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Refereed Original Paper

Motivation, Media Usage, and Intercultural Adaptation during the COVID-19 Pandemic: Comparing International Students from Mainland China and Others¹⁾

Keywords:

Integrative/Instrumental motivation, Media usage, Sociocultural/Academic adaptation, COVID-19 pandemic

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Abstract

This study aims to clarify the relationship between international students' (ISs') motivation (integrative and instrumental), media usage, and intercultural adaptation (sociocultural and academic) during the COVID-19 pandemic by comparing their social support networks (SSNs) with the Japanese language speakers (JLSs), same-language speaker (SLSs), and other-language speaker (OLSs), and whether there are any differences or similarities between ISs from mainland China (MCISs) and other ISs in these relationships. An online survey targeting ISs enrolled at universities in Japan was conducted from November 19 to December 10, 2021. The data from 364 ISs, including 160 MCISs and 200 other ISs, were analyzed. The results indicated that MCISs with higher levels of Japanese language proficiency and integrative motivation, a longer length of stay in Japan, and who mainly chose Japanese to take a course, were able to form larger SSNs with JLSs; this helped them receive more social support from JLSs which had mediating effects on improving their sociocultural and academic adaptations. On the other hand, it was found that in terms of other ISs-those with lower levels of Japanese language proficiency, shorter lengths of stay in Japan, and higher levels of integrative and instrumental motivation-preferred using various kinds of media which had mediating effects on their sociocultural adaptation; whereas demographics including both integrative and instrumental motivations had direct effects on improving their academic adaptation. These results show different ways to improve MCISs and other ISs' sociocultural and academic adaptations in the future.

1. Introduction

In July 2008, the Japanese government published a policy stating that it would accept 300,000 international students (ISs) by 2020; the targeted figures were achieved in 2019 (JASSO, 2020). Many ISs have since arrived in Japan for further education. However, although 60% of the ISs wished to find employment in Japan after graduation, only 30% were able to do so (JASSO, 2020). One reason for this may be that ISs are unable to easily adapt to the Japanese society.

Traditionally, ISs' successful social support networks (SSNs), including more Japanese language speakers (JLSs), have been considered effective in improving their adaptation in Japan (Tanaka, 2000). However, Ye (2017) investigated the causal relationship between ISs' SSNs and adaptation by comparing the SSNs formed through face-to-face (FTF) communications, voice calls, instant messaging (IM) texts, and emails between males and females. She found that ISs who adapted well were able to form larger SSNs with ILSs via FTF communication. and only female SSNs with JLSs were effective in decreasing their maladaptation. Moreover, it was found that compared to the SSNs formed via FTF communications, those established through voice calls and IM texts included more samelanguage speakers (SLSs) than JLSs.

Regarding the different effects of JLSs and SLSs on ISs' adaptation, Ye (2018) indicated that ISs' generalized trust of others not only had direct effects on improving their sense of acceptance in Japan but also increased their social support from JLSs, which had mediating effects on improving their sense of acceptance in Japan. However, no similar mediating effects were detected for social support from SLSs. Additionally, Ye (2021) compared the effects of ISs' generalized trust toward out-group members and their group identification toward in-group members on their feelings of stress in Japan, and found that the former had direct effects on decreasing their feelings of stress, while the latter had direct effects on increasing their feelings of stress. Furthermore, ISs' generalized trust, along with their SSNs with JLSs, led them to receive more social support from JLSs, and this had mediating effects on decreasing their feelings of stress. However, ISs' group identification and their SSNs with SLSs led them to receive more social support from SLSs, which in turn, had mediating effects on increasing their feelings of stress.

Owing to the influence of the COVID-19 pandemic, people have been trying to avoid FTF communication, and they preferred various forms of media to communicate with others. In addition, most universities had implemented COVID-19-mitigating measures such as shifting FTF classes to online modes, thus leading ISs to have fewer opportunities to meet JLSs and receive less social support from them. Meanwhile, their communication with SLSs became more frequent as media usage facilitated their selective interpersonal relationships. Ye (2022) conducted a survey targeting ISs in mid-to-early June 2020, immediately after the first state of emergency was lifted, and found that although ISs from mainland China (MCISs) had higher levels of Japanese proficiency, they used official media such as Japanese television and newspapers much less than other ISs, and most used Weibo to search information about COVID-19, even though they all stayed in Japan. However, issues such as the language/s used by ISs to search information, their attitudes toward various media from different countries, and differences or similarities in these variables between MCISs and other ISs have not been studied. Therefore, this study examined MCISs' and other ISs' frequency of information collection in their mother tongue and a foreign language and their degree of trust in different media from Japan, their home country, or other countries.

According to previous studies, there are two types of motivation for ISs' to study abroad: integrative and instrumental. The former refers to a favorable attitude toward the target language community and a possible desire to integrate and adapt to a new target culture using the language, while the latter refers to learning to accomplish a task, such as passing a course and getting better pay (Gardner, 1985). Additionally, there are two types of adaptation: sociocultural and academic (Searle & Ward, 1990). The former entails adjustment to social customs and norms, as well psychological adaptation caused by anxiety, depression, and loneliness owing to the loss of SSNs. Conversely, academic adaptation refers to factors such as second-language proficiency and academic performance.

In Japan, over 90% of the ISs come from Asia and nearly half come from mainland China (JASSO, 2022). This means that compared to other ISs, MCISs can easily form in-group members, especially among those with higher levels of group identification. Additionally, according to JASSO's (2017) survey results, regarding the reasons for coming to Japan, 48.3% answered "to work in Japan/get a job at a Japanese company," and 47.0% answered "to obtain an academic degree," while only 20.8% answered "interested in Japan and intercultural communication with the Japanese." This indicates that ISs in Japan have stronger instrumental motivation than integrative motivation. However, we still do not know how ISs' motivations relate to their adaptation and whether these would differ or not between MCISs and other ISs.

Until now, it has been pointed out that ISs' use of the host society's media facilitates effect on language acquisition and adaptation to the host culture (Elias & Lemish, 2011), while the frequent use of the home country's media is associated with ethnic identity and inhibits their adaptation (Lee & Lee, 2017). However, currently, people can use various kinds of media to obtain information and communicate with people from around the world conveniently. Therefore, it is supposed that ISs with higher levels of Japanese language proficiency and generalized trust, and stronger integrative motivation, may have higher levels of trust in Japanese media and use them more to obtain information objectively, which will improve their sociocultural and academic adaptations. On the other hand, ISs with lower levels of Japanese language proficiency with stronger instrumental motivation and higher levels of group identification may have higher level of trust in media from their home country, and therefore use them to obtain information more than media from Japan or other countries. This will improve their academic adaptation but not their sociocultural adaptation.

As mentioned above, MCISs possessed higher levels of Japanese language proficiency and longer durations of Japanese language learning than other ISs. Thus, it is reasonable to believe that these factors, along with their integrative motivation, will not only have direct effects on improving MCISs' sociocultural adaptation but also help form larger SSNs with JLSs. This will help them receive more social support from JLSs, which will benefit their sociocultural adaptation. On the other hand, higher levels of English language proficiency and stronger instrumental motivation will help improve the academic adaptation of other ISs. However, owing to their lack of Japanese language proficiency, their demographics may lack the ability to have similar effects on their SSNs with JLSs.

To examine these points, the present study investigated the model shown in Figure 1. In Figure 1, "Demographics" referred to age, gender, length of stay in Japan, duration of learning the Japanese language, Japanese and English language proficiency, experience from a part-time job, languages used mainly for taking courses, and their integrative and instrumental motivations. The "SSNs" included the communication partners, frequency of meeting each other, ways for contacting, and their communication partners' importance for ISs among these factors. Additionally, "social support received" referred to the support from JLSs, SLSs, and other-language speakers (OLSs). "Media usage" included the degree of trust in information resources from different countries. and the frequency of using media to collect information using ISs' mother tongue and foreign languages. This study examined the sociocultural and academic adaptations as dependent variables between MCISs and other ISs.

2. Research Method

To examine the above-mentioned issues, an online self-report survey was conducted between November 19 and December 10, 2021.²⁾ Questionnaires in Japanese, English, and Chinese (both simple and traditional) were used, allowing the participants to select the version they wished to answer. The English version was translated by the author and reviewed, and proofread by a native English speaker. The two Chinese versions were translated by native Chinese speakers whose Japanese language proficiency was close to that of native Japanese speakers. The participants were ISs enrolled in different universities throughout Japan. The questionnaire survey with four language versions was created using the SurveyMonkey tool. We sent out the links to the survey with instructions to ISs who had participated in the project's previous surveys and who studied at our graduate school. In addition, we sent invitations via emails and group chats to ISs in other graduate programs at the university for responses to the survey. We asked professors at other universities and ISs who responded to the survey to share the survey'



Figure 1. The model analyzed in this study

links. Before responding to the survey, the ISs for were provided with written instructions and (2 information regarding the storage of their data, Li informed consent, voluntary nature of their dia participation, privilege to withdraw, and privacy and protection of their personal information. In m total, 394 ISs submitted their responses. The to responses from ISs outside of Japan and those th who had stayed in Japan for less than three an months were excluded as this survey appraised (T

SSNs in the last three months. The remaining 364 responses were analyzed in this study. The survey comprised three parts. The contents of the survey were as follows:

Part A gathered personal information, including demographic data, such as gender, age, nationality, mother language, first and second foreign languages, academic standing, total length of stay in Japan, duration of learning of the Japanese language, level of Japanese language proficiency (score and level in the Japanese Language Proficiency Test [JLPT], and selfevaluation of Japanese language proficiency in reading. listening. speaking, and writing compared to an adult native Japanese speaker reported as a percentage),³⁾ English language proficiency (score in TOEFL-iBT and TOEIC, self-evaluation and of English language proficiency in reading, listening, speaking, and writing compared to an adult native English speaker, reported as a percentage),⁴⁾ lifestyle,⁵⁾ and experience with and frequency of working part-time jobs (see Table 1 for details).

In addition, six items were chosen from Yamagishi and Yamagishi (1994) to measure the participants' levels of generalized trust. Twelve items from Karasawa (1991) were used to measure group identification. Ten items were revised and used to measure the ISs' motivation for studying abroad based on JASSO's results (2017). The responses were rated on a five-point Likert scale (5=Strongly agree; 1=Strongly disagree).

Part B addressed the ISs' frequency of using media to collect information in their mother tongue and other languages per day in the last three months by making them choose one answer from "Over 10 times" to "Don't use" (Table 2).⁶⁾ In addition, ISs were asked to rate their degree of trust in the information sources from Japan, their home country, and other countries or regions, by choosing one answer from "5. Strongly reliable," "3. Neutral" to "1. Strongly unreliable," and "Don't use" (Table 3).

Part C measured ISs' SSNs by asking them to list up to 10 persons they communicated with over the previous three months. For each SSN, the ISs were asked to provide their contact person's gender, age, nationality, relationship, frequency of contact (4. Almost every day; 1. Less than one month), importance to the participants (5. Very important; 1. Not important), and so on (See Tables 4 & 5). In addition, 13 items were used to measure the social support received from SLSs, JLSs, and OLSs based on Okunishi and Tanaka (2008) and Ye (2021) (Table 6), by choosing "Yes" or "No." Furthermore, 11 items based on Pascarella and Terenzini (1980) were revised and used to measure the ISs' academic and sociocultural adaptations on a 5-point scale (5. Strongly agree; 3. Neutral; 1. Strongly disagree) (Table 7).

3. Results

3.1 Descriptive Results

The results indicated that 44.0% of ISs were from mainland China, followed by Indonesia (6.3%), Vietnam (5.2%), Malaysia (4.4%), and America (3.6%). This result is similar to that of Ye (2022) and the national survey results (JASSO, 2022).

Table 1 shows that regarding their lifestyle, more MCISs lived with other ISs, while more other ISs lived with family or relatives; the ratio of enrollment in doctoral programs among other ISs was much higher, and over 78% of them received a scholarship, while only 36.9% of MCISs received a scholarship. In addition, MCISs had a longer duration of learning Japanese, as 78.8% of them had passed the JLPT-1, and 76.9% took their courses mainly in Japanese, whereas 75.5% of the other ISs took their courses mainly in English. Furthermore, the *t*-test results (independent sample) showed significant differences in their language proficiencies. For the Japanese language, t(362) = 13.38, p < .001, and MCISs vs. other ISs=.66 vs. .33; for the English language, t(244.4)=8.34, and p < .001, MCISs vs. other ISs=.67 vs. .84.

Regarding the ISs' levels of generalized trust

| Items | MCISs (160) | Other ISs (204) | | |
|--------------------------------|--|--|--|--|
| Gender ratio | Males 36.9% Females 63.1% | Males 48.5% Females 51.5% | | |
| Age (in years) | 25.4 years (SD 3.01) | 28.8 years (SD 5.57) | | |
| A codomic standing | Undergraduate 20.6% Master's 55.0% | Undergraduate 19.1% Master's 31.9% | | |
| Academic standing | Doctoral 23.1% Other 1.3% | Doctoral 43.6% Other 5.4% | | |
| Length of stay in | 41.2 months (SD 28.3) | 37.6 months (SD 28.7) | | |
| Japan | | | | |
| Duration of | 55.3 months (SD 35.4) | 41.1 months (SD 47.5) | | |
| learning Japanese | (JLPT-N1/L1 holders 110, 68.8%) | (JLPT-N1/L1 holders 27, 13.2%) | | |
| English language | TOEIC 47.5% TOEFL 36.3% | TOEIC 31.9% TOEFL 29.4% | | |
| proficiency test ²⁾ | IELTS 6.3% Other 0.0% | IELTS 26.5% Other 0.5% | | |
| | University dormitory 12.5% | University dormitory 36.8% | | |
| | Dormitory for ISs only 11.3% | Dormitory for ISs only 6.4% | | |
| Residence | Private rental housing 70.6% | Private rental housing 54.4% | | |
| | Rental/house share of foreigners 0.6% | Rental/house share of foreigners 1.0% | | |
| | Other 5.0% | Other 1.5% | | |
| | Alone 68.1% With other ISs 20.0% | Alone 64.2% With other ISs 8.8% | | |
| Lifestyle | With family/relatives 7.5% | With family/relatives 15.2% | | |
| | With Japanese students 1.3% Other 3.1% | With Japanese students 4.9% Other 6.9% | | |
| | Yes 36.9% (MEXT: 45.8% | Yes 78.4% (MEXT: 66.9% | | |
| Scholarship | Private 39.0% Other 8.5%) | Private 23.1% Other 9.4%) | | |
| | No 63.1% | No 21.6% | | |
| Language for taking | Japanese 76.9% English 22.5% | Japanese 22.5% English 75.5% | | |
| course mainly | Other 0.6% | Other 2.0% | | |
| Deut time inte | Yes 46.3% (Mean 6.0 hour per week) | Yes 32.4% (Mean 4.5 hour per week) | | |
| Part-time job | No 53.7% | No 67.6% | | |

| Table 1. | Participant | characteristics |
|----------|-------------|-----------------|
| | | |

and group identification, MCISs had higher levels than other ISs on both scales. For the former, t(362)=2.06, p<.05, and MCISs vs. other ISs=22.06 vs. 21.15; for the latter, t(362)=4.63, p<.001, and MCISs vs. other ISs=45.73 vs. 41.70. Furthermore, it was found that other ISs had higher levels of both integrative and instrumental motivation than MCISs: for the former, t(307)=2.69, p<.01, and MCISs vs. other ISs=14.85 vs. 15.80; for the latter, t(362)=10.95, p<.001, and MCISs vs. other ISs= 17.99 vs. 21.73.

