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The network resilience of safety confirmation and social capital during natural disasters: the comparison of the U.S. and Japan

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Abstract
This study discusses safety confirmation systems and how Social Capital (SC) affects the resilience of the safety confirmation network for natural disasters in the U.S. and Japanese society. When a large-scale disaster occurs, people desire to inform their loved ones of their safety status and search for their loved one's status in a chaotic environment. Safety confirmation is the action of confirming the current status of people in disaster areas by collecting safety, injury, missing, and death information and sending the contact request. First, this study summarized the safety confirmation resources. The U.S. approach focuses on the missing and dead, while the Japanese approach focuses on the survivors and tries to define the remaining people who are missing and dead. Second, the social background that formed the SC was compared. Third, how SC affects the safety confirmation network in and between communities was analyzed. The case areas were Honolulu County in the U.S. and Aichi prefecture in Japan, and 1,324 samples were analyzed by ordinal logistic regression. The safety confirmation network reflected the social and SC structure for each country. The ethnic diversity in the network provided high resilience. Honolulu's network was more open beyond the community and connected more with others. Residents' economic network was linked to the safety confirmation network. Aichi's network was more closed in the community and connected with kinship or neighbor ties. Trust and interaction with others shaped the foundation of the safety confirmation network. Finally, the integrated safety confirmation system was discussed.

Keywords Safety confirmation · Social capital · Natural disaster · Network resilience · U.S. · Japan

1 Introduction

The number of disasters has increased over the past 50 years, and this trend is accelerating globally [1]. The three major disasters globally are floods, storms, and earthquakes, and 185 million people were affected by disasters in 2022 [2]. Asia and the American regions have been the areas with the highest disaster occurrence, and economic loss is also high. Therefore, the United Nations addresses the safety, resilience, and sustainability of cities and humans in the Sustainable Development Goals [3]. This goal stated that disaster risk reduction is essential for sustainable development and urgent issues. Disaster risk reduction requires a combination of various focuses, such as infrastructure, technology, institutions, governance, and public participation. As an action plan, the Sendai Framework for Disaster Risk Reduction mentioned seven target actions: reducing disaster mortality, reducing the number of people affected, reducing direct economic loss, reducing damage to critical infrastructure, increasing the countries with disaster risk reduction strategies, enhancing international cooperation, and increasing the ability to access early warning systems and disaster risk information [4].

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Although decision-making, investment, and behavior based on risks have been developed, transforming from national to community level is challenging in risk governance, accountability, and responsibility [5].

Measuring resilience is needed to improve disaster resilience in the community. Resilience is the ability to resist, absorb, accommodate, adapt, transform, and recover efficiently and effectively [1]. The Social Vulnerability Index (SVI) approach uses demographic and socioeconomic data to measure the more affected and less recovered communities in the disaster period. Cutter et al. [6] adopted the SVI idea in disaster management. The Centers for Disease Control and Prevention [7] and the University of South Carolina [8] used the SVI approach and created their own data set. On the other hand, this approach has limitations in identifying the vulnerable [9, 10] because demographic and socioeconomic data cannot explain all social phenomena. As other vulnerability approaches, Etongo and Arrisol [11] used the Livelihood Vulnerability Index to estimate the vulnerability of fishery-based livelihoods to the impacts of climate variability, and Bruneau et al. [12] approached the dimensions of resilience factors. They described a conceptual framework to measure seismic resilience in the community. Resilience requires the ability of both physical and social systems to have robustness, redundancy, resourcefulness, and rapidity. Still, these redundant elements become the backup, and a robust and resourceful system promotes the rapid recovery of communities. They also mentioned that resilience has four interrelated dimensions: technical, organizational, social, and economic. A high-resilience system is an integrated system with multiple dimensions.

