance, (2) psychological safety positively affects firm performance through organizational commitment, and (3) strategic intention positively affects the search for

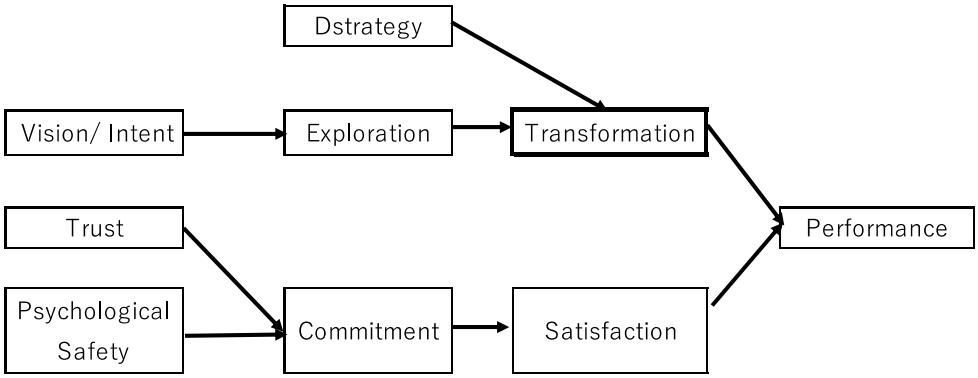

Figure 3. Analysis model

ambidexterity, (4) the coefficient for industries with high labor productivity is not necessarily larger than that for industries with low labor productivity, and (5) the effects of search and DX on business performance are larger for listed than non-listed firms. However, a sufficient causal relationship between organizational factors and DX strategy factors could not be confirmed. One possible reason for this is that covariance structure analysis tests the relationships among common factors but may not be able to analyze cases in which the variables constituting the factors are related beyond those factors. Therefore, this study does not seek out factors, but instead applies the causal search method to analyze the relationships between questionnaire items. This method facilitates the analysis of relationships beyond the factors. In addition, we analyzed how the roadmap is affected by differences in the organizational culture, as shown by Hartl and Hess (2017), based on additional research.

4. Causal Search for DX

4-1 Analysis Method

4-1-1 Investigation

The variables related to the DX were determined based on a literature review. Semi-structured interviews were conducted with information officers and IT consultants from companies in industries with high labor productivity (manufacturing, information and telecommunications, finance, securities, insurance, and real estate) and low labor productivity (construction, services, transportation, trade, wholesale and retail, and medical and welfare). Based on these results, we conducted the first survey in 2022 and a second survey by industry from 2023 to 2024.

Survey 1

A self-administered survey tool, Freeasy, was used to collect 3,951 samples between February 21 and 25, 2022. The sample comprises company employees (full-time employees) between the ages of 20 and 65 in industries with high labor productivity (manufacturing, information and telecommunications, finance, securities, insurance, and real estate) and those with low labor productivity (construction, services, transportation, trade, wholesale and retail, and healthcare and welfare). In total, 1,785 respondents were included in the survey. Those who took insufficient time to respond, chose the same options for all questions, or answered questions inconsistently were excluded. Following this process, 1,000 samples were obtained for the survey, which was conducted from February 25 to 26, 2022. After eliminating inconsistencies among the responses, a sample size of 822 was used for the analysis.

Most questions were rated on a six-point Likert scale. The six options were as follows: very much agree, agree, slightly agree, not so much disagree, disagree, and do not agree.

Self-response scales are subject to errors in reading, reflecting on, and answering questions. Biases during reflection are caused by (1) the degree of self-evaluation, (2) reactions to choices, (3) the respondent's mood at the time of answering, and (4) thinking within a narrow scope. Even if response errors during reflection show individual differences, the relationships between variables can be analyzed if the individual variables are uniformly high or low depending on the individual. Respondents from online surveys were unlikely to work in the same office; therefore, score distortion was unlikely to occur systematically.

Table 2: Respondent attributes

Industry	Male	Female	Total
Service Industry	69	82	151
Medical and welfare	21	96	117
Transportation	49	15	64
Finance, securities, and insurance	19	51	70
Construction	47	21	68
Trading, wholesale and retail	47	52	99
Information and Communication	36	19	55
Manufacturing	105	67	172
Real estate	10	16	26
Total	403	419	822

Table 2 presents the demographic characteristics of the respondents. The number of respondents by industry and sex was not necessarily symmetrical; however, this should not be a problem because the causal search method used in this study assumes that the data are not normally distributed.

Table 3 shows the results of asking whether the respondents had heard the term DX in the workplace. In the IT industry, where informatization is highly advanced, more respondents answered “yes” than “no”; however, this percentage was lower in other industries. In a survey conducted by INDUSTRIAL-X, the total of “never heard of/never heard of” or “have only heard of the word” exceeded 80% in 2021 and 67.2% in 2022. Therefore, the percentages listed in Table 2 are not unusual.

Table 3: Percentage of respondents who have heard the term DX in the workplace

Industry	No	Yes	Total
Service Industry	119	32	151
Medical and welfare	108	9	117
Transportation	50	14	64
Finance, securities, and insurance	41	29	70
Construction	50	18	68
Trading, wholesale and retail	71	28	99
Information and Communication	20	35	55
Manufacturing	111	61	172
Real estate	18	8	26
Total	588	234	822

In the following analysis, all questions were standardized, and questions with a correlation coefficient less than 0.4 were excluded from the analysis. Of all respondents, 73.4% worked for privately held companies, indicating a high likelihood of many respondents being SME employees.