Table 2 shows the frequency of information collected using the mother tongue and foreign languages between the two groups. The results indicated that MCISs used their mother tongue more than foreign languages, while other ISs used foreign languages more than their mother tongue to obtain information in their daily lives. Additionally, Table 3 shows the degree of trust in the two groups for different media. To compare MCISs and other ISs' degrees of trust in media in Japan/home country/other countries, this study conducted *a t*-test (independent sample). The results showed that, compared to MCISs, other ISs had higher levels of trust in official institutions and mass media, whereas MCISs had higher levels of trust from celebrities and influencers in Japan and their home country (China).

3.2 ISs' configurations of SSNs and social support received

The ISs' configurations of SSNs are detailed in Tables 4 and 5. The results indicated that compared to MCISs, other ISs formed larger SSNs, met with JLSs and OLSs more frequently than MCISs, and considered JLSs and OLSs to be more important than MCISs.

Regarding the social support that ISs received from JLSs, SLSs, and OLSs, this study conducted a *t*-test (independent sample) to compare which group that MCISs and other ISs received more social support from. The results showed that

Table 2. Frequency of information collection per day in the last three months using different languages

| | MCISs | Other ISs | |
|--|----------------|----------------|--|
| Method of information collection | Mother Foreign | Mother Foreign | |
| 1. Official sources (TV, government press, etc.) | 96.6 113.3 | 114.9 138.4** | |
| 2. News apps and sites (Google News, LINE News, Yahoo! News, etc.) | 113.3 115.1 | 129.0 149.7* | |
| 3. Social media (Facebook, Twitter, Instagram, Weibo, etc.) | 165.8*** 127.3 | 192.1 191.8 | |
| 4. Messenger app (LINE, WhatsApp, WeChat, etc.) | 213.0*** 117.6 | 164.3 157.7 | |
| 5. Blog (Ameba Blog, Seesaa Blog, etc.) | 63.2*** 24.6 | 21.0 33.5* | |
| 6. Information sharing website (Tabelog, etc.) | 93.8*** 49.1 | 38.8 49.7 | |
| 7. Q&A website (Yahoo! Answers, etc.) | 93.8*** 46.3 | 32.4 53.8*** | |
| 8. Video website (YouTube, Niconico Video, Vine, TikTok, Bilibili, etc.) | 184.3*** 136.9 | 171.3 193.1 | |
| 9. E-mail, chat, forward articles, etc., with friends and acquaintances in Japan | 90.0 105.8 | 117.9 150.2*** | |
| 10. E-mail, chat, forward articles, etc., with friends and acquaintances in | 138.0*** 68.8 | 154.1*** 117.8 | |
| home country | | | |

Note: **p*<.05; ****p*<.001.

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| | | MCISs | | | Other Is | Ss |
|---|-------|----------|-------|--------|----------|--------|
| Information and news items | Japan | Home | Other | Japan | Home | Other |
| 1. Information disseminated by the official institutions (Government or Administrative agencies) | 3.7 | 3.6 | 2.9 | 4.3*** | 3.6 | 3.4*** |
| 2. Information disseminated by the mass media | 3.2 | 3.1* | 2.6 | 3.4* | 2.9 | 2.9* |
| 3. Information disseminated by the private organizations (Companies or NPOs) | 3.1 | 2.8 | 2.4 | 3.3 | 3.0 | 2.8*** |
| 4. Information spread and posted by friends/acquaintances in real life | 3.2 | 3.2** | 2.44 | 3.1 | 2.9 | 2.6 |
| 5. Information spread and posted by Japanese celebrities | 2.6** | * 2.4*** | 2.1 | 1.9 | 1.9 | 2.0 |
| 6. Information spread and posted by strangers in Japan | 2.0* | 2.2*** | • 1.9 | 1.7 | 1.7 | 1.7 |

Table 3. Degree of trust in different media between MCISs and other ISs

*Note: *p*<.05; ****p*<.001.

Table 4. Configuration of SSNs (from the perspective of gender)

| | MCISs | | | Other ISs | | |
|--------|-------|-------------|----------------|-----------|-------------|----------------|
| | Total | Same gender | Crossed-gender | Total | Same gender | Crossed-gender |
| Number | 5.7 | 3.6 | 2.2 | 7.8*** | 4.6*** | 3.2*** |

Note: ***p<.001.

| Table 5. Configuration of SSNs | (from the perspective of nationality |) |
|--------------------------------|--------------------------------------|---|
| | (| , |

| | MCISs | | | Other ISs | | |
|--|-------|------|------|-----------|--------|--------|
| | SLSs | JLSs | OLSs | SLSs | JLSs | OLSs |
| Number | 4.1 | 1.4 | .2 | 4.2 | 2.0 | 1.7 |
| Frequency of meeting | 8.8 | 3.8 | .5 | 12.6 | 5.5*** | 5.2*** |
| Importance for ISs | 17.2 | 5.5 | .82 | 18.1 | 7.7** | 6.9*** |
| Communication via voice calls/messages | 3.1 | .64 | .1 | 3.3 | .6 | .8*** |
| Text messages | 3.4 | .92 | .2 | 3.8 | 1.2 | 1.5*** |
| Emails | .1 | .63 | .0 | .12 | .7 | .2** |

Note: ***p*<.01; ****p*<.001.

overall, MCISs received more social support from SLSs while other ISs received more social support from OLSs (Table 6). In addition, MCISs received more social support from JLSs in terms of learning the Japanese language and better understanding the Japanese culture; whereas other ISs received more social support from JLs in terms of interpersonal relationships and obtaining useful information. Furthermore, compared to the period before COVID-19 (Ye, 2021), the percentage of ISs' receiving social support from JLSs in terms of better understanding the Japanese culture and customs (item 3) and helping with research (item 6) increased for both MCISs and ISs, while the percentage of ISs' receiving social support from JLSs in providing useful information and material support decreased (items 11, 12).

3.3 Sociocultural and academic adaptations of ISs' and factors influencing them

Table 7 lists the items, the average score for each item, and the *t*-test results (independent sample) for the sociocultural and academic adaptations between the two groups. The results indicated significant differences between the two groups in terms of academic adaptation; however, there were no significant differences in their sociocultural adaptation.

This study performed structural equation modeling (SEM) analysis to clarify the relationships indicated in Figure 1 and compared the effects of generalized trust and group identification on ISs' media usage and SSNs with JLSs, SLSs, and OLSs, and the social support received from JLSs, SLSs, and OLSs in their sociocultural and academic adaptations.⁷⁾ As a result, only the models including generalized

| Table 6. ISs | ' social support | received from others: | Compared to the | period before COVID-19 |
|--------------|------------------|-----------------------|-----------------|------------------------|
|--------------|------------------|-----------------------|-----------------|------------------------|

| Items | | Ye (202 | 1) | MCISs | Other ISs |
|--|-------|---------|-------|------------------------|------------------------|
| Received social support | JLSs | SLSs | OLSs | JLSs SLSs OLSs | JLSs SLSs OLSs |
| 1. Explained Japanese to me when I did not | 90.4% | 73.7% | 51.7% | 90.6% 81.3%*** 34.4% | 89.2% 61.3% 64.2%*** |
| understand it even after reading or listening to | | | | | |
| it | | | | | |
| 2. Corrected my mistakes in Japanese when | 75.1% | 56.0% | 38.8% | 81.3%* 60.6%** 17.5% | 72.1% 44.6% 47.5%*** |
| writing or speaking | | | | | |
| 3. Explained Japanese culture and customs to | 38.8% | 68.4% | 46.9% | 88.1% 68.8% 21.3% | 88.7% 63.7% 57.8%*** |
| me | | | | | |
| 4. Became interested in my country's culture | 82.8% | 59.8% | 65.1% | 86.9%** 70.6%*** 41.3% | 75.5% 49.5% 70.6%*** |
| and customs and tried to understand them | | | | | |
| 5. Helped me finish my homework and pass | 45.0% | 47.8% | 39.2% | 40.0% 52.5% 18.8% | 42.6% 44.1% 42.6%*** |
| examinations | | | | | |
| 6. Helped me conduct my research | 58.4% | 44.5% | 38.8% | 79.4% 74.4%*** 26.9% | 70.6% 50.5% 53.4%*** |
| 7. Could be consulted when I experienced | 47.4% | 84.2% | 45.9% | 48.8% 90.0% 26.3% | 57.4% 83.3% 61.8%*** |
| personal problems | | | | | |
| 8. Encouraged me when I did not do well | 57.4% | 83.3% | 54.5% | 56.9% 90.0%* 28.7% | 66.7% 82.4% 72.1%*** |
| 9. Went out for leisure and to have fun together | 58.9% | 85.6% | 60.3% | 60.6% 94.4%* 36.3% | 70.6%* 67.6% 76.0%* |
| 10. Gave me necessary/useful items | 60.8% | 83.3% | 56.0% | 56.9% 85.6%* 25.0% | 67.6%* 76.0% 62.7%*** |
| 11. Lent me money when I needed it | 26.8% | 63.2% | 27.8% | 16.9% 57.5% 6.9% | 25.0% 56.9% 34.3%*** |
| 12. Provided useful information for my life in | 81.3% | 81.3% | 57.4% | 65.6% 85.6%* 24.4% | 78.9%** 75.0% 66.2%*** |
| the local area | | | | | |
| 13. Told me how to conduct necessary | 72.2% | 74.2% | 50.7% | 75.0% 81.9%** 23.1% | 82.8% 69.1% 66.2%*** |
| procedures and provided information about | | | | | 1 |
| important notices at the university | | | | | 1 |

Note: Ye (2021) conducted the survey from June to July 2018. **p*<0.5; ***p*<.01; ****p*<.001.

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| Items | MCISs | Other ISs |
|--|-------|-----------|
| 1. My non-classroom interactions with the faculty have positively influence my personal growth, values, and attitudes. | 3.8 | 3.8 |
| 2. My non-classroom interactions with the faculty have had a positive influence on my intellectual growth and interest in ideas. | 3.6 | 3.8 |
| 3. My non-classroom interactions with the faculty have had a positive influence on my career goals and aspirations. | 3.5 | 3.7 |
| 4. Since enrolling at the current university/graduate school, I have developed a close and personal relationship with at least one faculty member. | 3.7 | 3.8 |
| 5. I am satisfied with the opportunities to meet and interact informally with the faculty members. | 3.6 | 3.5 |
| 6. I am satisfied with the extent of my intellectual development since enrolling at the current university/ graduate school. | 3.7 | 3.9 |
| 7. My academic experience has had a positive influence on my intellectual growth and interest in ideas. | 3.9* | 4.2* |
| 8. I am satisfied with my academic experience at this university/ graduate school. | 3.6** | 4.0** |
| 9. Some of my courses this year have been intellectually stimulating. | 2.9** | 2.5** |
| 10. My interest in ideas and intellectual matters has increased since enrolling at the current university/graduate school. | 3.8** | 4.1** |
| 11. I have performed academically as well as I anticipated. | 3.4** | 3.8** |

Table 7. ISs' sociocultural and academic adaptations' mean score and results of the t-test

Note: *p<.05; **p<.01. Items 1~5: Sociocultural adaptation; Items 6~11: Academic adaptation.

trust and SSNs with JLSs could be adopted; those including group identification and SSNs with SLSs or OLSs were neither adopted nor had any effect. All the indexes, parameter estimates, and goodness of fit are depicted in Figures 2-5.

The demographics of MCISs were found to have positive effects on SSNs with JLSs, helping them receive more social support from JLSs, which had mediating effects on improving their sociocultural and academic adaptations. In particular, it was found that MCISs with higher levels of Japanese language proficiency, a longer stay in Japan, higher levels of integrative motivation, and those who took courses mainly in Japanese had such effects. Additionally, it was found that demographics had slightly significant effect on their sociocultural adaptation, but they did not have any effect on their academic adaptation. Furthermore, although generalized trust had effects on their media usage, neither it nor media usage had any effect on sociocultural or academic adaptation. Finally, it was found that generalized trust had slightly significant effects on the formation of SSNs with JLSs.

In terms of other ISs, it was found that their demographics not only had direct effects on their media usage but also had effects on their generalized trust; this made them use more media, which had mediating effects on improving their sociocultural adaptation but had no similar effects on their academic adaptation. Additionally, it was found that demographics had direct effects on academic adaptation. In particular, ISs with higher levels of instrumental and integrative motivation, lower levels of Japanese and English language proficiencies, and a shorter stay in Japan seemed to directly affect their academic adaptation. Finally, it was found that their



GFI= .888, CFI= .953, RMSEA= .053.

Figure 2. Results for MCISs' sociocultural adaptation



Figure 3. Results for MCISs' academic adaptation

demographics did not have any effect on their SSNs with JLSs, and the effects of their SSNs with JLSs on social support from JLSs could also not be found, although social support from JLSs helped to improve their sociocultural and academic adaptations.

4. Discussion

This study investigated the relationship between ISs' integrative and instrumental motivation, media usage, and sociocultural/ academic adaptation during the COVID-19 pandemic, comparing their SSNs with JLSs, SLSs, and OLSs, from the perspective of generalized trust and group identification, as well as the differences in these relationships between MCISs and other ISs.

Compared to MCISs, other ISs had higher levels of integrative motivation, instrumental motivation, and academic adaptation, and were able to form larger SSNs with JLSs and OLSs,



GFI= .907, CFI= .957, RMSEA= .049.