When a large-scale disaster occurs, survivors desire to inform their loved ones, families, and friends of their safety status as soon as possible, and their loved ones also start to search for their safety status. Safety confirmation is the action of confirming the current status of people in disaster areas by collecting safety, injury, missing, and death information and sending the contact request [13, 14]. For disaster management, the first three days are the emergency phase to save lives. At the same time, the demand for safety confirmation has surged. The greater the disaster, the greater the confirmation demand. On the other hand, people lose their ordinary contact tools during large-scale disasters due to infrastructure damage, loss of property, or loss of cell phones. The electricity and internet lines will be cut, cellphone towers will collapse, and the access roads to other communities will be destroyed. Even though there are welfare check services by the first responders, they are also affected by the disaster, and their priority is rescuing life in the emergency phase. In addition, there are procedures to identify bodies; however, the information about who the survivors are is unclear. It makes counting the missing persons difficult. In the same way, first responders also need safety information for people in disaster areas to rescue and identify them. Some technologies use image data recognition [15, 16] for safety confirmation and the identification technology of emergency requests in big data [17, 18]. However, accurate and detailed safety information relies on information from survivors, their families and acquaintances, and governmental databases. Safety confirmation is a universal first response to a disaster. However, many disaster resilience plans do not mention safety confirmation, and there is little academic research analyzing safety confirmation. Why do some countries succeed in safety confirmation and collecting accurate data in a short period?

The SC is the productive and embedded resource in every community and increases the achievement of institutional and community activity [19]. In the disaster period, people face a shortage of physical facilities and formal assistance; however, if people can access informal assistance from neighbors or acquaintances, they can improve their recovery speed. SC is the relationship among people and shapes the safety confirmation network. Putnam [19] states that SC is "the features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions." He explains that trust is an essential concept in SC and entirely predicts the behavior of individuals. Moreover, trust itself emerges as a worth of the social system as a social trust. Social trust is constructed with norms of reciprocity and networks of civil engagement. Bihari and Ryan [20] described the role of SC in community preparedness for wildfires. They found out that place attachment and involvement in natural resource planning affect SC, and this SC encourages resilience actions for wildfire risks. In addition, there is a link between public knowledge and participation, and it can motivate people and be used as a policy tool [21]. SC is an essential resource that affects disaster risk reduction and is crucial for a community to survive until assistance arrives from outside communities [22].

It is known that even if the same policies are provided to communities, the outcome is different. One reason is SC, which is determined by the cultural and social background. SC affects people's behavior and the system implementation for safety confirmation. Grzegorczyk [23] introduced the difference in structural SC between the U.S. and Asia. The SC in the U.S. is more open and has weak bridging ties. The results and benefits that can be delivered are important and value-centric. The SC in Asia is typically closed and has strong bonding ties. The long-term relationships are important and relationship-centric. On the other hand, The U.S. has a long disaster management history in an ethnically diverse community and a specialized disaster management institution, the Federal Emergency Management Agency: FEMA. Japan has unique safety conformation network resources and has experienced a quick recovery from massive disasters.

The comparison of the U.S. and Japan will provide insights for building a more resilient safety confirmation system. This study compares the safety confirmation systems and how SC affects the resilience of the safety confirmation network for natural disasters in the U.S. and Japanese society.

2 Safety confirmation resources during the disaster period

Immediately after the disaster, people start to tell their situation to their loved ones, families, and friends, and at the same time, people begin to confirm their loved one's safety. Safety confirmation is the action of confirming the current status of people in disaster areas by collecting information on safety, injury, and death and sending contact requests [13, 14]. Regarding the identification of the body, formal institutions have verification procedures and criteria, so this study does not include this process. Table 1 shows the main safety confirmation resources in the U.S. and Japan during the disaster period. Rescue activities are not included in this chart because the rescue teams' mission is to rescue lives and does not include tracking relocated people.

As a worldwide system, Google Person Finder by Google and Restoring Family Links by Red Cross and Red Crescent Societies have been used in both countries. Google Person Finder is a web application where individuals can post and search about the status of relatives or friends affected by a disaster [24]. After analyzing the impact of disasters, the Google Crisis Response Team started this service. Restoring Family Links helps people who have lost contact with their family due to a conflict, a natural disaster, or migration by using their international networks and local Red Cross [25].