The following questions were used in the main analysis. A detailed list is provided in the appendix.

[Psychological safety]

PS1: At my workplace, I freely share what I feel and notice.

PS2: At my workplace, I can say that I do not know what I do not know.

PS3: My workplace has an atmosphere in which people are always ready to help me when I go to them for advice.

PS4: When a problem arises, my workplace has an atmosphere that encourages thinking about constructive solutions rather than blaming others.

PS5: I feel that taking on challenges is good not bad.

PS6: In my workplace, it is difficult to introduce something without a precedent or track record.

PS7: In my workplace, I feel that I am welcome to use my strengths and individuality in my role.

PS8: I feel welcomed to bring about different perspectives and ways of seeing things in my workplace without being bound by conventional wisdom.

[Vision, Mission, Purpose]

Vision: Team members have a clear vision of what the future should look like and what management envisions.

Goal_Sharing: Action goals are shared in the workplace.

[Ambidextrous Management: Search Factors]

Search5: My workplace emphasizes entering and developing new markets.

Serach7: My workplace encourages innovative and risk-taking behavior.

[Digital Strategy/Strategic Intent (areas of current focus that will lead to the realization of the vision)]

Strategy1: My workplace has a clear vision of how information and digital technology will contribute to business value.

[Organizational Commitment]

Psychological state related to continued membership in the organization.

Commit1: I feel as if the problems in my workplace are my own (emotional commitment).

Commit2: I am attached to my co-workers (emotional commitment).

Commit3: I am proud to be a part of this company (emotional commitment).

[Satisfaction]

Fun: I enjoy working at my workplace.

Growth: I feel that I am growing through my work.

[Maturity] Kane et al. (2022)

Maturity: An ideal organization is transformed by digital technology and can leverage it to improve processes, engage the organization's talent, and facilitate business models that create new value now and in the future.

[Digital Technology]

Data_ana: Data analysis results are helping to improve sales.

DX_Talent: My company is actively recruiting digital talent.

[DX Results]

Transformation1: We are providing new products and services using information and digital technologies.

Transformation2: We are improving new products and services using information and digital technologies.

Survey 2

Survey 2 incorporated industry differences, especially cultural differences, into its model. Table 4 presents the average values of the four cultural factors for the financial and service industries used in the analysis. Market and hierarchical culture scores are higher in the financial industry.

Clan_Culture: My organization has a family like atmosphere, and my employees have a strong bond.

Market_Culture: My organization is competitive and focuses on achieving goals and results.

Adhocracy_Culture: My organization values creativity and innovation and always seeks new ideas and solutions.

Hierarchical_Culture: My organization emphasizes adherence to rules and policies.

Table 4: Differences in cultural factors

	Clan	Market	Adhocracy	Hierarchical
Financial	3.1	3.8	3.3	4.2
Service	3.1	3.3	3.2	3.9

4-1-2 Causal Search Methodology

The analysis was conducted using a linear non-Gaussian acyclic model (LiNGAM[10]), a type of causal search that automatically identifies causal relationships from data. The advantage of this method is that it requires less background knowledge than other methods and can explore complex relationships among multiple elements. Specifically, when considering the causal relationship between two variables, the residual and explanatory variables are independent if the explanatory variable is the cause. However, if the explanatory variable is the effect, a dependent relationship between the explanatory variable and residual is used. A model is identifiable if the following conditions are satisfied.

- The observed variables can be sorted according to a certain causal order.
- Each variable has a zero mean and is the noise added to the previous linear combination in causal order.
- All noises are independent: (1) the distribution is not normal, and (2) the variance is non-zero.

DirectLiNGAM: The process of detecting and removing exogenous variables (i.e., variables without a parent in the causal graph) is sequentially repeated by repeating a simple regression between two variables. Therefore, the order in which the variables are removed is considered to be causal.

Using the residuals of the regression equation and the mutual information content of the explanatory variables, the variable with the highest independence is the independent variable. The explanatory part of the independent variable is removed from the objective variable, and the process of finding the next independent variable and eliminating its influence is repeated.

4-1-3 Hypotheses to be Analyzed

In Study 1, the following hypotheses were tested using the causal search method:
H1: Psychological safety has a positive effect on firms' DX performance.
H2: Strategic intention positively influences ambidexterity-related searches.
H3: Organizational and strategic factors simultaneously influence DX progress.

The following hypothesis was added in Study 2:

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[10] Shimizu(2017)

H4: Cultural differences influence the causal relationships among variables.

4-2 Analysis Results

Survey 1[11]

The results of the causal search, computed using DirectLiNGAM with 1000 repeated resamplings across the entire dataset, show that each path has a probability of at least 50% of having a nonzero causal coefficient with a coefficient value greater than 0.11 (Figure 4).