Figure 4. Results for other ISs' sociocultural adaptation



Figure 5. Results for other ISs' academic adaptation

and received more social support from them. However, the SEM results showed that MCISs' demographics had positive effects on their SSNs with JLSs, which helped them receive more social support from JLSs, while other ISs' demographics did not have any effects on their SSNs with JLSs. One of the main reasons for this might be their lack of Japanese language proficiency, as only 13.2% had passed the JLPT-L1/N1 and 75.5% had taken courses mainly in English. Additionally, their SSNs with JLSs did not help them receive more social support from JLSs. This may be due to their larger SSNs with OLSs (Table 5) and more social support received in some items from OLSs than JLSs and SLSs, as indicated in Table 6. These results suggest that improving MCISs' Japanese language proficiency and integrative motivation for those taking courses mainly in Japanese will help form larger SSNs with JLSs resulting in receive more social support, which will improve their sociocultural and academic adaptations. In contrast, as other

ISs' demographics had significant direct effects on their academic adaptation, it is suggested that improving their instrumental and integrative motivations for taking courses mainly in English, will help improve their academic adaptation, as these three factors had the strongest positive effects among their demographics.

Regarding the effects of media usage on other ISs, it was found that those with lower levels of Japanese language proficiency, shorter stays in Japan, and higher levels of integrative and instrumental motivations used different media to obtain information, which helped improve their sociocultural adaptation. In particular, their trust in Japanese media seemed to have the largest effect, followed by media from other countries or regions, while the home country's media seemed to have the least effect. These results show that the use of the host society's media has a facilitating effect on language acquisition, and that a better understanding of the host culture is effective for other ISs with lower levels of Japanese language proficiency, a shorter stay in Japan, and higher motivation to understand Japanese culture.

Previously, it was suggested that the frequent use of the home country's media is associated with ethnic identity and may inhibit adaptation (e.g., Lee & Lee, 2017). However, from the SEM results for MCISs, it was found that media usage did not have any effect on their sociocultural or academic adaptation, although they had the highest degree of trust in their home country's media. These results suggest that for MCISs, media usage (including that of the home country) does not directly improve or inhibit the two types of adaptation. However, as MCISs used voice calls and IM messages to form larger SSNs with SLSs than with JLSs and OLSs (Ye, 2017; 2021), with no effect for SSNs with SLSs or OLSs on improving their sociocultural and academic adaptations from the SEM results, it is suggested that the effects of media used to communicate with speakers of different languages may differ from those of media used to obtain information in daily life. However, this requires further investigation.

In contrast to Ye (2021), there were slightly significant effects of MCISs' generalized trust on SSNs with JLSs; however, no similar effects were found among other ISs. This might be partly due to the MCISs' higher level of generalized trust than other ISs. It is necessary to examine this in detail in future studies.

5. Conclusion

This study was conducted during the period when the fewest number of people were affected by the COVID-19 pandemic; however, there were many restrictions on people's daily lives compared to those before COVID-19. The results indicated that MCISs and other ISs had different ways of improving their sociocultural and academic adaptations, including media usage. Although this study was conducted during a specific period, as ISs' communication behaviors, learning and using language habits, and motivations for studying in Japan might not have changed much because of the pandemic, it is believed that the implications obtained from this study will help understand how to support ISs better to improve their sociocultural and academic adaptations based on their demographic factors and cultural backgrounds.

Notes

1) Segments of the results have been reported at the

37th SIETAR Japan Annual Conference in November 2022.

- The survey was conducted with the approval of the Research Ethics Review Board of the Faculty of Library, Information and Media Science at the University of Tsukuba.
- 3) Japanese language proficiency was determined as follows: (a) For ISs that had passed JLPT-L1/ N1, it was calculated as L1 score/400 or N1 score/180. (The total score of L1 is 400, while that of N1 is 180.); (b) For ISs that had passed JLPT-L2/N2, it was calculated as L2 score/400 × .08 or N2 score/180 × .08. (L2/N2 level is approximately 80% of L2/ N2's.); (c) For ISs who did not pass JLPT 1/2, it was calculated as (self-evaluation percentage of "listening"+speaking"+"reading"+"writing")/400.
- 4) English language proficiency was calculated as follows: (a) for ISs who had taken TOEIC: their score/990; (b) for ISs who had taken TOEFL-iBT: their score/120; (c) for ISs who had taken IELTS: their level/9; (d) for ISs who had taken multiple tests, their average percentage from (a) and/or (b) and/or (c) was used; (e) for ISs who had not taken any test, proficiency was calculated as (selfevaluation percentage of listening+speaking+read ing+writing)/400.
- Regarding their living style, "living alone" was coded as "1" and living with others was coded as "2" in the analysis.
- 6) Their frequency of information collecting was calculated monthly as follows: "over 10" was counted as 300, "6-10" was counted as 240, "3-5" was counted as "120", "1-3" was counted as 60, "less than once" as 30, and "did not use" was 0.
- 7) This study coded "Japanese" as "0" "English" as "1" and "others" as "2" when analyzing "language for taking courses mainly." As there was one MCIS that chose "others," which was not sufficient sample to analyze, this study only used 159 MCISs

and 200 other ISs' data in the SEM.

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Refereed Original Paper

Pandemic Fatigue in Japan: A panel data analysis of factors that affect human mobility during the seven waves of the COVID-19 pandemic

Keywords:

Mobility changes, COVID-19 pandemic, mobility restriction policies, vaccination rate

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Abstract

This study aims to elucidate factors that affect mobility change throughout the seven waves of the COVID-19 pandemic in Japan. Specifically, it examines the impact of policy interventions and COVID-19 case numbers on mobility patterns. The study focuses on the effects of the Emergency State Declaration (ESD), the "Pre-emergency measures", and the "Go To Travel" campaign as significant policy factors. Additionally, it explores how vaccination rates influence mobility changes. The author utilized daily data spanning from March 18, 2020, to October 15, 2022, across 47 Japanese prefectures and employed a Feasible Generalized Least Squares (FGLS) model to analyze the panel data for each wave of the pandemic. Three principal findings emerge from this analysis: First, the positive COVID-19 cases negatively influences mobility, and this effect diminishes as the pandemic persists. Second, both the ESD and the "Pre-emergency measures" effectively reduced mobility, whereas the "Go To Travel" campaign significantly promoted mobility. Third, increases in the vaccination rate correlates positively with mobility increases. With previous studies emphasize the importance of restricting mobility to mitigate the pandemic spread, this study presents a contrasting perspective, highlighting that people's behaviors are inherently influenced by the pandemic situation. This interplay between the pandemic and human mobility should be conceptualized as a dynamic, interactive process.

1 Introduction

1.1 Background

The global outbreak of a novel coronavirus, the COVID-19 pandemic, marked 2020. Due to its highly infectious nature, by the end of 2020, over 90 million cases had been confirmed worldwide (Johns Hopkins University, 2020). Since the main transmission route is through person-to-person contact, staying at home and maintaining social distance are important ways to lower the risk of infection. To control the spread of the COVID-19 pandemic, governments in many countries have launched formal (legally imposed) restrictions on personal movements, such as closing borders, publishing "stay at home" orders, banning crowd gathering, and closing non-essential retail units and schools.

In Japan, the first COVID-19 case was confirmed on 16 January 2020. At the initial stage, Prime Minister Shinzo Abe called for a national response to the COVID-19 pandemic on 26 February 2020, suggesting that the nation should re-engage in "jishuku". The Japanese word "jishuku" is defined as voluntary restraint from fun, luxury, and celebration activities (Ida et al. 2015). Up to 7 April 2020, there were 4478 cumulative positive and 98 death cases. The Japanese government announced an ESD (Emergency State Declaration) on 7 April in seven prefectures (Tokyo, Kanagawa, Saitama, Chiba, Osaka, Hyogo, and Fukuoka) to control the pandemic. On 16 April, the ESD was expanded to all 47 prefectures. On 25 May, the Japanese government lifted the ESD because it seemed the pandemic was under control. Due to subsequent waves of the pandemic, the Japanese government has issued three additional ESD. Furthermore, since April 2021, the Japanese government has also implemented "Pre-emergency measures (まん延防止等重点措置)" to curb the spread of the pandemic. Specific measures include shortened operating hours for dining establishments and voluntary refraining from outings to crowed locations to reduce infection risks. These measures were implemented just before issuing an ESD, defined as a stage requiring responses to prevent a rapid increase in infections and significant disruption to medical services.

The spread of the COVID-19 pandemic has caused severe damage to various industrial and social sectors. Tourism-related industries are among the most notably affected ones. Both the inbound and domestic tourism demand has decreased dramatically. According to the Overnight Travel Statistics Survey conducted by the Japan Tourism Agency (2021), the relative number of hotel guests staying in business hotels, resort hotels, city hotels, and ryokan (a classical Japanese style lodging) from March to June 2020 decreased by 48.9-84.9% compared with the same period in 2019. Meanwhile, inbound tourists to Japan were 32 million in 2019, but the cumulative count by October 2020 was only 4 million (JNTO 2021).

In order to promote the recovery of tourism demand, the Japan Tourism Agency initiated the "Go To Travel" campaign on 22 July 2020. This campaign offered 35% discounts on hotel charges and consumption coupons. By doing so, it aimed to increase tourism and consumer demand, thereby stimulating economic recovery. However, the campaign did not apply to Tokyo residents. Travel to Tokyo was also not included until October 2020 due to the severe pandemic.

1.2 Human mobility

To visualize human mobility changes during

the pandemic, Google released "Community Mobility Reports" (CMR) (Google 2020). The data was collected from peeople who access Google's applications using mobile phones or other devices and allow "location history" recording. The data is widely used to study the relationship between mobility and COVID-19 incidence.

This study uses mobility data of "retail and recreation" and "transit station" areas as proxies for mobility in crowded areas. Section 5.1 presents detailed explanations of Google Mobility data used in this study.

1.3 Objectives of this study

The COVID-19 pandemic has lasted for over three years in Japan. As previous studies suggested, when a pandemic outbreak lasts for a long time, people's vigilance gradually slackens and their willingness to take protective measures decreases, which is known as pandemic fatigue. From this perspective, this study investigates how people adjust their mobility according to COVID-19 cases and policy influences throughout the seven waves of the pandemic and reveal whether there was pandemic fatigue in Japan's case. As the specific objectives, firstly, this study aims to reveal the variations in the degree of influences COVID-19 cases have on mobility. Secondly, to reveal how the ESD, "Pre-emergency measures", and the "Go To Travel" Campaign affect mobility. Thirdly, to verify how the vaccination rate affect mobility.

2 Previous studies

Many previous studies evaluated the connection between human mobility and the COVID-19 pandemic. Jung et al. (2021) combined

human mobility data, temperature, and risk awareness to predict the reproduction number of COVID-19 in Japan. Kraemer et al. (2020) analyzed the correlation between real-time mobility data from Wuhan and COVID-19 cases. Their result shows that travel restrictions implemented in China were effective, particularly in the early stage of an outbreak. In another highly influential study, Badr et al. (2020) show that mobility patterns strongly correlate with COVID-19 case growth rates for the most affected counties in the United States. Specifically, decreased mobility has a significant positive relationship with reduced case growth. Kurita et al. (2020) applied Apple mobility data to estimate the increase in COVID-19 cases. They concluded that mobility data could explain Japan's pandemic outbreak trend. Therefore, monitoring mobility data is a helpful way to adjust measures to control the pandemic.

Based on the verified fact that human mobility plays a decisive role in the COVID-19 case growth, measures implemented to restrict mobility, such as lockdowns and stay-at-home orders, were also effective in previous studies. Tian et al. (2020) found that measures including suspending intracity public transport, closing entertainment venues, and banning public gatherings were associated with COVID-19 case reductions. The national emergency statement appears to have delayed the growth and limited the influence of the COVID-19 pandemic in China.

Regarding the case of Japan, Inoue and Okimoto (2022) evaluated the relationship between mobility, vaccination, and the number of new infections. Their results show that mobility control measures and the ESD have effectively lower the growth rate of new infections. Moreover, they found that vaccination suppressed the increase of new infections, but encouraged increases in mobility. Masuhara and Hosoya (2022) investigated how mobility and vaccination affect the trends of COVID-19 Infections in Canada, Germany, Italy, and Japan. Their results also indicated that vaccination increases mobility.

As introduced above, most previous studies used mobility to monitor or forecast COVID-19 cases reproduction. In these studies, the number of COVID-19 cases is used as the dependent variable. However, there was little discussion about how the pandemic affect mobility, in other words, how people adjust their behavior according to the pandemic. Except for Watanabe & Yabu (2020), they used mobility data to examine how government's policies led to mobility changes. Their analysis found that the declaration of the state of emergency significantly reduced the number of people leaving their homes by 8.5%. Second, a 1% increase in new infections reduces people's outings by 0.027%. Their findings offer pivotal insights into behavioral adaptations during the pandemic. Nevertheless, their analysis is confined to data ranging from January 6 to June 28, 2020. The dynamic nature of the impact relationship throughout the seven waves of the pandemic remains unexplored. Moreover, the author extends this investigation by incorporating the effects of vaccination, a critical determinant influencing both the actual risk of infection and public perception thereof.

3 Hypotheses

The author set up the following hypotheses to investigate the aforementioned questions. Firstly, Hypothesis 1 assumes that COVID-19 cases' influence on mobility was gradually weakening with the long-lasting pandemic.

H1: COVID-19 cases' influence on mobility was gradually weakening.

Secondly, since vaccination can effectively reduce the risk of infection, hypothesis 2 assumes that vaccination rate has a positive influence on mobility.

H2: The vaccination rate has a positive influence on mobility.

Thirdly, policies implemented during the pandemic significantly influence people's behavior. Hypothesis 3.1 assumes that the ESD and "Preemergency measures" restricted mobility in "retail and recreation" and "transit station" areas, while hypothesis 3.2 assumes that the "Go To Travel" campaign stimulates mobility in these areas.

H 3.1: The ESD and "Pre-emergency measures" has a negative influence on mobility.

H 3.2: The "Go To Travel" campaign has a positive influence on mobility.

4 Model specification and variables

The model presented below is constructed to verify the hypotheses. Table 1 shows explanations of each variable and corresponding data sources. In the model, GM_{it} represents mobility in "retail and recreation" areas and "transit station" areas in prefecture *i* at time *t*. $C_{i(t:n)}$ represents daily reported Covid-19 positive cases in each prefecture *i* at time *t-n*. In the analysis, the author applied different lags for this variable to examine positive cases' incluence on mobility. Since the number of newly confirmed positive cases is reported one day later, $C_{i(t:n)}$ indicates the newly confirmed positive cases that reported one day before (which is actually the confirmed cases of

two day before). *K_dum_{it}* is the dummy variable of the ESD period, M_dum_{it} is the dummy variable of the "Pre-emergency measures" period. The specific start and end dates of each ESD and "Pre-emergency measures" period varies from prefecture to prefecture. Values of this two variables is is set according to "The period of the COVID-19 emergency declaration state" published by Ministry of Justice (2022). $G_{dum_{it}}$ is the dummy variable of the "Go To Travel" campaign period. H_dum, represents the dummy variable of holidays, including statutory holidays, and consecutive holidays such as the New year, Golden Week, and Obon Festival. W dum, represents the dummy variable of the seven waves of the COVID_19 pandemic. The specific start and end dates of each wave are set according to the National Institute of Infectious Diseases (2022)'s research (Table 2)⁽¹⁾. $V_{i(t-1)}$ represents vaccination rate in prefecture *i* at time *t-1*.