2.1 The safety confirmation resources in the U.S.

The safety confirmation in the U.S. focuses on the missing and dead after a disaster. The safety confirmation starts after a person is reported as unaccounted for. The service providers are mainly NGOs, NPOs, and Private organizations, and no database can identify all residents in the community. The Restoring Family Links by Red Cross and Red Crescent Societies have been used for major disasters in the U.S. and U.S. territories. In addition, when the President declares a disaster, the National Emergency Child Locator Center (NECLC) by the National Center for Missing and Exploited Children (NCMEC) activates through a request by a State, Tribe, or Territory to FEMA [26]. NCMEC assists with reunifying children who have become separated from their parents or legal guardians during a disaster. Reunification Support is a multi-agency program by FEMA, the American Red Cross, and NCMEC. FEMA coordinates and provides human and technological resources to reconnect people quickly. This program promotes family communications, facilitates notification between inside and outside of disaster areas, and prioritizes requests for wellness checks for physically or mentally challenged people [27].

2.1.1 Maui wildfire in Hawaii

In the case of the Maui wildfire in Hawaii on August 8, 2023, the safety confirmation during the emergency phase was challenging. It was announced that West Maui lost power, telephone landlines, and cellphone service on August 9 [28]. The complete restoration of the cellular system with reduced/limited capacity occurred on August 20 [29]. Governmental agencies also could not determine the safety of the residents; therefore, it had been announced for two weeks that over 1000 people were unaccounted for. In the evacuation shelter, people wrote down the names of their loved ones with their contact information on paper and stuck them on whiteboards [30]. There was no database about residents; hence, grassroots efforts helped with the safety confirmation. One of the residents developed the missing people's list, Maui Fires People Locator, on a comprehensive spreadsheet on August 9 [30], and the local TV praised this database. They collected most of the safety information from the Facebook page they established. In addition, safety information was collected from social media, news reports, and relief center volunteers. Fourteen days after the disaster, they collected safety information about 6000 people [31]. Finally, on August 24, the FBI and Maui County released the missing people list [32] that included 388 individuals. This first list had duplication and uncertainties because of the lack of detailed information in some reports and various lists from government agencies and shelter logs [33]; this list was later improved [34].

Table 1 Main Safety Confirmation resources during the disaster period (Excluding rescue activities)

Service	Provider	Form	Contents
World wide			
Google Person Finder	Google	Private	It is a web application that allows individuals to post and search for the status of relatives or friends affected by a disaster. The Google Crisis Response Team starts this service after analyzing the impact of a disaster
Restoring Family Links	Red Cross and Red Crescent Societies	NGO	Red Cross and Crescent Societies help people who have lost contact with their family as a result of a conflict, a natural disaster, or migration by using their international networks and local Red Cross
USA			
National Emergency Child Locator Center (NECLC)	National Center for Missing and Exploited Children (NCMEC)	NPO, Private	The NECLC is activated through a request to FEMA from a State, Tribe, or Territory during Presidentially declared disasters. The mission is to assist with the reunification of children who have become separated from their parents or legal guardians during a disaster
Reunification Support	Federal Emergency Management Agency (FEMA), American Red Cross, and NCMEC	Government, NGO, NPO, Private	FEMA coordinates and provides human and technological resources to reconnect individuals quickly. Promote family communications, facilitate notification between inside and outside of disaster areas, and prioritizes requests for wellness checks for physically or mentally challenged people
Japan			
Disaster Emergency Message Dial 171 (Telephone service)	Nippon Telegraph and Telephone Corporation (NTT): Joint system with telecommunication companies	Private	It is a voice message board that is provided in the disaster area. People can record (register) safety information (message) by voice and playback (confirm) from anywhere in Japan by using a phone number in the disaster area as a key. The message recording time limit is 30 s/message, and basically, 20 messages can be recorded. The message storage period is as long as NTT provides the service during the disaster
Disaster Message Board Web 171 (Web service)	Nippon Telegraph and Telephone Corporation (NTT): Joint system with telecommunication companies	Private	The residents of the disaster area can access this message board via the internet and register text messages using a phone number in the disaster area as a key. Registered messages can be checked from all over the world using the phone number in the disaster area as a key, and additional messages can be registered. Twenty messages can be stored. The storage period is six months or until the end of the service period
Basic Resident Registration	Ministry of Internal Affairs and Communication (MIC), Local Government (City, Town, and Village)	Government	The Basic Resident Registration is a resident database that includes name, date of birth, gender, address, etc., and is the foundation for administrative processing related to residents. All residents must notify the mayor of the municipality where they move to within 14 days. During the disaster period, the list will be provided to local governments, the self-defense forces, the police, or fire departments as a database of information on people whose safety is unknown