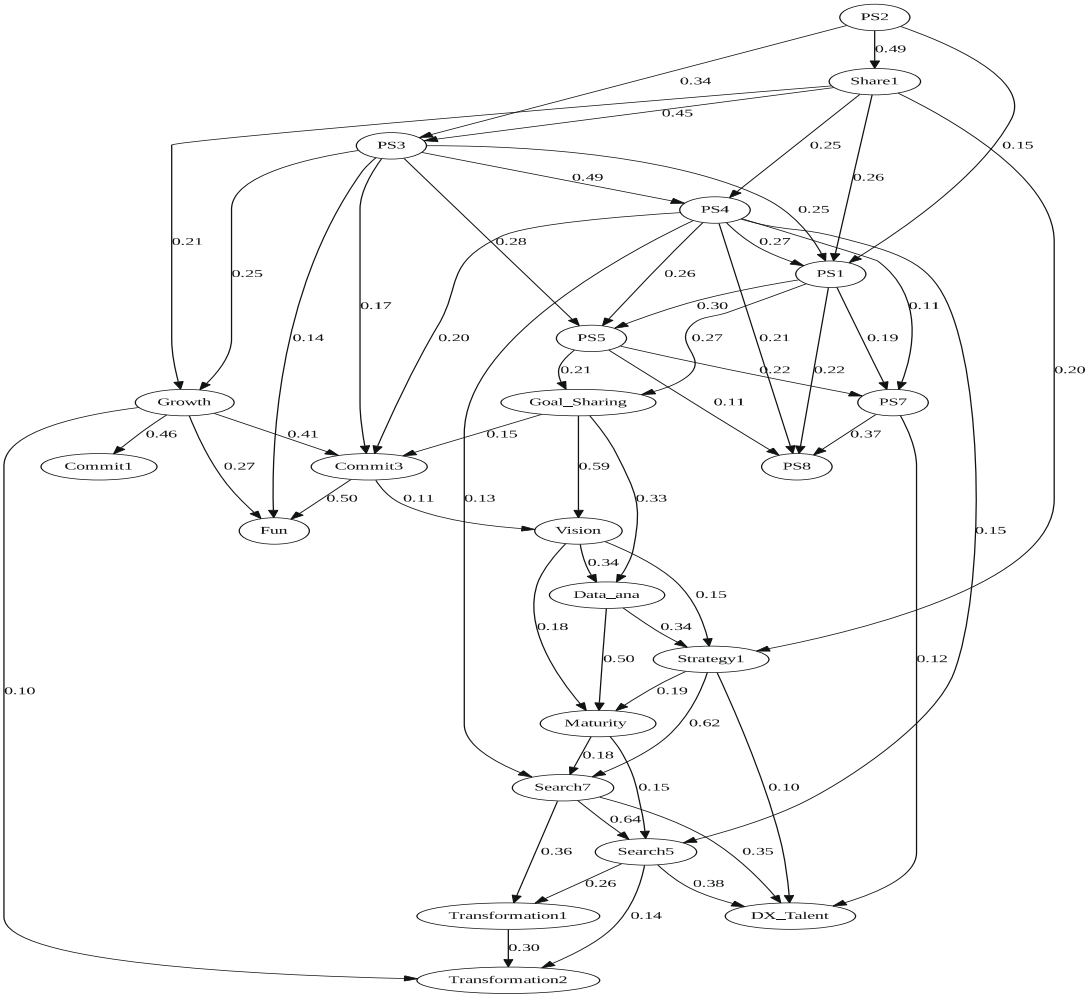

Figure 4. Overall view

[11] Watanabe (2023)

Below, we explain the results by dividing them into organizational and cultural factors (growth, psychological safety [PS], commitment, sharing, and enjoyment), strategic factors (shared goals, vision, and strategy), and DX factors (maturity, data analysis, transformation, exploration, and DX human resources).

Watanabe's (2022) structural covariance analysis found no significant paths between strategic and organizational factors. However, this relationship could not be verified because the factors were created within the framework of existing theories. As Figure 5 shows, a relationship exists between organizational and strategic factors.

Table 5 Bootstrap probability

Rank	Direct causal relationship			Probability
1	**PS2**	⇒	**PS3**	97.9%
2	**Growth**	⇒	**Commit3**	96.5%
3	**Growth**	⇒	**Fun**	95.8%
4	**PS1**	⇒	**PS8**	93.6%
5	**PS2**	⇒	**PS1**	92.3%
6	**Vision**	⇒	**Maturity**	88.3%
7	**PS3**	⇒	**PS4**	87.3%
8	**Goal_sharing**	⇒	**Vision**	86.9%
9	**Growth**	⇒	**Commit1**	86.5%
10	**Commit3**	⇒	**Fun**	85.6%
11	**PS3**	⇒	**PS7**	83.1%
12	**Goal_sharing**	⇒	**Data_ana**	81.4%
13	**PS4**	⇒	**PS8**	79.0%
14	**Search7**	⇒	**Transformation1**	76.3%
15	**PS5**	⇒	**PS7**	76.2%
16	**PS2**	⇒	**Share1**	76.1%
17	**Strategy1**	⇒	**Search7**	72.9%
18	**Share1**	⇒	**Strategy1**	72.4%
19	**PS4**	⇒	**PS1**	70.9%
20	**Vision**	⇒	**Data_ana**	70.8%