 $GM_{it} = \beta_0 + \beta_1 C_{i(tn)} + \beta_2 K_d um_{it} + \beta_3 M_d um_{it} + \beta_4 G_d um_{it} + \beta_5 H_d um_t + \beta_6 W_d um_t + \beta_7 C_{i(tn)}^* W_d um_t + \beta_8 V_{i(t-1)} + \varepsilon$

i=1,...,47 Japanese prefectures. *t*=Daily

In sum, mobility changes are influenced by COVID-19 cases, two policies aimed at restricting mobility (the ESD and pre-emergency status), the "Go To Travel" campaine, holidays, and vaccination rates. Furthermore, the interaction term between $C_{i(tn)}$ and W_dum_t is applied to elucidate how the relationship between COVID-19 cases and mobility varies across the seven waves of the pandemic.As shown in the column "data frequency" in Table 1, Google Mobility data, COVID-19 case data, and vaccination rate data is daily based data by prefecture. The collected

dataset contains data of 47 prefectures in 942 days.

Regarding the estimation method, as well known, the advantage of panel data is that it includes information in both time-series and cross-section dimensions. However, panel regression models also tend to have problems such as autocorrelation and heteroskedasticity in the error terms. The issues of autocorrelation (where error terms are correlated over time) and heteroskedasticity (where the variance of error terms differs across observations) violate the

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| Notation | Variable Meaning | Data frequency | |
|----------|----------------------------------|-------------------|--|
| | Location history data | nequency | |
| GM | published by Google | Daily | |
| | Mobility | | |
| С | The number of daily new | | |
| | confirmed COVID-19 | Daily | |
| | positive cases | | |
| K_dum | Emergency State | Dummur | |
| | Declaration | Dummy | |
| M_dum | Pre-emergency measures | Dummy | |
| G_dum | "Go To Travel campaign" | Dummy | |
| H_dum | Holidays | Dummy | |
| W_dum | The seven waves of the pandemic. | Dummy | |
| V | Vaccination rate | Daily | |

Table 2 The start and end date of the seven waves

| Waves | Start and end date |
|-------|----------------------|
| 1st | 2020.3.23~2020.5.17 |
| 2nd | 2020.6.22~2020.9.27 |
| 3rd | 2020.10.26~2021.2.28 |
| 4th | 2021.3.1~2021.6.20 |
| 5th | 2021.7.12~2021.9.26 |
| 6th | 2022.12.20~2022.6.19 |
| 7th | 2022.7.1~2022.10.15 |

fundamental assumption of Ordinary Least Squares (OLS) estimation, leading to biased and inconsistent estimation results.

To confirm heteroskedasticity and autocorrelation in this panel dataset, the author conducted the Modified Wald test (for groupwise heteroskedasticity) and the Wooldridge test (for autocorrelation). The results show that there is groupwise heteroskedasticity and first-order autocorrelation. Therefore, the author estimates the model by the feasible generalized least squares (FGLS) estimator since it addresses these problems and produces a consistent and more robust estimate.

The fundamental concept of FGLS involves constructing a weighted variance-covariance matrix of error terms based on the heteroscedasticity and autocorrelation characteristics present in the data. This construction aims to ensure that the weighted exhibits homoscedasticity matrix and no autocorrelation, therefore enables parameter estimation using Ordinary Least Squares (OLS) while mitigating the biases mentioned earlier. Its advantages include providing more efficient and consistent estimates that accommodate complex data structures, thereby enhancing the reliability of statistical inference in empirical research. In addition, the FGLS estimator is particularly suitable for the long panel data used in this analysis, which has a greater number of periods (T) and a much smaller number of cross-sections (N).

5 Data visualization

5.1 Mobility

The dependent variable GM_{it} represents the mobility in prefecture *i* at time *t*. Google "Community Mobility Reports" provides data that reflect the mobility changes in six categories

of areas: retail and recreation, grocery stores and pharmacies, parks, public transport, workplaces, and residences. This data is derived from users who have opted into Location History and accessed Google's service. It reflect mobility's relative percentage change compared to baseline period (2020.1.3-2020.2.6), not the absolute number of visitors. Specifically, the daily percentage changes were calculated relative to the median for each corresponding weekday or weekend during the baseline period. Since mobility patterns will be different on weekdays and weekends, data on a Monday are compared to corresponding data from the baseline series for a Monday. Baseline day figures are calculated for each day of the week and as the median value (Google 2020). For example, a decrease of 50% in retail and recreation mobility indicates that mobility in that area reduced to half of the baseline level. The mobility data of Japan was downloaded on 10 December 2022.

Figures 1 and 2 illustrate the mobility trends in "retail and recreation" and "transit station" areas across Aichi, Kanagawa, Osaka, and Tokyo. The left y-axes on of Figures 1-3 represents the percentage change in mobility compared to the baseline period. The right y-axes represent the values of the ESD dummy variable. The figures are marked with light orange zones representing the ESD periods (i.e., with a value of 1), which varied among the prefectures. For Tokyo, the specific ESD periods were from April 7 to May 25, 2020; January 8 to March 21, 2021; April 25 to June 20, 2021; and July 12 to September 30, 2021. Mobility in both categories of areas experienced the most significant decline during the first ESD period, which was announced at the beginning of the pandemic. Subsequent ESD periods also show notable reductions in mobility. Notably, the

22

"transit station" areas saw a more pronounced decrease compared to "retail and recreation" areas. This disparity could be attributed to the substantial reduction in public transport usage as remote work became more prevalent.



Figure 1 Mobility in retail and recreation areas



Figure 2 Mobility in transit stations areas

Figure 3 shows the mobility trend in Tokyo, with the light green zone indicating the period of the "Go To Travel" campaign. Following a marked decrease during the first ESD period, mobility in these areas rebounded to a level approximately 30% lower than the baseline, subsequently exhibiting a slow but upward trend with sporadic downturns.

By July 2020, a notable recovery in mobility was observed. The implementation of the "Go To Travel" campaign on the 22nd of July 2020 contributed to a further increase in mobility. This campaign was suspended in 27th December 2020 in response to a new wave of severe COVID-19 cases growth.



Figure 3 Mobility in retail and recreation areas -Tokyo

5.2 The number of COVID-19 Cases

The author uses daily reported COVID-19 positive cases as explanatory variable to assess the pandemic's impact on mobility changes. Data were retrieved from the NHK website dedicated to Coronavirus updates (NHK 2022). Figures 4 presents the COVID-19 positive cases for the same four prefectures, illustrating the evolving trend of the pandemic. All prefectures demonstrate a similar trend with seven waves of increasing positive cases. The first and second peaks (occurring around April 2020 and August 2020, respectively) are barely discernible due to their relatively smaller magnitude compared to the latter two peaks (around July to August 2022), which marked the most severe outbreaks in all the prefectures. The light orange zones in the figures, indicating the ESD periods, coincide with the periodic surges in positive cases.

5.3 Vaccination rate

In the initial phase of the pandemic, mobility



Figure 4 Daily reported COVID-19 positive cases

restrictions served as the primary means to mitigate the spread of the virus. With the efficacy of vaccines against infection established through clinical trials, vaccination became the principal strategy to reduce infection risks. In Japan, the first round of vaccinations started from April 2021. According to Idogawa, et al. (2020), by December 2021, over 70% of the population in most prefectures had received their second vaccine dose, indicating complete vaccination. This study analyzes the completed vaccination rate to determine its impact on individuals' decisions to engage in outdoor activities, thereby influencing mobility patterns.

6 Results

This chapter presents the estimation results. Subsequent interpretations and discussions are based on the results of the FGLS model. The author applied three different time lags (4 days, 8 days, and 12 days) to the variable of COVID-19 cases to reveal the delayed effects of its influence on mobility.

6.1 Retail and recreation mobility

Table 3 presents the results with GM (retail and recreation) as the dependent variable. All variables show statistically significant estimated coefficients across all three models, except for W_dum (7).

First, W_dum is used to represent the seven waves of the pandemic. Since the first wave is designated as the base period, subsequent waves are compared to the first wave. Thus, a significant coefficient for $W_dum(2)$ indicates that the mean mobility during the second wave differs significantly from that during the first wave. The same interpretation applies to the third through sixth waves, except for the seventh wave. $W_dum(0)$ represents periods that do not belong to any wave (as shown in Table 4, there are empty days between waves). The coefficient for $W_dum(0)$ signifies that the mean mobility during these periods differs significantly from that during the first wave.

Secondly, concerning the impact of COVID-19 positive cases, the lagged effects (4-days, 8-days, 12-days) of C(positive) all show a negative influence on mobility. Moreover, the coefficients of the interaction terms $C_{t,n}^*W_{dum}$ are all statistically significant, indicating that the influence of COVID-19 positive cases on mobility differs significantly across subsequent waves compared to the first wave. Using the result of model C_{ts} , the author computed the marginal effects⁽²⁾ of positive cases on mobility. As shown in Table 5 and Figure 5, during the first wave, an increase in positive cases correlates with a mobility decrease of 0.036 in "retail and recreation" areas. During the second wave, this decrease is 0.020. The effect slightly strengthens in the fourth wave compared to the third, before gradually diminishing until the seventh wave of

| Dependent | GM (retail and recreation) | | | | |
|----------------------|----------------------------|------------|------------|--|--|
| 1 | Ct-4 | Ct-8 | Ct-12 | | |
| C_{t-n} | -0.028*** | -0.036*** | -0.023*** | | |
| | (0.006) | (0.006) | (0.005) | | |
| W dum(2) | 4.836*** | 6.573*** | 7.284*** | | |
| _ () | (1.017) | (1.012) | (1.043) | | |
| W dum(3) | 3.253*** | 4.986*** | 5.956*** | | |
| | (0.940) | (0.938) | (0.970) | | |
| W dum(4) | 6.135*** | 7.984*** | 8.642*** | | |
| _ () | (0.905) | (0.903) | (0.936) | | |
| W dum(5) | 2.597** | 4.483*** | 5.366*** | | |
| _ () | (1.030) | (1.028) | (1.055) | | |
| <i>W</i> dum (6) | 0.827 | 3.070*** | 3.629*** | | |
| _ () | (1.057) | (1.055) | (1.079) | | |
| W dum(7) | -0.340 | 1.624 | 2.430** | | |
| _ () | (1.110) | (1.106) | (1.130) | | |
| W dum(0) | 3.841*** | 5.806*** | 6.589*** | | |
| _ () | (0.894) | (0.906) | (0.936) | | |
| $C_{t-n}^*W dum(2)$ | 0.012* | 0.016** | 0.012** | | |
| _ `` | (0.006) | (0.007) | (0.006) | | |
| $C_{t-n}^*W dum(3)$ | 0.026*** | 0.031*** | 0.020*** | | |
| _ 、 , | (0.006) | (0.006) | (0.005) | | |
| $C_{t-n}^*W dum(4)$ | 0.024*** | 0.029*** | 0.018*** | | |
| | (0.006) | (0.006) | (0.005) | | |
| $C_{t-n}^*W dum(5)$ | 0.028*** | 0.035*** | 0.023*** | | |
| | (0.006) | (0.006) | (0.005) | | |
| $C_{t-n}^*W dum$ (6) | 0.028*** | 0.035*** | 0.023*** | | |
| | (0.006) | (0.006) | (0.005) | | |
| $C_{t-n}*W_dum(7)$ | 0.028*** | 0.036*** | 0.023*** | | |
| | (0.006) | (0.006) | (0.005) | | |
| $C_{t-n}*W_dum(0)$ | 0.026*** | 0.032*** | 0.021*** | | |
| | (0.006) | (0.006) | (0.005) | | |
| K_dum | -5.335*** | -5.082*** | -5.050*** | | |
| | (0.147) | (0.143) | (0.140) | | |
| M_dum | -2.833*** | -2.768*** | -2.775*** | | |
| | (0.103) | (0.101) | (0.100) | | |
| G_dum | 3.843*** | 3.792*** | 3.806*** | | |
| | (0.637) | (0.623) | (0.629) | | |
| H_dum | 5.006*** | 5.077*** | 5.261*** | | |
| | (0.401) | (0.393) | (0.393) | | |
| V _{t-1} | 0.134*** | 0.127*** | 0.129*** | | |
| | (0.009) | (0.009) | (0.009) | | |
| Constant | -15.660*** | -17.250*** | -18.060*** | | |
| | (0.736) | (0.743) | (0.780) | | |
| Observations | 44,086 | 43,898 | 43,710 | | |

Table 3 Results of Retail and recreation Mobility (Made by the author)