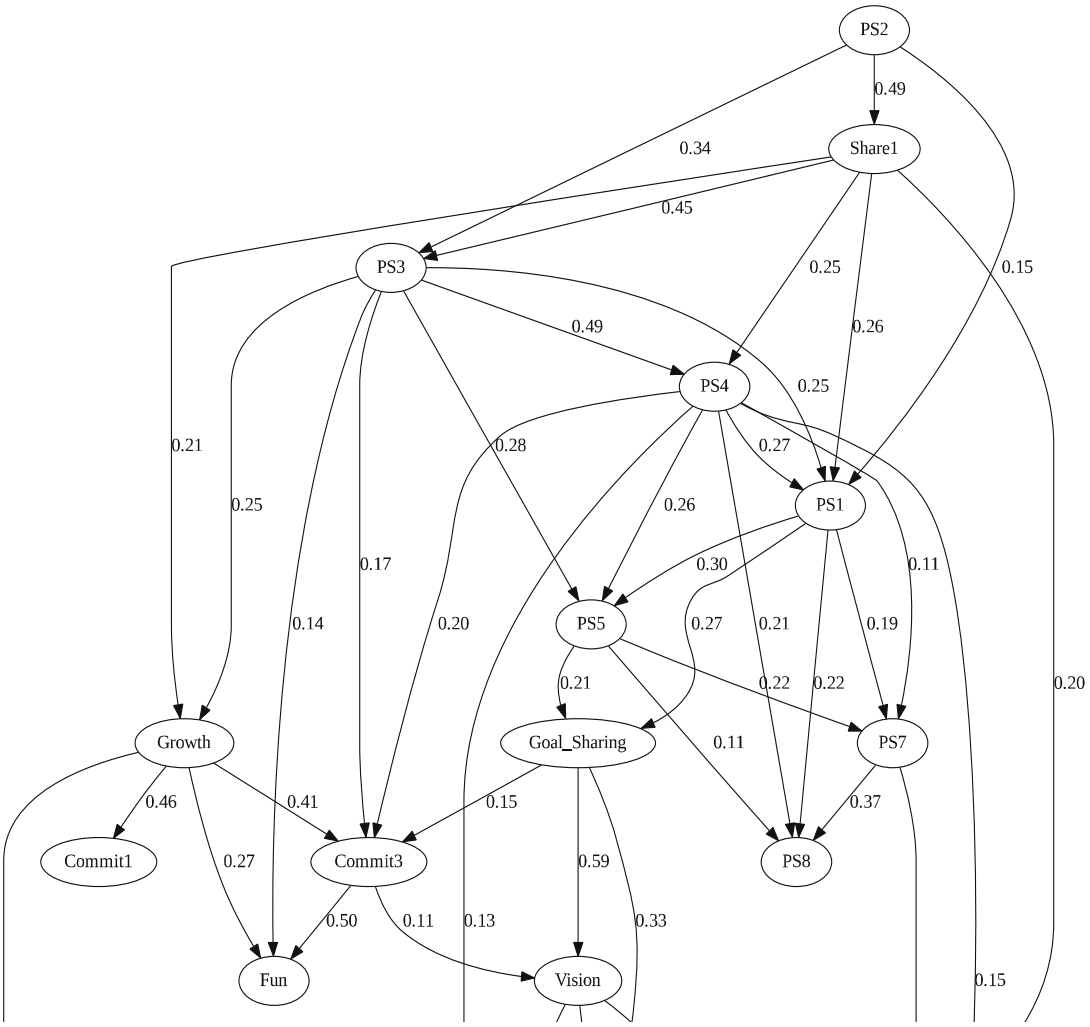

Figure 5. Examination of causal paths for organizational and cultural factors

Table 5 shows the top 20 paths in terms of the probability that each path has a nonzero causal coefficient, calculated using DirectLiNGAM after 1000 repeated resamplings of the entire dataset.

First, the organizational and cultural factors are explained (Figure 5). Starting with the relationship between the variables related to psychological safety, as psychological safety increases, personal growth, commitment to the firm, and job enjoyment also increase.

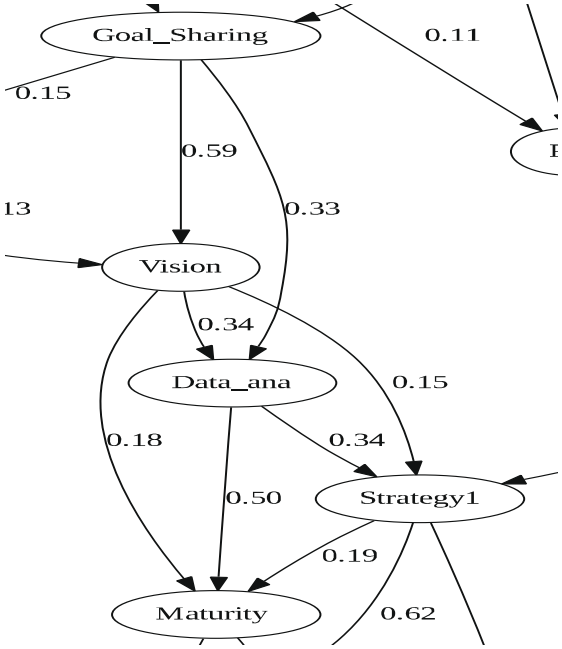

Figure 6. Examination of causal paths strategic factors

As Figure 6 shows, shared goals help members retain their visions of the future and convey their intentions regarding information and digital strategies. Kane's (2022) maturity level can be interpreted as a summary of organizational relationships.