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Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

| | | 5 (| , |
|----------------------|------------------|-----------------------|------------|
| Dependent | | GM (transit stations) | |
| | C _{t-4} | C1-8 | Ct-12 |
| Ct-n | -0.016*** | -0.017*** | -0.019*** |
| | (0.005) | (0.005) | (0.005) |
| W dum(2) | 9.997*** | 10.990*** | 12.360*** |
| _ 、 、 | (1.145) | (1.143) | (1.165) |
| W dum(3) | 7.250*** | 8.522*** | 10.030*** |
| _ 、 、 | (1.060) | (1.060) | (1.083) |
| W dum(4) | 12.440*** | 13.550*** | 14.930*** |
| | (1.031) | (1.032) | (1.055) |
| <i>W</i> dum (5) | 5.989*** | 7.081*** | 8.614*** |
| _ , , , | (1.178) | (1.179) | (1.197) |
| <i>W</i> dum (6) | 5.472*** | 6.763*** | 8.090*** |
| | (1.286) | (1.298) | (1.314) |
| W dum(7) | 9.459*** | 10.640*** | 12.340*** |
| _ , , , | (1.348) | (1.356) | (1.372) |
| W dum(0) | 9.754*** | 10.700*** | 12.180*** |
| _ , , , | (1.013) | (1.041) | (1.064) |
| $C_{t-n}^*W dum(2)$ | 1.50E-05 | -0.003 | 0.004 |
| _ 、 | (0.005) | (0.006) | (0.005) |
| $C_{t-n}^*W dum(3)$ | 0.013*** | 0.014*** | 0.016*** |
| _ 、 | (0.005) | (0.005) | (0.005) |
| $C_{t-n}^*W dum$ (4) | 0.011** | 0.011** | 0.015*** |
| Cl-n // _uum (+) | (0.005) | (0.005) | (0.005) |
| $C_{t-n}^*W dum$ (5) | 0.015*** | 0.016*** | 0.017*** |
| _ 、 | (0.005) | (0.005) | (0.005) |
| $C_{t-n}^*W dum$ (6) | 0.016*** | 0.017*** | 0.018*** |
| | (0.005) | (0.005) | (0.005) |
| $C_{t-n}^*W dum$ (7) | 0.016*** | 0.017*** | 0.018*** |
| _ 、 | (0.005) | (0.005) | (0.005) |
| $C_{t-n}^*W dum(0)$ | 0.013*** | 0.014*** | 0.017*** |
| | (0.005) | (0.005) | (0.005) |
| K dum | -4.032*** | -3.908*** | -3.923*** |
| | (0.193) | (0.191) | (0.190) |
| M_dum | -2.115*** | -2.139*** | -2.155*** |
| | (0.143) | (0.143) | (0.142) |
| G_dum | 7.970*** | 8.024*** | 7.943*** |
| | (0.723) | (0.707) | (0.707) |
| H_dum | -3.709*** | -3.773*** | -3.894*** |
| | (0.369) | (0.362) | (0.367) |
| V _{t-1} | 0.178*** | 0.178*** | 0.176*** |
| | (0.012) | (0.012) | (0.012) |
| Constant | -33.990*** | -35.100*** | -36.490*** |
| | (0.835) | (0.845) | (0.876) |
| Observations | 44,086 | 43,898 | 43,710 |

Table 4 Results of Transit stations Mobility (Made by the author)

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

| | (| , | | | | |
|---|---------------------|-----------------------|-----------|---------------------|-----------|--|
| - | C _{t-8} at | Retail and recreation | Std. Err. | Transit stations | Std. Err. | |
| | $W_dum(1)$ | -0.036*** | (0.006) | -0.017*** | (0.005) | |
| | $W_dum(2)$ | -0.020*** | (0.003) | -0.020*** | (0.002) | |
| | $W_dum(3)$ | -0.005*** | (0.001) | -0.004*** | (0.001) | |
| | $W_dum(4)$ | -0.007*** | (0.001) | -0.006*** | (0.001) | |
| | $W_dum(5)$ | -0.001*** | (0.000) | -0.001*** | (0.000) | |
| | W_dum (6) | -0.000*** | (0.000) | -0.000*** | (0.000) | |
| | $W_dum(7)$ | -0.000*** | (0.000) | -0.000*** | (0.000) | |
| | | | | | | |

Table 5 The marginal effect of COVID-19 cases at each wave of the pandemic (Made by the author)

Notes: *** p<0.01, ** p<0.05, * p<0.1



Figure 5 The marginal effect of COVID-19 cases at each wave of the pandemic (Made by the author based on the second and fourth columns values in Table-5)

the pandemic.

Thirdly, regarding the impact of the ESD and "Pre-emergency measures", the significant coefficients of both K_dum and M_dum indicate that they effectively restricted mobility in "retail and recreation" areas, with the ESD exerting a stronger influence. Fourthly, the coefficients of *G_dum* indicate that the "Go To Travel" campaign promoted mobility in "retail and recreation" areas, resulting in an increase of approximately 3.8. Fifthly, the coefficient of *H_dum* suggests that mobility in"retail and recreation"areas significantly increases during holidays. Lastly, the one-day lag of the vaccination rate contributes positively to increases in mobility.

6.2 Transit stations mobility

Table 4 presents the results with GM (transit stations) as the dependent variable. The estimated coefficients for all variables are statistically significant in all three models, except for the coefficient of the interaction term between $C_{tn}^*W_dum$ (2). W_dum is defined as explained in Section 6.1.

COVID-19 positive cases have a significantly negative effect on mobility in "transit station" areas. Concerning the interaction terms, most coefficients are significant, indicating that the

impact of positive cases on mobility during the third to seventh waves differs significantly from that during the first wave. However, the coefficients of $C_{t,v}^*W_dum(2)$ are not significant, suggesting no significant difference in the impact of positive cases on mobility between the second wave and the first wave. The marginal effects are presented in the fourth column of Table 5. An increase in positive cases is associated with a decrease of 0.017 in mobility in "transit stations" areas during the first wave. This impact not only did not diminish compared to the first wave but rather intensified during the second wave (In Table 5, the coefficient of W_dum (2) in the fourth column shows a significant result, indicating that during the second wave, the impact of positive case numbers on mobility is significantly -0.020. This is not contradictory to the insignificant coefficient of the interaction term $C_{t,n}^*W_{dum}$ (2) in Table 4, which indicates that the difference between the second and first waves is not significant). During the third wave, an increase in positive cases is associated with a decrease of 0.0038 in mobility, which is significantly weaker compared to the first two waves. In the fourth wave, this effect strengthened slightly compared to the third wave, and the trend of weakening has persisted since the fourth wave until the seventh wave of the pandemic.

The significant coefficients of both K_dum and M_dum reveal that they effectively restricted mobility in "transit stations" areas. Specifically, the ESD had a greater impact than "Preemergency measures". The coefficients of G_dum show that the "Go To Travel" campaign significantly encouraged mobility in these areas, with an increase of about 8.0, which is much greater compared to its impact on mobility in "retail and recreation" areas (approximately 3.8). Regarding coefficients of *H_dum*, there was a significant decrease in mobility in "transit stations" areas during holiday periods. Lastly, the vaccination rate also contributes positively to mobility increases in "transit stations" areas.

6.3 Summary

Drawing from the above results, all hypotheses are strongly supported. In summary, the COVID-19 pandemic had a negative impact on mobility in both "retail and recreation" as well as "transit stations" areas. As illustrated in Figure 5, the negative impact of positive cases on mobility was most pronounced at the initial stage of the pandemic and gradually approached zero as the pandemic persisted. The results from three different time lags (4-days, 8-days, and 12-days) for COVID-19 cases are consistent, indicating the stability of the estimated effects. They also suggest a persistent influence of positive cases on mobility with a time lag. Specifically, the number of positive cases reported on a given day significantly affected people's decision to go out four, eight, and twelve days later. Furthermore, the efficacy of both policy measures is confirmed. The ESD and the "Pre-emergency measures" effectively restricted mobility, whereas the "Go To Travel" campaign encouraged mobility increase. Finally, increases in the vaccination rate significantly promoted an upturn in mobility.

Additionally, the author included *H_dum* to examine the impact of holidays on mobility. The results indicate a significant increase in mobility in "retail and recreation" areas during holidays, while mobility in "transit stations" areas significantly decreases. This difference may stem from two reasons. Mobility in "transit stations" areas encompasses commuting, tourism, and other purposes. Firstly, commuting is unnecessary during holidays, resulting in a significant reduction in mobility. Secondly, considering the impact of the pandemic, there is a corresponding decrease in long-distance travel that requires the use of public transportation, which may also contribute to the reduction in mobility.

7 Discussions

This study endeavors to attain a more nuanced comprehension of mobility changes during the COVID-19 pandemic, with a particular focuses on the pandemic fatigue in the context of the prolonged health crisis. In this section, the author further discusses insights that may be gain from the results.

7.1 COVID-19 cases and mobility

This analysis found that the number of COVID-19 cases negatively affects mobility patterns. The results indicate that individuals adjust their decisions regarding visits to crowded areas based on the number of newly reported cases. While extant literature predominantly provides evidence of how human mobility influences the spread of the COVID-19 pandemic, this study offers a contrary perspective, demonstrating that the pandemic's severity significantly impacts mobility trends. In other words, the interplay between the pandemic and human mobility should be conceptualized as a dynamic, interactive process. This reconceptualization is critically important, as previous studies has extensively investigated the necessity of restricting human mobility to the pandemic's mitigate proliferation. Nonetheless, there is a paucity of research on the factors that influence mobility and the strategies to modulate it effectively. The current study reveals that the reporting of new COVID-19 cases can lead to changes in actual behavior. Echoing Chan et al. (2020), it is posited that perceived risk, rather than actual risk, predominantly dictates behavioral responses.

It is noteworthy that the impact of the pandemic on mobility, though pronounced initially, has diminished across the seven waves. As shown in Figure 5, during the first wave, an increase in reported cases was correlated with a 0.036 decrease in mobility in "retail and recreation" areas, and a 0.017 decrease in mobility in "transit stations" areas. Contrastingly, during the sixth and seventh waves—despite a substantial rise in COVID-19 cases—the public's responsiveness to the pandemic waned considerably. By the seventh wave, the correlations between the rise in positive cases and mobility changes are as minimal as approximately zero.

7.2 The effect of the ESD and "Pre-emergency measures"

Regarding the effect of the ESD, the results indicate that the ESD have led to mobility decreases in both "retail and recreation" areas and "transit station" areas. These findings are in alignment with previous studies that have confirmed the influence of restrictive measures on mobility, as evidenced in studies by Badr et al. (2020) and Kurita et al. (2020). The results verified that the ESD has effectively contributed to mobility decreases in crowded areas.

Furthermore, the "Pre-emergency measures" also effectively reduced mobility in these two areas. As introduced in Section 1.1, the "Pre-emergency measures" were implemented before the ESD to prevent the rapid spread of the pandemic. In terms of intensity, the requirements

of the "Pre-emergency measures" are weaker than those of the ESD. This is also reflected in the results of this analysis, where the effect of the ESD on mobility reduction (approximately –5 in "retail and recreation" areas and –4 in "transit station" areas) is greater than that of the "Preemergency measures" (approximately –2.8 in "retail and recreation" areas and –2.1 in "transit station" areas).

As indicated by previous study (National Institute of Infectious Diseases 2021), the reduction in mobility resulting from these two preventive policies is attributed, on one hand, to direct factors such as closures or shortened operating hours of commercial and dining facilities, and event cancellations. On the other hand, the implementation of these policies inherently communicates the severity of the pandemic, raising public awareness and indirectly influencing individuals' decisions to go out. In other words, the rigorous mobility restriction measures heightened the public's sense of urgency and awareness of the infection risk, subsequently leading to significant mobility decreases.

7.3 The effect of the "Go To Travel" campaign With respect to the impact of the "Go To Travel" campaign, this analysis revealed that it has fostered increased mobility in both "transit station" and "retail and recreation" areas. Moreover, since the "Go To Travel" campaign encouraged people to travel by offering discounts on travel expenses, it resulted in an 8.0 increase in mobility in "transit stations" areas, which was much greater than that observed in "retail and recreation" areas.

Delgado (2023) stated that the campaign significantly bolstered tourism. During the

protracted periods of quarantine, tourism demand had been considerably suppressed. Within this context, the launch of the "Go To Travel" campaign emerged as a pivotal stimulus for travel by conveying to the public that the pandemic has subsided and that travel was once again safe. The implementation of the "Go To Travel" campaign met the repressed demand for tourism, effectively contributed to tourism recovery. However, from the perspective of pandemic control, it has led to significant increases in mobility, resulting in crowded gatherings and increased infection risks. Consequently, it faced widespread criticism and was suspended in late December 2020.

7.4 Vaccination rate and mobility

Vaccination is the key factor in controlling the spread of the virus, subsequently alleviating the public's fear of infection and contributing to increases in mobility. This analysis investigated the impact of vaccination rates on mobility, concluding that higher rates of completed vaccinations correlate with mobility increases. This finding aligns with previous studies (Fukao and Shioji 2022, Masuhara and Hosoya 2022), which have also confirmed the positive effects of vaccinations on mobility. As the vaccinated population grows, the resumption of events and social gatherings becomes more probable. At the mean time, as more people get vaccinated, it could restore confidence in attending avents, participating in outline activities, and visiting crowded areas, which all contributes to the boost of mobility.

8 Conclusions

This study examines factors influencing

human mobility across the seven waves of the COVID-19 pandemic in Japan. Using a Feasible Generalized Least Squares (FGLS) model with panel data from 18 March 2020 to 15 October 2022, the author arrives at several key conclusions. First, the number of COVID-19 cases negatively affects mobility, reflecting behavioral adaptations in response to the evolving pandemic situation. Notably, while the pandemic's initial impact on mobility was profound, this influence has steadily waned, becoming negligible by the seventh wave. This trend illustrates the behavioral adaptations during a prolonged public health emergency, the so-called "pandemic fatigue". Second, the study examines the role of the ESD and the "Pre-emergency measures" in reducing mobility. Conversely, the "Go To Travel" campaign, led to significant mobility increases, especially in "transit stations" areas. Lastly, the findings show that the vaccination rate exerts a considerable positive effect on mobility increases.

Factors affecting personal movement decisions are complex and interrelated. During the global transmission of the COVID-19 pandemic, the more complex and continually changing situation makes it much more difficult to cope with. This study aims to enhance the comprehension of behavioral responses during such public health emergencies and assist corresponding policymaking. As a major contribution, this study has quantitatively evaluated the relationship among the pandemic, policy interventions, vaccination, and mobility, specifically through the lens of pandemic fatigue. Diverging from most prior research that discusses the influence of human behavior on the spread of COVID-19, the present study focuses on how individuals adapt their behavior in response to the severity of the pandemic and the impact of related policies. It adds a discussion to the existing literature on risk perception and determinants of human mobility amidst public health crises. Additionally, this study offers insights into the efficacy of the ESD and the "Pre-emergency measures" in limiting mobility and underscores the critical role of vaccination as a prerequisite for economic recovery.

This study subject to certain limitations. First, the mobility data provided by Google are derived from users who utilize Google's services or applications and consent to sharing their location history. Consequently, this data may not comprehensively represent the mobility patterns of the entire population. Nevertheless, this data source has been widely employed in prior research to evaluate mobility chenges during the pandemic. Second, the analysis is predicated on observational data that exclusively encapsulate mobility changes and does not encompass other behavioral responses to the pandemic, such as mask-wearing, hand hygiene, or social distancing. Future studies are necessary to uncover additional behavioral and psychological changes, particularly concerning pandemic fatigue, using surveys or in-depth interviews.

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Note

 According to National Institute of Infectious Diseases (2022),the period of epidemic waves is defined based on the pandemic curve by diagnostic week. Each wave is defined as follows: the start week is characterized by "an increase over three weeks with a peak increase of 10% or more compared to the previous week, or two consecutive weeks with a week-over-week increase of 1.5 or more." The end week is defined as "a decrease over three weeks with a peak decrease of 10% or less (until the start of the next wave)".

(2) The marginal effects of interaction terms refer to how changes in the independent variables impact the predicted outcome variable when these variables interact with each other. Specifically, it quantifies the additional change in the predicted outcome variable due to the interaction between two independent variables, holding all other variables constant. This helps to understand how the relationship between variables changes depending on the values of the interacting variables, providing insights into complex relationships and conditional effects within the regression model.

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Translation

Comprehending Conceptual Structure in Risk Through Phenomenology

Keywords:

Risk, Concept, Generalization, Phenomenology, Structure

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Abstract

Although there have been many studies on the concept of risk in previous research, there is no widely accepted concept or definition of risk. Since risk is a concept and does not exist in nature, its essential nature cannot be pursued in ways that are generally considered scientific. This has implications for risk management and risk engineering. To solve this problem, we attempt to abstract the structure that makes people feel a particular way, which is common when people feel that there is some risk in a way that does not specify the field or type of risk, through phenomenology and non-conventional science based on it. The structure of risk from the perspective of the perceiver can be summarized as (1) having a future story that the perceiver does not want to be influenced by surroundings and (2) holding a personal belief, doxa, or conjecture that an incident may affect the progress of that story and prevent it from going forward as expected. Having a future story is the premise for the existence of risk, while holding a person belief about the story's progress is the essential nature of what we generally call risk. This new perspective could trigger a paradigm shift in risk-related academia and practices, such as risk management and risk communication.

1. Introduction

Currently, although there are standard guidelines for organizational management regarding risk (JIS, 2019), there is no widely accepted concept or definition of risk (e.g., Matsushita, 2018; Kinoshita, 2016).

Generalized considerations of risk include approaches from sociology, such as the proposal to position risk as the possibility of future damage by an entity that is highly controllable by that entity (summarized from Luman, 2014), the consideration of risk in contrast to a fluctuating world situation (Giddens, 2004), and Beck's proposal (1998) regarding the concept of a "risk society." However, these sociological approaches to risk mainly focus on how risk exists in society and the definition of risk has not been sufficiently examined.

In response, this study demonstrates the essence of the problem, discusses the means to solve it, and proposes a generally acceptable hypothesis regarding the concept and definition of risk, what risk is, which is generalized according to the policy of the solution.

The Guideline for Risk Management (JIS, 2019) advises that the first step to do is to discover the risks for the risk management activity. However, this step is fraught with difficulties (Maeda, 2010). One reason for this is that the definition of risk has not yet been clarified. It is logically impossible to distinguish and indicate unidentified objects, risks, from the chaos. Therefore, risk management practices actually implemented (e.g., Niki, 2009) cannot escape the yoke of arbitrariness.

The absence of a definition of the concept of risk is also a problem in risk communication, which is the practice of sharing and discussing knowledge about risk while seeking the best direction for reaching a consensus on problemsolving (summarized from Kinoshita, 2016). No matter how much information about risk, which is understood differently by different people, is exchanged, it is difficult to reach consensus, consilience, or a problem-solving agreement that integrates all the concepts and understandings of risk; the result is often a list of discrete issues.

These situations indicate that risk-related practice in the world is still in the realm of art, that is, skill or technique, based on intuition and experience, and that in academia, systematic knowledge of the risk concept itself that is applicable to any given situation (i.e., science of risk) has not yet been established.

One reason why current risk studies (Society for Risk Analysis Japan, 2019) and risk engineering (University of Tsukuba, 2022) remain in the realm of item-by-item research, such as considering the treatment of specific accidents in a particular field or studying mathematical tools to handle ambiguity, is that the concept of risk itself has not yet been established as a system of knowledge, i.e., a science.

This study aims to address the above situation regarding risk using the phenomenological approach, to systematize the general theory of risk, and to provide an entry point for thinking scientifically about the concept expressed as "risk."

2. Problems Inherent in Risk Identification

According to the International Standard for Safety (ISO, 2014), risk is defined as the combination of the probability of the occurrence of harm and the degree of that harm. In actuarial science, risk is defined as the product of the occurrence probability of a target accident and its impact, specifically, the degree of harm assessed, that is, the expected value of the impact. In industrial safety and insurance practices, risk is evaluated from the following two perspectives: the probability of an incident⁽¹⁾ and magnitude of its impact. In risk studies, these two perspectives are considered basic principles or, in a sense, absolute rules.

However, several issues remain to be discussed in each of these perspectives when considering risk, as outlined in the following subsections.

2.1 Issues Inherent in Occurrence Probability

The occurrence probability in the international standard of risk and actuarial science makes sense under the assumption of universality of target systems, that is, the invariance of the statistical properties (i.e., ergodicity). In other words, it is implicitly assumed that the nature of the dice does not change.

When considering incidents, such as simple accidents that physically occur in the real world, the invariance of the statistical properties of the system can be assumed to a considerable degree and can also be assumed a substantial number of populations. Therefore, the occurrence probability can ordinarily be scientifically identified from a frequentist perspective. Insurance against accidents, disasters, illnesses, and so on can become a product under this assumption and within the size of the population for which the statistics are meaningful.

Meanwhile, in fields involving human arbitrariness, such as crime and rumors, which are influenced by human behavior and social trends, the universality of the system or the invariance of statistical properties cannot be necessarily assumed. In the cases where the universality of the system cannot be assumed, such as dice with a soft clay die whose shape changes every time it is thrown and whose number of sides is not even fixed, even if the probabilities are calculated based on past results, they do not necessarily predict the future. In such cases, it is difficult to describe the future with probability.

In addition, if an event has never occurred in the past, or if an event cannot be identified as a target, i.e., if *E* in probability P(E) cannot be identified, then probability cannot be derived from past performance, nor can risk be considered on that basis.

There is a hidden structure of time related to the past and the future behind the concept of risk. The essence of the past is static information about things that have already appeared, that is, memories (i.e., knowledge), records, and, in addition, traces of events. The essence of the future, on the other hand, is imaginary stories from now on, as it relates to a person, that the person has arbitrarily made up in the person's mind based on the past (see Subsection 6.4). The structure in time is somehow forgotten when considering risk. Considering risk is basically thinking about upcoming incidents (i.e., the future) based on information so far, that is, the given knowledge about previous incidents that have already occurred (i.e., the past). Therefore, when considering risk, we need to be very careful about the given information, which is often a priori knowledge or premises⁽²⁾ that we are not aware of, and which we often introduce arbitrarily and implicitly.

2.2 Issues Inherent in Impact

In the international standards and in the field

of insurance, another component of risk is the impact of an incident, that is, the reduction in value it causes. This is often assessed on a monetary scale and expressed as the amount of loss. This means that the reduction in value has become an object of arbitrary evaluation based on the sense of value of the parties involved, similar to a merchandise price determined by an agreement at the time of purchase/sale (Amari, 2018).

To examine the reduction in value, it is necessary to understand what value is (Amari, 2021a). However, many discussions on risk (e.g., Japan Risk Research Society, 2019) have not considered this issue, and many studies that quantify risk or consider it in a mathematical model have treated the value affected by risk and the magnitude of the harm (i.e., the reduction in value) as given variables. Simply put, they have not touched on what value is, i.e., axiology.

Because value is neither objective nor natural, the value of the same object can often differ for different people and situations. Therefore, it is difficult to determine what value is by using methods that are generally considered scientific. We consider that this may be a remote cause of the current situation in which the main focus of risk consideration is on the probability of an incident occurring, rather than on the degree of impact or the reduction in value objectively assessed by some scientific measure.

In summary, in many actual cases, the reduction in value is almost completely neglected when considering risk.

Clues to Pursue the Nature of Risk and the Structure of the Risk Concept

Risk is a concept that cannot exist in an

uninhabited world and is not something that exists in the natural world. The systematic way of thinking that seeks the essence of such an object is philosophy. In this study, we consider risk scientifically in an abstract form, without specifying any field or object, with the help of philosophy. The reason for this is easy to understand based on Takeda's (2020, p. 169) following statements:

- At the philosophical table, a "question to be explored" is presented, such as "What is the world?" This "what is" question means "to explain the essence of a thing in terms that everyone can understand."
- A philosopher tries to show this "essence" by setting some key words or principles.
- The principle of philosophy is to seek what words best explain the "essence of things," not to show what is the truth.

For risk, which is a concept understood differently by different people, we cannot pursue natural scientific facts or truth. What we can pursue is the best explanation in words that everyone can understand or a common understanding with universality. Therefore, this study draws on philosophy⁽³⁾ to explore the general nature of risk.

In this study, we consider the nature of risk in an abstract form, without specifying the field, using phenomenology, which is a philosophy of cognition, and a scientific approach based on phenomenology, which we call "phenomenological science" in this paper (see Subsection 5.2). Simply put, this scientific approach to risk is an attempt to find a reasonable structure, sufficient for common understanding, that makes people feel that there is a risk, regardless of the field or type of risk. In addition, this study attempts to develop a hypothesis that best explains the structure in risk.

Ultimately, we aim to broaden the understanding of risk to take it out of the realm of art and skill, to make risk an object of science or academia, and to provide guidance for engineering risk from a generalized perspective. In practical terms, we intend to create a foothold to provide a basis for systemizing risk-related work, such as risk management and communication, beyond intuition and experience.

4. Why Systematizing Risk in a General View is Difficult

Today, we are caught up in the idea that we perceive the world outside ourselves through visual, auditory, and other sensory perceptions. This seems so obvious and natural that we are rarely aware of it. The idea that there is an object that is perceived in the world around us, and that our consciousness, or the perceiving subject, the subjectivity understands it as objective (i.e., Descartes' dualism), has been the basis for the progress of science and technology in the modern era. Today's society is basically built on this idea, or natural attitude.

The perceptions of physical existence and related events do not vary significantly from person to person, given the same conditions. Therefore, generality is not lost when a theory is devised based on a person's perception and understanding, and an academic system is developed by amplifying the theory. This is the foundation of natural science. Today's science and technology are also based on this premise.

Meanwhile, dualism results in a major issue regarding cognition, specifically, can the subject of cognition or human consciousness correctly grasp an object? The senses or perceptions of the person as the subject of cognition, subjectivity, are "different for each person" when "entities without physical nature" such as concepts, senses, and values are the object of cognition (Takeda, 2020, p.79). Therefore, it is not easy to generalize one person's knowledge or perception and to make it acceptable to everyone, or "science," when the object of cognition is an entity that does not have a concrete form in the natural world, namely a conceptual object.

Risk consideration involves thinking about an incident that has not yet occurred. This object has no substance because it has not yet occurred. Therefore, the perception of risk differs for each person, making it difficult to deal with risk in the manner of current science, which is based on dualism. This means that the nature of risk cannot be understood just by relying on the dualistic thinking system on which modern society is based. It seems that many of the current risk studies (e.g., Society for Risk Analysis Japan, 2019) fall into this trap to a greater or lesser extent.

5. Ways to Understand the Risk Concept⁽⁴⁾

5.1 The Thinking Framework of Phenomenology

In contrast to Descartes' dualism, there is a way of thinking, or the philosophy of cognition, that does not presuppose the outside world. This is the phenomenology developed and systematized by Husserl.

Consciousness, the subject of perception, is confined in the physical body and cannot go beyond it. Therefore, consciousness cannot know objectivity in the true sense, or the reality that must exist in the outside world.

Meanwhile, information from the perception of the outside world through the eyes, ears, and other sense organs, as well as from memories and unconscious knowledge, is brought to the consciousness imprisoned in the physical body, and then appears⁽⁵⁾ there as immanence. Phenomenology considers this immanence or consciousness, appearance in called а phenomenon, as the main actor of our cognition. On this basis, it adopts the phenomenological attitude that the immanence, i.e., what is felt by our consciousness, causes our consciousness the subject of cognition - to have the belief that the object in the outside world is definitely like this, namely transcendence (Takeda, 2020, p.72). Moreover, without considering everything in the outside world (i.e., phenomenological reduction), phenomenology focuses only on the immanence, the appearance as a phenomenon of "it" in consciousness, i.e., the feeling that "it is it," namely, the qualia of "it." Next, it tries to discover from the immanence an identity (i.e., an isomorphic structure) that makes us feel a certain way and positions the found identity as the essence of "it." The above sequential procedures give us the nature of "it," the target. and are called essential insight in phenomenology.

In dualism, it is necessary to presuppose an objective existence to be recognized in the outside world. Therefore, if the perception of a supposedly objective existence as an object differs for each person, the following question emerges: Based on whose perception should we understand its existence? Consequently, we cannot determine the understanding about the object as the result.

Phenomenology, on the other hand, takes the feeling that appears in consciousness as the main actor and pursues what causes that feeling (i.e., the feeling that "it is it") in consciousness. In phenomenology, it is sufficient to pursue only the isomorphic structure that evokes that feeling in our consciousness. It is not necessary to assume an objective existence in the outside world. Phenomenology does not pursue objective facts but identifies the structure that brings our conviction about "it," or that "feeling," regardless of whether or not "it" exists in the outside world. This isomorphic structure, or identity, is the essence of an object found phenomenologically.

5.2 Science Not Premised on the Existence of Objectivity

To scientifically examine the nature of risk, which is a concept and has no substance in the outside world, this study positions structuralist scientific theory (Ikeda, 1998; 2006) and structural constructivism (Saijo, 2013; 2005, Kirita, 2009), which are based on phenomenology, a way of thinking about cognition that does not presuppose the existence of an object in the outside world, as phenomenological science and uses them as tools for examination.

According to the structuralist scientific theory, science is the activity of finding identities or isomorphic structures in multiple phenomena, or immanence, that appear in the consciousness of several perceivers or of one perceiver at different times, and of expressing or encoding them in some expressive way. Expressions here can take various forms, such as qualitative natural language expressing a feeling, such as "red," numerical values, illustrations or diagrams, such as a table or graph, or mathematical formulas or symbols, e.g., $f=m \cdot d^2 r/dt^2$, $2H_2 + O_2 \rightarrow 2H_2O$, $\mathcal{A} \Leftrightarrow$, etc.

Structural constructivism, an extension of structuralist science, has been proposed to scientifically treat conceptual objects that are largely related to human arbitrariness, especially in the humanities and sociology, and that are understood in different ways by different people. Structural constructivism asserts an "interest correlation" (Saijo, 2013; 2005), whereby things as phenomena appear in consciousness and are understood by the consciousness in a way that is correlated with the interest of the perceiver or the party. This means that in order to find identity in multiple objects, the party must pay attention to the objects so that they - the phenomena of the objects - appear in consciousness. Furthermore, this interest has the nature of "opportunity correlation" (Kirita, 2009), in which the state or strength of interest changes depending on an opportunity as a trigger provided to the party. These two correlations work particularly well in understanding the concept of risk, i.e. in achieving a common understanding of risk with conviction (see subsection 6.4).