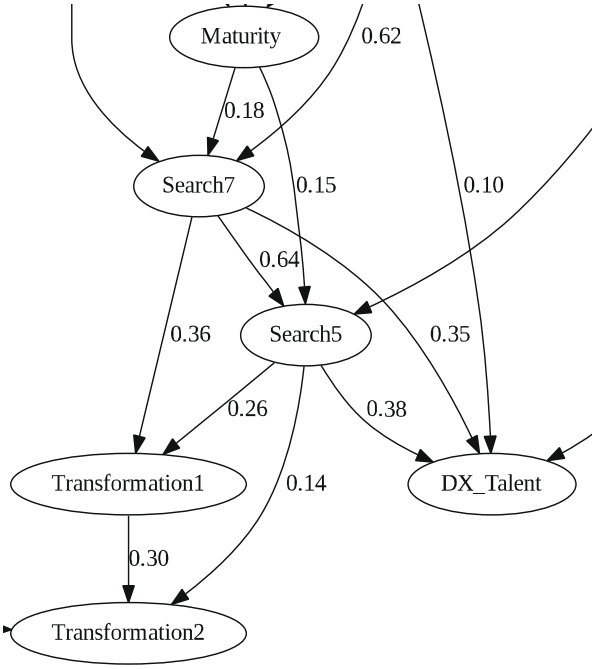

Figure 7. Causal pathway study of DX factors

As Figure 7 shows, the provision and improvement of new products and services using information and digital technologies is promoted by the exploratory behavior of ambidextrous management. Furthermore, the promotion of DX encourages the hiring of personnel. The data analysis falls under Level 4 of the Gökalp and Martinez's (2021) roadmap.

The following three points can be derived from the analysis:

(1) Psychological safety positively affects corporate change.
(2) Strategic intention positively affects searches related to ambidexterity.
(3) To advance the DX, organizational factors must be advanced before strategic factors.

These results are consistent with those of Gökalp and Martinez (2021), who explained the necessity of introducing cultural changes in workforce management before initiating process transformation.

Survey 2

Based on the results of Survey 1, we added interviews and a literature review, and modified the questions to explicitly consider culture. The sample consisted of company employees (regular employees) between the ages of 20 and 65 years. Six times points were screened for each of the industries with high labor productivity (manufacturing, information and telecommunications, finance, securities, and insurance) and low labor productivity (services, medical care and welfare, and public employees). Respondents who selected all the same options or whose answers were inconsistent with the questions were excluded and asked to participate in the main survey. The survey was conducted from December 25, 2023, to January 29, 2024. This report compares the results of the financial industry, which is highly regulated, and the service industry. We analyzed 572 samples from the financial industry and 796 samples from the service industry. We exclude those whose response times deviated by more than two standard deviations from the standard response times and those whose responses were inconsistent. The entire dataset was resampled 1000 times, and only paths with a coefficient value of 0.11 or higher are shown (Figures 8 and 9), as calculated using DirectLiNGAM. The probability of having a nonzero causal coefficient was 40% or higher for each path.

To avoid complicated presentations, questions on psychological safety was limited to two. Compared with Study 1, this analysis focused on a specific industry; thus, the assumptions of the causal search may not be satisfied.

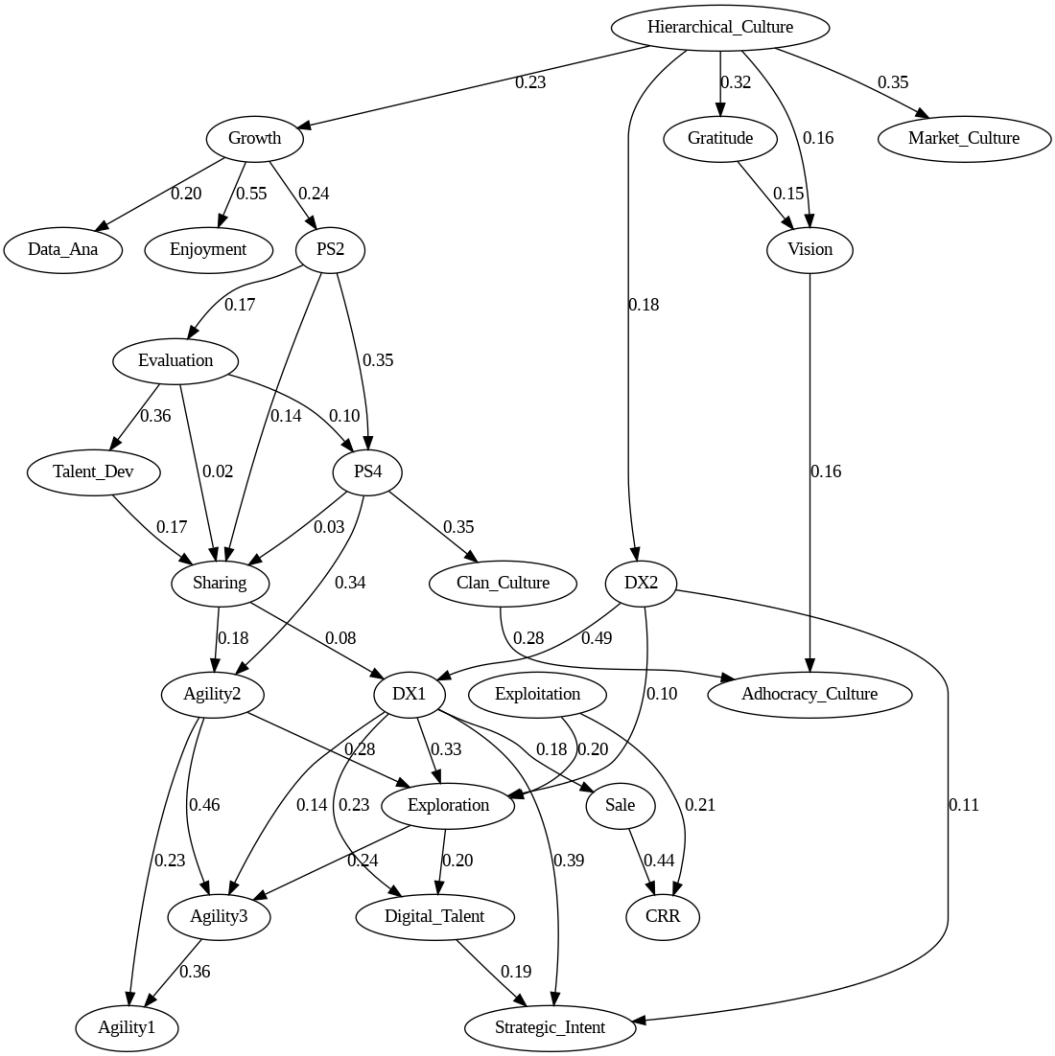

Figure 8. Causal search for financial industry considering organizational culture