Incidentally, phenomenology, which does not take the position that there is objectivity, proposes the concept of intersubjectivity instead of objectivity. It is the conviction that others must feel and understand similarly to how I feel and understand.

According to structuralist science, the requirement for establishing intersubjectivity is isomorphism in the process of deriving identity from phenomena. In this study, we understand and postulate this requirement as narrativity, or contextuality in thinking, in the process leading to appearance in consciousness. Structural constructivism further formalizes this requirement for intersubjectivity in structuralist science and asserts that disclosure of conditions of examination is a requirement to establish intersubjectivity, that is, to ensure scientificity in a broad sense.

When deriving a hypothesis about the concept of risk in this study, we conduct condition disclosure that shows the flow of thinking as a narrative with context, that is, a scenario. We do this to ensure the intersubjectivity that is phenomenological-scientifically necessary to be science.

In the case of reasonable, convincing understanding through appropriate essential insight in the phenomenological framework, in which strong intersubjectivity is broadly established, the understanding or the result through the insight is sometimes taken for granted, not as a scientific result. The reason that one sometimes thinks so is because the closer to the essence the stated is, the higher the intensity of the understanding and the more natural, or self-evident, it seems (Saijo, 2017). The sense of a matter of course or self-evidentiality of things seen with the naked eye is an effect of the strong intersubjectivity of visual images, phenomena that appear in our consciousness. The strong intersubjectivity, or the sense of taking-forgranted (i.e., the transcendence), of the "appeared images in consciousness from one's own eyes," is due in large part to the "narrative" of the process that brings the appearance in consciousness, that is, the process leading up to the appearance has sufficient contextuality and is not contradictory, comprehensibility is strong, and there is little room for doubt.

An example of contextuality here is the continuous change of visual images that appear in consciousness, flows of experience, in correlation with motor sensations, i.e., "kinesthesis," such as moving the position of the eyes, while maintaining a "consistent temporal relationship," narrativity (Takeda, 2020, p. 103).

- 6. Conceptual Structure in Risk Through Phenomenology
- 6.1 Structural Model of Risk Identification and Risk Management

Figure 1 shows a schematic of the isomorphic structure.

The sentence in Subsection 2.1, "Considering risk is basically thinking about upcoming incidents (i.e., the future) based on information so far, that is, the given knowledge about previous incidents that have already occurred (i.e., the past)." is a model in natural language that expresses or encodes the identity, specifically, the isomorphic structure, that is common to the activities that we call risk identification and management, regardless of the domain or risk type.

Understanding that there is a particular risk, that is, risk identification, is the construction of a model of incidents from given information about past incidents, events 1 through N, that have already occurred, basic knowledge, and numerous assumptions. This is tantamount to creating a system of identities about incidents that have occurred so far. In other words, risk identification is positioned as the science of incidents that have already occurred. In addition, risk management refers to the engineering or technique that attempts to predict and control incidents, event X, that may occur in the future, which have not yet occurred and are therefore intangible, based on the incident model in risk identification or knowledge of the identity of past incidents, and further assumptions, some of which are arbitrary.

In this section, the main part of this study, we attempt to apply the framework of phenomenological science to the concept of risk. starting from the schematic structure shown in Figure 1, and to find the identity, or isomorphic structure that latently exists in the concept. Thus, we attempt to apply the methodology of the essential insight to the concept of risk. In this way, the goal in the title of this study, "Comprehending Conceptual Structure in Risk Through Phenomenology," can be achieved.

In summary, when people perceive a risk, we attempt to find out why they feel that way, that is, the isomorphic structure common to all cases in which the term risk is used, and to express it, i.e., to code it, using some expression or model.



Figure 1: Structure of "Risk Identification" and "Risk Management"

6.2 Contradictions in the Common Understanding of Risk

As can be understood from a few expressions in the Encyclopedia of Risk Research (Society for Risk Analysis Japan, 2019), such as "familiar risks hidden in everyday life" (p. 24) and "various risks existing in the world" (p. 26), the common understanding of risk is based on conventional science, which implicitly assumes that subjectivity and objectivity coincide. In other words, people are dominated by the subject-object composition, i.e., dualism, and think that the objectively existing object, risk, is perceived by the cognizing subject, i.e., consciousness, subjectivity.

However, as some of the structural reasons suggested in Section 4, the common understanding of risk, that is, the common thinking and natural attitude based on the dualism that "there is an initial existence of risk, and the result of the perception, such as cognition, awareness, and discovery, of it is risk" (e.g., Nakayachi, 2012; JIS, 2019) is not necessarily appropriate. Examples are given below.

Shortly after the Kumamoto earthquake in Japan in April 2016, false information began circulating on social media that a lion had escaped from a zoo, along with a fake photo of a lion walking in the city (Kawano, 2020). This disinformation led to people's false knowledge or belief that there was a lion in town. This false knowledge from the disinformation reminded people of the possibility of being attacked by the lion; in other words, the thought that the incident could happen - that there was a risk - made people uneasy. Although the lion's escape did not actually happen and the story was a hoax, this incident shows a case in which knowledge based on disinformation became the basis for creating a risk⁽⁶⁾ that should not have existed from a dualistic

perspective.

Another example involves a long period of wet weather, which is an incident for sun-dried food producers. Here, the possibility of such an event, a period of wet weather, is a risk to them. However, the same wet weather event would be desired by farmers suffering from drought, and thus, is not a case of risk.

These cases cannot be rationally explained by the natural way of thinking (i.e., the natural attitude based on dualism) that first there is an entity called risk, and then people perceive it in the same way no matter when or who they are. That is, the common scientific perspective contradicts the above examples.

6.3 Knowledge: Premises for Understanding the Existence of Risk

We can only consider risk within the scope of our own knowledge of a target event or incident. This knowledge (i.e., the model in Figure 1), which is about similar incidents that have already occurred or may occur, is formed based on information provided through experience, hearsay, records, and teachings.

One example is the risk of Cascadia earthquakes, which have recently been found to occur every few hundred years along the northwest coast of North America. The details of the earthquakes were revealed by records of the 1700 tsunami in Japanese archives (Satake, 2003; Tsuji, 1998; Atwater, 2015) and communicated to people; thereafter, the risk was recognized as real for the first time.

Here, individual knowledge is the premise on which an individual identifies risk. Knowledge is a means of human understanding, and like risk, it is also a concept that does not exist as a physical substance in nature. Therefore, the understanding of the concept called knowledge depends on the individual and differs from person to person. Accordingly, it is necessary to phenomenologically reaffirm the understanding of what individual knowledge is and to share a reasonable agreement on knowledge with intersubjectivity in order to advance the consideration of risk, that is, its nature, absence/presence, and how it exists.

From a phenomenological perspective, the essence of an individual's knowledge, that is, the isomorphic structure common to all cases in which a person says, "I have knowledge of it" or "I know it," is that the person has "doxa," a personal belief about it, the target object, which is constituted by the information about the object that the person has received so far. Because this study is based on phenomenology and does not adopt the idea of objectivity, it takes the position that all of an individual's knowledge is their own beliefs, doxa, which have been constructed in their consciousness as a result of the information provided to them.

For example, the concept of trust, which is a type of knowledge and closely related to risk, is also an understanding, that is, a belief about the person or organization that is constructed in consciousness through the information, often repeatedly conveyed from multiple sources. That is, the knowledge called trust that the target person or organization has responded faithfully and will continue to do so in the future has been constituted with information conveyed to the perceiver assuming that the nature of the person or organization is unchanging.

6.4 How is Risk Constituted?

To summarize first, risk is a perceiver's belief, or knowledge, about an event that may happen in the future and that it could become an incident that affects the upcoming story that the party arbitrarily imagines. In addition, the upcoming story often has some purpose⁽⁷⁾. Figure 2 illustrates the process through which this belief emerges in consciousness as a risk. Here, incidents refer to events that affect the story.

Risk emerges first as a perceiver's knowledge that consists of (1) firsthand information brought to the perceiver's consciousness as perceptions from situations in the past and immediate past; (2) secondhand information drawn from a priori knowledge, that is, beliefs, which are constituted based on information brought to the perceiver from others in the past or by some learning; and (3) information from assumptions arbitrarily made by the perceiver. Then, if some (4) triggering information is provided to the perceiver, this knowledge changes into (5) personal belief, or constitutive immanence, that a similar event could happen as an incident that affects the future story, in which "I" am involved. This personal belief, (5), which is also knowledge of the perceiver, is the true nature of the entity called risk.

Consider the following example. Suppose that people have prior knowledge, an understanding, that consists of information from (1') the realization that abnormal temperatures are frequent, (2') learning about climate change, and (3') the assumption that the same trend will continue. In this situation, if (4') information about the occurrence of Event T, such as super typhoons and poor catches of marine products for example, is conveyed to the people and stimulates their emotions, (5') the belief will appear in their consciousness that if the climate trend continues, disasters, Incident F, caused by global warming, may occur around them, and the



Figure 2: Structure of "Risk Appearance" in Consciousness

disasters may negatively affect the future of the people concerned, including themselves and their descendants. This belief in consciousness, (5'), is a risk called the global warming risk.

Since the nature of knowledge is beliefs about an object that consist of information about the object, risk, which is a belief about an incident that has not yet occurred, formed from information (1) to (4), is also personal knowledge in its nature. Therefore, the risk has no objective substance in the natural world. It goes without saying, but it is easy to forget, that once a risk appears in the world with some substance and is perceived as affecting the story one has conceived, it has already become a past incident that has already happened and is no longer an entity called a risk.

If we were to dualistically state where and how risk with such attributes exists, it would appear in each of our consciousnesses and exist as something we have come to understand as existing.

Similar to knowledge, risk is a phenomenon, i.e., an immanence that appears in the consciousness of a party or an individual as a belief. Because of the interest correlation of a phenomenon, advocated by the structural constructivism introduced in Subsection 5.2. risk, as one of the phenomena, appears in a manner that correlates with a party's interest. In addition, from the opportunity correlation of interest. this interest also appears in consciousness as a phenomenon through the trigger in which some information is brought to the party as an opportunity.

This interest appears in the consciousness of the parties concerned because they have a story in peaceful normal times in the future. This peaceful future story, which is a source of the interest, is also arbitrarily drawn in the consciousness of the parties concerned by information based on the aforementioned points (1) to (3), brought to their consciousness. In addition, some opportunity to induce the interest is involved in the drawing of the future story. In this sense, the interest correlation of phenomena and the opportunity correlation of interest in structural constructivism have much to do with how risk exists.

A key element in the process of constituting risk with this structure is a vehicle called the present that moves along the time axis from the past to the future at the same speed as the passage of time. We are forced to ride this vehicle facing backward: thus, we see only the past. All events in the world, events 1 to N, are always migrating from the future to the past on the time axis at the same speed of the time transition and are constantly appearing as if they were real that is, as transcendence - before the eyes of our consciousness. We, or more precisely our consciousness, can only see or intuit the landscape of the ever-changing past, to which new past events are constantly being added. Some of this past landscape or the previous story remains in the form of static information, that is, memories, understood knowledge, records, and traces of events that have already occurred. This static information is the nature of what we call the past. It is sometimes called history.

Meanwhile, the landscape of the future, no matter how immediate, is a story from now on as a prediction that each of us has made in our consciousness based on information about past events. We live in anticipation of the future, which we can never see directly, based on the past, which we can see, that is, intuitively feel and know. In other words, we always accept given information, that is, (1) information about various past events on the time axis, which is constantly updated as time passes, (2) information brought to consciousness from personal knowledge or beliefs related to the object event, which is formed through past learning, and (3) information from many arbitrary assumptions. Then, based on the given information, (1) to (3), we live imagining the events from now on that will happen in the future, that is, the future story in which we are involved, and sometimes worry about the future events, event F, that might happen and change the future story as an incident, even though they are essentially knowledge, or beliefs in our consciousness. These beliefs in consciousness, i.e., knowledge, are the essential nature of risk.

Furthermore, based on beliefs, or the knowledge of past events that are an appearance in consciousness, people arbitrarily make many more assumptions to predict the future events, event F (i.e., possible incidents that have not yet occurred), and try to control the predicted future events so that they do not affect the future story. This is the essential structure of an activity known as risk management.

6.5 The Process by which Risk is Constituted

In this subsection, we examine the process by which risk (i.e., the belief that an incident may affect the future story that we have arbitrarily conceived) emerges.

For risk to appear in the consciousness of a perceiver, an individual, whether they are aware of it or not, there must be a future story in which they are involved, and often in which they appear directly. The scenario of this story is arbitrarily based on the information (1) to (3) brought to their consciousness. Only then do they become interested in future incidents, event F, that may occur in the future and could influence the course of events in the story. Considering the interest correlation of structural constructivism, if the party concerned does not have an interest, that is, a future story to which they are related, then it does not matter to them what kind of event may occur in the outside world, or even if this event actually occurs, it does not evoke an incident, event F, in the future that constitutes a risk.

Consider, for example, an earthquake on the moon. On the one hand, such an earthquake generally does not appear as an incident, event F, in a person's consciousness because there are very few people who currently have a story on the lunar surface in the future, but on the other hand, if there are some parties, such as astronomers who have a story there that they want to progress smoothly, such as lunar exploration, an earthquake on the lunar surface would appear in their consciousness as an incident that constitutes a risk.

As shown in the example of the risk due to the false information about the lion's escape (Subsection 6.2), this future incident, event F, is also an appearance in consciousness, that is, an immanence, based on the information (1) to (4), brought to consciousness. Therefore, the future incident, event F, is not something in the world outside with objectivity.

Risk first appears as an individual's knowledge, that is, a personal belief about the target event, made from the information (1) to (3) brought to consciousness. However, this stage is a state in which the information is understood by the intelligence in the form of the model (illustrated in Figure 1) of the event as an understanding; in other words, there is knowledge about the possible event. This is the precursor stage before risk becomes literal risk. At this stage, the model represents literal knowledge, which is often not perceived as a risk and is rarely referred to as such. An example of this is the state of having knowledge of a disease.

For the risk to decisively appear as a literal risk to consciousness, some (4) triggering information, such as a friend having contracted the disease, needs to be provided to the above precursor state. This triggering information induces interest in the future course of the story, which leads⁽⁸⁾ to a belief – that is, appearance in consciousness – that this future event, event F, could happen and become an incident and affect the future course of the story. This is (5) risk emergence, in which risk emerges from the precursor state and appears in the individual's consciousness.

Note that although the information and its sources, (1) to (4), are considered separately here for simplicity in understanding the riskconstituting process, in actual cases the information, (1) to (4), is often complicatedly mixed and not clearly perceived independently.