Organizational factors are broadly classified into **organizational and cultural factors** (communicating appreciation, growth, psychological safety, sharing, and enjoyment), **strategic factors** (shared goals, vision, and strategy), and **DX factors** (data analysis, transformation, exploration, and DX human resources). Organizational factors remain primary, although the paths have decreased compared to Study 1. A hierarchical culture, which emphasizes discipline, is a leading cultural factor in the financial industry. Although not presented in this analysis, hierarchical culture was also a leading factor in the analysis of the manufacturing industry, but not in the service industry. Regarding causality, the hierarchical cultural factor ranks last in the service industry. Applying the values of clan culture (tolerance for change, agility, tolerant attitude toward failure, willingness to learn, participation, and trust), as shown by Hartl and Hess (2017) to Figure 8, we see that a

tolerant attitude toward failure (PS4) leads to clan culture.

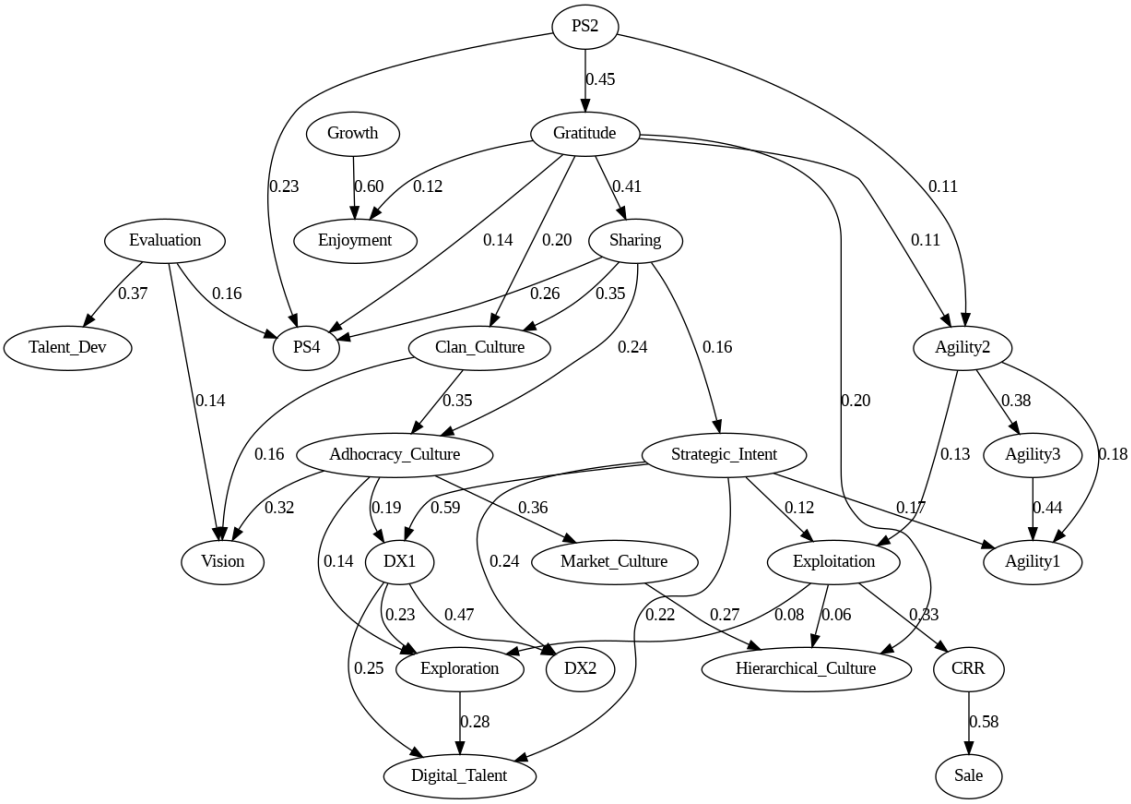

Figure 9. Causal search for service industries considering organizational culture

We did not draw this line for the service sector, because the probability was below 40%. This finding indicates that a clear path is unlikely to occur if firms without sufficient DX advancement are included. Considering cultural changes in response to DX, the emphasis on values should shift from clan to adhocracy culture. Figures 8 and 9 show the causal relationships. Furthermore, the importance of the leader presenting a vision affects the adhocracy culture in the financial industry; however, a clear path has not been drawn in the service industry because of its low probability. As most respondents were SME employees, a long-term perspective may not have been emphasized in the service industry.

5. Roadmap for DX

Based on the above analysis, we present a roadmap for DX in Figure 10.

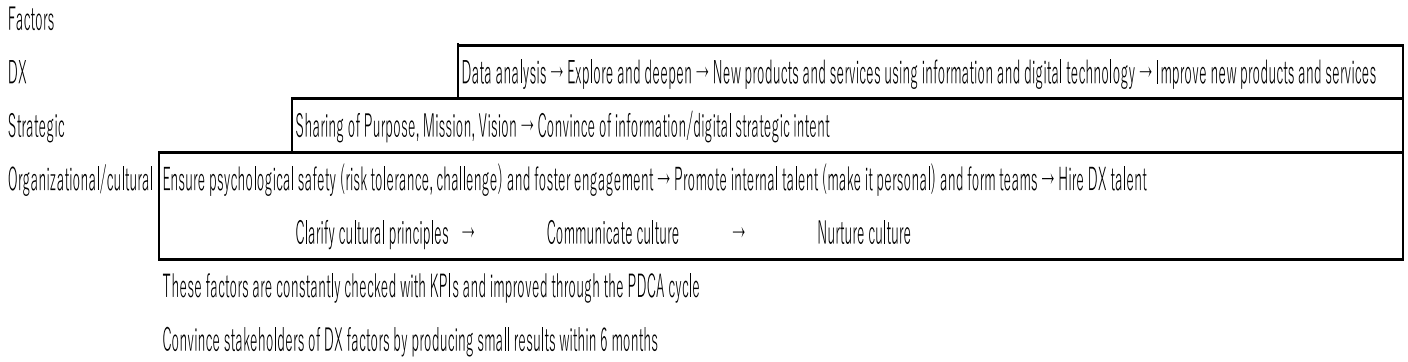

Figure 10. Roadmap for DX

Convinced of information/ digital

Industries with strict discipline, such as the financial industry, have a culture in which failure is not tolerated, and psychological safety is low. Therefore, even if DX is promoted in situations of low psychological safety, sharing a common vision and addressing new challenges will not be promoted. First, the evaluation system must be changed to one that addresses these challenges. The government recommends introducing a job-based personnel system into the DX framework. However, in some cases, this hinders information sharing and does not enhance psychological safety. The system of objectives and key results (OKR) adopted by Google and Mercari allows employees to have the entrepreneurial spirit (setting bold and ambitious goals) necessary for DX, as the achievement or non-achievement of goals is not related to an increase or decrease in rewards. However, caution is necessary when introducing OKRs in companies where this system is inconsistent with the organizational culture[12]. The visualization of employee growth is necessary to promote challenges and create an environment in which employees can face challenges without fear. It is difficult for DX to succeed unless it fosters engagement with the organization by increasing psychological safety, promoting internal talent, and convincing employees to act on their own initiative. This requires a foundation that clarifies the principles of culture and communication and nurtures corporate culture. According to Kotter (2012,2021), this cultural change must occur in 10-year increments.

The company that most closely matched this roadmap was Chugai Pharmaceuticals

[12] As Hartl and Hess (2017) noted, OKR implementation requires psychological safety (tolerance for failure), a willingness to learn, and a shared vision (goals) that can be broken down into individual-level goals. If OKRs are successfully implemented, members will be able to realize their growth through their work, as seen in the model.

(Figure 11). Chugai is the most advanced company in the pharmaceutical industry in terms of AI drug discovery, and is under the umbrella of a foreign company that is making progress in governance reform.

Figure 11. Chugai's roadmap Source: Chugai Annual Report 2021, p.41

Chugai's roadmap clearly calls for the transformation of employees, organizational climate, and culture to strengthen digital infrastructure.

To implement the proposed roadmap, labor policies that affect organizational and cultural factors must be prioritized. However, as Hartl and Hess (2017) indicated, the cultural values essential for DX success are concentrated in adhocracy and clan cultures. DX is easier to promote in US firms with an ad hoc culture than in Japanese firms. Studies show that Japanese companies tend to have a family like clan culture and a hierarchical culture that emphasizes stability and control. However, corporate organizations do not simply fall into one of these categories, but are affected by a combination of factors.

Thus, to promote DX as a policy, it is important to ensure psychological safety, as emphasized in clan culture. The government must support the creation of a roadmap that fits the organizational culture and support training in digital technologies, including artificial intelligence, which will drive changes in organizational and cultural factors (Melina et al. 2024). The specific measures outlined by Hartl (2019), including (1) physical relocation to new office facilities to decouple from previous routines and (2) consistent application of technology throughout the change process, such as the use of internal social networking services, have proven successful in Japan. Furthermore, a grant program with expanded

eligibility is needed to support bold changes in organizational cultures[13].

6. Conclusion and Future Directions

The main findings of this study are as follows:

(1) Psychological safety positively affects corporate change.

(2) Strategic intention positively affects searches related to ambidexterity.

(3) To advance the DX, organizational factors must be advanced before strategic factors.

(4) Organizational cultural factors differ by industry, causing differences in the order of causality.

(5) On the roadmap, organizational culture factors should be developed first, and strategies should be formulated before DX is implemented. Therefore, the creation of a roadmap for this order must be supported.

(6) The scope of subsidies must be expanded as a governmental policy. Additionally, guidelines for the implementation of OKRs are required.

O'Reilly and Tushman (2008, 2016) noted that the success of ambidextrous management depends on top leadership. As the surveys in this study were conducted with company employees, the questions were not limited to top leaders. We plan to conduct surveys and interviews with top leaders at the end of 2023. Additionally, we are currently developing an international maturity model of DX drivers by analyzing the timing of the transformation of corporate culture, operations, organizations, processes, products, services, business models, and transformational leadership using an international questionnaire and interviews.