In general, the trigger, (4), for risk to appear in consciousness as risk comes in the form of narrative information that some event, event T, has occurred. Information that the object event, event T, has resulted in harm to a familiar, or perceived so, person, (i.e., the identifiable victim and iconic victim cases) (Nakayachi, 2009, 2021) could become the trigger, (4) because of its strength in narrativity. In addition, information about an event with a significant impact, subjectively perceived, can also be this trigger, (4) in many cases because of its contextual nature or its narrative strength.

As the former example regarding information of harm to a victim familiar to people, it has been pointed out that information about the death of a nationally well-known comedian in Japan from COVID-19 stimulated people's sensibilities or emotions about risk more than the results of a mathematical epidemiological simulation of the disease, effectively changing their behavior (Nakayachi, 2021).

Examples of the latter type of high-impact information include major accidents at nuclear power plants or airplanes, frequent occurrences of super typhoons, and news of the emergence of infectious diseases with high mortality rates, such as Ebola hemorrhagic fever.

Neither the upcoming scenario in the future story in this structure nor risk as a belief about future incidents - that is, events that can or are perceived as likely to affect the story – are static. Given that all events continue to be incorporated into the tense of the indeterminate future to the determinate past as time passes, (1) information about events that have occurred is constantly changing. In addition, knowledge changes with the information through risk communication in a broad sense, such as learning from others' experiences and opinions and from hearsay that continues to come from the surroundings. Accordingly, (2) information from knowledge related to past events also continues to change its form with some contingency. Furthermore, (3) information from assumptions that a party posits is not fixed. This is because the assumptions are always made arbitrarily under the influence of the party's interests because they are phenomena with the interest correlation. Thus, the information, which is the basis of risk in consciousness, comes from a variety of sources and also changes over time with some arbitrariness of the person receiving it. Consequently, the risks in our consciousness are always complex and fluid. The shape of risk in our consciousness varies for each person, depending on the information that comes from different sources and also changes with time and circumstances. Given the above process by which risk is constituted as an immanence in our consciousness, it is inevitable that each person's understanding of risk will differ at any given time.

6.6 The Tense of Risk and the Nature of the Future

Another reason that everyone's understanding of risk is different is that risk is always in the future.

The axis of time from the past to the present always ends at the present. Beyond that endpoint, there is only the idea that things should go on like this from now on. In other words, an extension beyond the present does not exist in reality. Nevertheless, for a long time, we have arbitrarily extended the time axis that ends at the present, selfishly called the extended part that does not really exist the future, and treated it as if it has existed⁽⁹⁾.

What we call the future is conjecture as a premonition, that is, a belief in each of our consciousnesses, and it never exists as a given. The essential nature of the future is the belief about the story from now on to which we are related, that is, the models/scenarios inherent in our consciousness that each of us has arbitrarily created in our minds. The belief as a premonition, or an upcoming story in ordinary times in peace, is arbitrarily plotted by a party based on the information brought to the party from (1) various events from the past to the present, (2) the knowledge the party has, and (3) many assumptions arbitrarily posited by the party.

When the information that something bad, event T, has happened in the past or just recently is brought to our consciousness, it will (4) trigger a (5) feeling that a similar event, event F, might happen as an incident in the future and could disturb the future story, that is, the scenario of the future in ordinary times that we have first arbitrarily plotted and assumed. This feeling is the true nature of what we call risk.

In addition, with the appearance of the risk, which is a possible incident in the future, another story, generally an undesirable future, different from the first in ordinary times, also appears in our consciousness as a conjecture.

The nature of the future is a belief as a story to come; that is, a model/scenario from now to hereafter to which we are related, arbitrarily created or constituted in each of our consciousness as an immanence. Moreover, the verb tense in the concept of risk is this future that does not exist in reality. These two are the structural reasons, in addition to those mentioned in the previous section, why people understand risk differently.

6.7 Essential Nature of Risk: Summary of the Discussion

This subsection summarizes the discussions so far. Regardless of the field or type of risk, any entity that we call a risk appears in the consciousness of the parties involved as a feeling or conjecture about possible incidents that may affect their imagined story of their related future. At that time, different kinds of information brought into consciousness affect the appearance of risk in consciousness.

This is the essence in the concept of risk, which is phenomenologically derived, or the identity common to all cases in which we say, "there is a risk." The aforementioned sentences are the linguistic models, i.e. descriptions of risk in natural language. In addition, Figure 2 expresses a schematic diagram of identity in risk, that is, the isomorphic structure common to every appearance of risk in consciousness, derived through the framework of phenomenology and phenomenological science.

Risk is not something that objectively exists in the outside world, but a phenomenon or qualia as an immanence that appears in the party's consciousness in correlation with their desire (i.e., interest) to keep the future story in which they are involved progressing smoothly. This appearance of risk as immanence is often accompanied by the individual's feeling, often called worry⁽¹⁰⁾, that something bad may happen and interfere with the future story that they want to continue smoothly.

This structure is less related to the physical form (i.e., the type or scale) of incidents that may affect the story and the intentions/actions of the party trying to reduce risk. Even if an event is scientifically and rationally concluded to have a low probability of its occurrence and/or almost no impact, if there is a feeling (sometimes a delusion), an appearance in the party's consciousness that the event may become an incident and affect the future story in which the party is involved, then it becomes a risk, even if it is objectively considered irrational.

For example, as has been widely reported in the Japanese media in the past and is well known there, if people feel that beef may cause bovine spongiform encephalopathy (BSE), also known as mad cow disease, despite sufficient countermeasures against beef, or if they feel that some seafood may develop radiation damage despite confirmation that it is not contaminated with radioactivity, these feelings become rumor risks and often change people's behavior.

A related specific example is the case of the postponement of the planned relocation of a food market in Tokyo to a site where soil contamination had been observed (Sakamaki, 2009). Despite the measures taken to deal with the soil contamination, the postponement was executed with a statement from the head of the local government, "The site was safe, but there was no peace of mind." Although some have pointed out that this view of the municipal head is neither scientific nor rational, we consider that there is the sense of risk proposed in this study at its root.

Assuming that risk is an appearance in the consciousness of the perceiver or the party as immanence, we can understand that the possibility of an event and the situation caused by the event, both external to the party, cannot play a leading role in risk. This is because everything becomes a matter of appearance or immanence in the consciousness of the party as far as risk is concerned. From a phenomenological point of view, if the feeling or qualia of risk appears in the party's consciousness, then it is a risk. However, if this feeling does not appear, it cannot be considered a risk⁽¹¹⁾.

Incidentally, the word "concern" (especially for the bad) is a good word (i.e., an appropriate, concise natural language model) in our everyday vocabulary to appropriately describe the sensibility structure of risk that we have been discussing so far.

The model of risk, the definition of risk discussed and hypothesized in this study, is a structure that makes people feel that there is a risk. This model is common to all cases in which people perceive existence of a risk, regardless of the field or type of it. We believe that the risk model considered in this study represents or codes the latent identity, the isomorphic structure in all that we call risk, regardless of its diversity and arbitrariness.

7. Reconsidering "Risk Communication"

Many social issues in Japan, such as the BSE scare in the early 2000s, the overreaction to the handling of personal information triggered by the Personal Information Protection Law enacted in 2003, and the suspension of the recommendation for the HPV vaccine against cervical cancer in 2013, are related to the social risks generated by information conveyed in the mass media or the news press in Japan.

As discussed in Section 6, risk is a belief and an immanence in consciousness and is perceived differently by each person because it has the attribute of personal knowledge. In addition, it also follows the structure of the concern. Therefore, if we try to understand risk in the usual way of thinking, which assumes a subjective-objective composition whereby subjectivity coincides with objectivity, we must consider exceptional treatments, such as the so-called bias in risk perception. This makes it difficult to share and consider risk perceptions – risk communication – among a number of people who are not necessarily in the same position and who do not always have the same opinions.

Reconsidering risk as an appearance in consciousness or an immanence under the immanence-transcendence composition in phenomenology must bring about a major change to the current methodology of risk communication (Kinoshita, 2016; Lundgren, 2013).

It is an important consideration in the practice of risk sharing (i.e., risk communication) that risk is a party's belief constituted in consciousness by the information brought to the party, has the attribute of knowledge individually possessed by the party, i.e., the party's understanding, and also has the structure of sensibility in the form of concern at the same time. This is because a belief that appears in our consciousness, made from some news brought to us through communication (i.e., information), is what we call "risk," which simultaneously has the attribute of personal knowledge (i.e., doxa: conjecture) as understanding and the structure of concern as personal sensibility.

If we assume that risk has attributes of personal knowledge due to the information brought to us, and also has a structure of concern that we have at the same time, then the current ways of bringing information to us, or risk communication in a broad sense (e.g., the current media's reporting attitude, which is unconsciously based on dualism), must necessarily change.

When we perceive a risk, we should have definitely received some information through some way (i.e., risk communication in the broad sense) prior to the perception of the risk. It is not risk communication to first suppose the risk and then communicate information about it. In reality, the provision of information or risk communication comes first, and as a result, what appears to the individual consciousness as the party's belief or conjecture is the risk (see Subsection 6.3).

What can be communicated is information that makes the risk present in consciousness or change in its state, and never the risk itself. Discussions on risk communication will henceforth require this Copernican paradigm shift.

Based on the hypothesis of this study, risk communication means engaging with risk as a belief or a conjecture that has attributes of both knowledge and structure of concern, by bringing information to people's consciousness. From this view of risk, the mass media are more than mere informants who merely convey information about objectively existing risks to the masses from the standpoint of a non-party, in a third-party manner. As far as risk is concerned, the mass media are directly responsible for creating or changing the risk present in people's consciousness through the dissemination of information.

In previous studies using the phenomenological framework, we have discussed that service and peace of mind (Amari, 2021a, 2021b) both appear in consciousness (i.e., immanence) and do not exist in the outside world. The same thinking can be applied directly to the case of risk. Nowadays, when the term "risk" abounds, the press must henceforth pay attention to the following points in news reporting. That is, risk is not a risk of being, but a risk of becoming, and risk is what appears in people's consciousness as a result of the information they receive through the mass media. In summary, it is necessary for the news press to reconsider risk communication to the general public from the new perspective.

8. Conclusion

Since the concept of the "risk society" was proposed by Beck (1986), the term "risk" has gained recognition and is now almost an everyday term. It is probably no coincidence that the spread of the term "risk" in the world has kept pace with the popularization of the internet. This is because the vast amount of real-time information available through the internet about other people's experiences and events elsewhere has dramatically increased the size and frequency of updates to the models of future events that people hold in their consciousness as beliefs and has also significantly affected the risk that people perceive as their subjective feelings.

Some may feel that the hypotheses about risk proposed in this study are a matter of course, selfevident, obvious, and not based on science, as mentioned in Subsection 5.2. In response to this doubt, this study has provided a train of thought (i.e., logical flow) to ensure scientificity in the broad sense. as stated bv structural constructivism. If many people agree that something is reasonable under the condition that the train of thought is shown, then it means that thought experiments under the same conditions have been repeated by many people, and they have arrived at the same conclusion. Therefore, we believe that it is reasonable to think that this conclusion is scientifically based.

Takeda states that (2020, p. 170) "In philosophy, one's own experience is the central material, and the philosopher tries to gain insight into the nature of things by reflecting on it. Science begins with this insight or hypothesis and tests the hypothesis by working on nature through observation, experimentation, and measurement." In this study, we have conducted the first half of this process, from insights into the nature of risk to the formulation of the hypothesis about the risk. Verification of this hypothesis requires future research⁽¹²⁾.

We believe that the hypotheses proposed in this study could be a step toward envisioning a new, different picture of risk-related science, engineering, and practices such as risk management and risk communication. We expect that this study will provide a new view for the systematization of a "general theory of risk" for academia and a springboard for the consideration of a new form of risk in the field of risk-related practice in industry.

Notes

 When considering safety and insurance practices, events such as hazards and accidents are often concrete and have a clear causal relationship to their effects. In contrast, "events when considering risk," such as rumors, are often vague and do not have a clear causal relationship to their effects. In this study, we use the term "incident" to denote a factor that disturbs operations in some way (Amari, 2018, 2020) and use it to describe a broader range of events, including people's behavior and social trends, not limited to simple accidents or malfunctions that are easy to identify specifically.

- (2) Special attention should be paid to numerical information, such as probabilities, because it is often introduced alone and its premises tend to be easily forgotten.
- (3) In the author's prior studies on service and peace of mind (Amari, 2021a, 2021b), for the same reason, Takeda's summary and the outline of phenomenological scientific theory shown in Subsection 5.2 are also introduced, and their discussions are developed with the help of philosophy.
- (4) The ways of thinking introduced in Section 5 are outlined with examples in the papers on services and peace of mind (Amari, 2021a, 2021b).
- (5) This is expressed as "phenomena in consciousness." Phenomena in phenomenology, a discipline of philosophy, refers to the appearance of images that appear in consciousness, not physical events as is commonly used.
- (6) When the certainty of the lion's escape is unknown, it is more natural and reasonable to understand that there is a risk, and it is unnatural to assume that there is no risk.
- (7) In previous research on the concept of security (Amari, 2018, 2020), the story in which the objective is clear is called an "operation" and is considered an essential entity that we need to protect when considering security.
- (8) The interest correlation of a phenomenon and the

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opportunity correlation of an interest in structural constructivism contribute to this process.

- (9) One reason for our illusion that the future exists as a given is that we are surrounded by fictional representations, such as people coming from the future to the present, in manga, movies, and other media.
- (10) When one's involvement in the story is great, such as when it concerns one's own future, the sense of risk that appears in one's consciousness is often expressed (i.e., coded) as worry, anxiety, or fear.
- (11) The idea that the appearance of a risk in the consciousness of the parties involved determines whether it is a risk or not may seem strange to those who deal with risks in actual business. The main reason for this strangeness is the habit of modern people to think about things based on the implicit assumption of the outside world that is, objectivity without being aware of it. However, as mentioned in Section 4, it is not necessarily appropriate to think about risk based on a dualism that assumes its existence in the outside world.
- (12) Future issues include validating the applicability of the hypotheses proposed in this study to each of the risk theories that have been proven useful in practice, such as equipment failure and public health theories.

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We are delighted to present Volume 17 of JSI (Journal of Socio-Informatics). The current volume features three significant contributions: rigorously peer-reviewed original research papers and a carefully translated article previously published in Japanese. JSI, reflecting the mission of SSI, continues to serve as an international platform for advancing Socio-Informatics research. We warmly welcome submissions from scholars and graduate students worldwide who share our interest in this dynamic field. For those interested in contributing to our next volume in 2025, detailed submission guidelines are available at https://www.ssi.or.jp/en/cfp/.

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