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[13] Regarding DX, we note that business restructuring subsidies (a system to support SMEs) used for business restructuring, such as expansion into new business fields, change of business category, change of business or industry, business reorganization, or expansion of scale through these efforts). However, although the reorganization policies under the Companies Act are covered by this system, it does not directly cover the reform of organizational culture highlighted in this study. In addition, the funds do not need to be returned even if the company does not achieve the final 10% sales requirement and the ex-post evaluation does not function.

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Appendix

Survey 1 Questions

Question: Vision/Strategic Intent Trust

[Trust]

I believe that most people are basically honest.

I am a person who trusts people.

I consider most people to be basically good and kind.

Most people believe that they can trust others.

I believe that most people can be trusted.

[Vision, Mission, and Purpose]

Team members have a clear vision of what the future should look like and what management envisions.

Action goals are shared in the workplace.

[Ambidextrous Management: Search Factors]

Search5: My workplace emphasizes entering and developing new markets.

Serach7: My workplace encourages innovative and risk-taking behavior.

Question: Ambidextrous Management

[Exploration]

Employees are voluntarily oriented toward the simultaneous achievement of multiple goals such as cost, quality, and functionality.

Funds and human resources are being allocated to areas that lead to value creation.

[Exploitation]

My workplace emphasizes entry into and development of new markets.

My workplace encourages innovative and risk-taking behavior.

My workplace prioritizes the allocation of resources to the development of new technologies and products.

Question: Digital Strategy/Transformation

[Digital Strategy/Strategic Intentions (leading to realization of vision, current areas of focus)

My company successfully integrates business strategy with information and digital strategy.
My company has a clear vision of how information and digital technology contribute to business value.

[DX posture]

My company remains up-to-date with information technology.
My company fosters a supportive atmosphere for experimenting with new ways of using information technology.
My company promotes new business processes based on digital technology.
My company integrates digital technology to facilitate change.

Question: Organizational Culture/ Psychological Safety

[Organizational Execution]

In my workplace, I am expected to finish what I started.
Specific ways to execute and achieve workplace goals are discussed.

[Organizational Discipline[14]]

Events such as athletic meets and company trips are set up at my workplace.
Work routines have changed little since I joined my current department.
Punctuality is strictly enforced at my workplace.
My workplace is well organized.
My workplace has many rules that must be followed, such as greetings and cleaning.
My workplace offers many opportunities for cross-departmental interaction (e.g., in-house club activities and in-house cafeterias).

[Psychological Safety]

At my workplace, I can freely share what I feel and notice.
In my workplace, I can say that I do not know what I do not know.
My workplace has an atmosphere in which people are always ready to help me if I visit them for advice.
When a problem arises, my workplace has an atmosphere that encourages thinking about constructive solutions, instead of blaming others.
I feel that taking on challenges is a good thing and not a bad one.
At my workplace, introducing something with no precedent or track record is difficult.
At my workplace, I feel welcome to use my strengths and individuality in my roles.
I feel welcome to bring different perspectives to my workplace without being bound by conventional wisdom.

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[14] This question corresponds to Vial's noted PRACTICE.

Question: Organizational Commitment Satisfaction/Results

[Organizational Commitment: Psychological State of Continued Membership in the Organization]

I feel as if my problems are my own (emotional commitment).

I am attached to my co-workers (emotional commitment).

I am proud to be a part of this company (emotional commitment).

[Satisfaction]

I enjoy working at my workplace.

I feel that I am growing through my work.

[Outcome]

My company's customer retention rate over the past three years has been high compared with that of other companies in the same industry.

My company's sales growth rate over the past three years has been higher than that of industry peers.

[Maturity Level]

An ideal organization is transformed by digital technology and can leverage it to improve processes, engage the organization's talent, and facilitate business models that create new value both now and in the future.

[DX Factors]

Data analysis results are helping to improve sales.

My company is actively recruiting digital talent.

[DX Outcome]

We are providing new products and services using information and digital technologies.

We are improving new products and services using information and digital technology.

Survey 2 Questions

Data_Ana: Results of data analysis contribute to sales improvement.

Enjoyment: I enjoy my work at my company.

Growth: I can feel personal growth through my work.

Evaluation: My company has an evaluation system in which results and abilities are reflected in compensation.

Talent_Dev: My company has a systematic employee training program.

PS2: At my company, I can say I do not know what I do not know.

PS4: When problems occur, my company has an atmosphere that fosters thinking about

constructive solutions rather than blaming others.

Agility1: My company can introduce new products and services quickly.

Agility2: My company can respond quickly to changing customer needs.

Agility 3: My company responds quickly when competitors launch new products or services.

Sharing: My company can learn from others and exchange knowledge and ideas.

Gratitude: My company has an environment where we can honestly express our gratitude.

Strategic_Intent: My company has a clear vision of how information and digital technologies contribute to business value.

DX1: My company drives new business processes based on information and digital technologies.

DX2: My company's business operations are changing to take advantage of information and digital technology.

Exploration: My company is continuously developing and producing new products and services.

Exploitation: My company prioritizes improving the quality of its products and services

CRR: My company's customer retention rate over the past three years has been high compared with that of other companies in the same industry.

Sale: My company's sales growth rate over the past three years has been high compared with industry peers.

Digital_Talent: My company actively recruits digital talent.

Vision: Our leaders have a clear and positive vision of the future.

Clan_Culture: My organization has a family like atmosphere, and my employees have a strong bond.

Market_Culture: My organization is competitive and focused on achieving goals and results.

Adhocracy_Culture: My organization values creativity and innovation and always seeks new ideas and solutions.

Hierarchical_Culture: My organization emphasizes adherence to rules and policies.