Table 1 (continued)

Service	Provider	Form	Contents
List of People Requiring Evacuation Support	Local Government (City, Town, and Village)	Government	Under the Basic Act on Disaster Management, it is an obligation that municipalities create a list of people who need evacuation support and are challenged to evacuate by themselves in the disaster period. Based on the person's consent, municipalities will provide a list to evacuation supporters such as police and fire departments. In the event of a disaster, a list can be provided to evacuation supporters without the consent of the person concerned
Voluntary Disaster Prevention Organizations	Ministry of Internal Affairs and Communication (MIC), Local Government (City, Town, and Village)	Volunteer	It is a community-based voluntary disaster prevention organization managed by residents, as stipulated in the Basic Act on Disaster Management. In the event of a disaster, they collect information on injuries, deaths, and property damage and report it to the local headquarters of the voluntary disaster prevention organization. Their duty includes collecting information, firefighting, rescue, evacuation guidance, or food and water distribution support. They are one of the recipients of the list of people requiring evacuation support
Commissioned Welfare Volunteer	Ministry of Health, Labor and Welfare (MHLW), Local Government (City, Town, and Village)	Volunteer (Unpaid local government officer)	Providing social services to improve social welfare by consulting with residents, providing necessary assistance, and cooperating with related administrative agencies such as welfare offices. They are the main recipients of the list of people requiring evacuation support. In the event of a disaster, they will help to confirm the safety of people requiring evacuation support and provide community information to evacuation supporters

Source: Google, Red Cross and Red Crescent, NCMEC, FEMA, NTT, Japan Cabinet office, MIC, MHLW, 2023

2.2 The safety confirmation resources in Japan

The Japanese approach focuses on the survivors and tries to define the remaining people who are missing and dead. It includes preparation and registration in ordinary times and searching for missing people after a disaster. Governmental and private organizations facilitate the services, and some databases can identify all residents in a community. During a catastrophic disaster, the communication traffic excessively increases beyond the capacity of the infrastructure, making residents' communication difficult. Therefore, Nippon Telegraph and Telephone Corporation (NTT) provides a free voice message board in disaster areas, and this service is called the Disaster Emergency Message Dial 171 [35]. People can record (register) safety information messages by voice and playback (confirm) the voice from anywhere in Japan using a phone number in the disaster area as a key. In addition, NTT provides the Disaster Message Board Web 171 [36]. The disaster area residents can access this web message board via the Internet and register text messages using a phone number in the disaster area as a key. Recorded messages can be checked worldwide using the phone number in the disaster area as a key, and additional messages can be entered. Dial 171 and Web 171 can mutually confirm recorded voice and text messages, and these services are joint systems with major telecommunication companies in Japan.

Local governments (City, Town, and Village) have built an all-residents database with name, date of birth, gender, address, etc., under the Basic Resident Registration Act, and it is the foundation for administrative processing [37]. All residents must notify the mayor of the municipality where they move to within 14 days of the move; otherwise,

people cannot receive government services, national health insurance, and welfare services. During the disaster, the list will be provided to local governments, the self-defense forces, the police, or fire departments as a database on people whose safety is unknown. The Basic Act on Disaster Management stipulates a community-based voluntary disaster prevention organization by residents [38]. In the event of a disaster, they collect information on injuries, deaths, and property damage and report it to the local headquarters of the voluntary disaster prevention organization. Haddad [39] mentioned that Japan's volunteer fire department was created in 1634, and despite being affected by the democratization of civil society, it has maintained community safety.

In addition, there are assistants for safety confirmation for socially vulnerable people. The local government has to create a list of people who need evacuation support and have challenges evacuating by themselves under the Basic Act on Disaster Management [38]. In a disaster, this list can be provided to evacuation supporters. The Commissioned Welfare Volunteer is an unpaid local government officer commissioned by the Minister of Health, Labour, and Welfare [40] and the primary recipient of the list of people requiring evacuation support. In the event of a disaster, they will help to confirm the safety of people requiring evacuation support and provide community information to evacuation supporters.

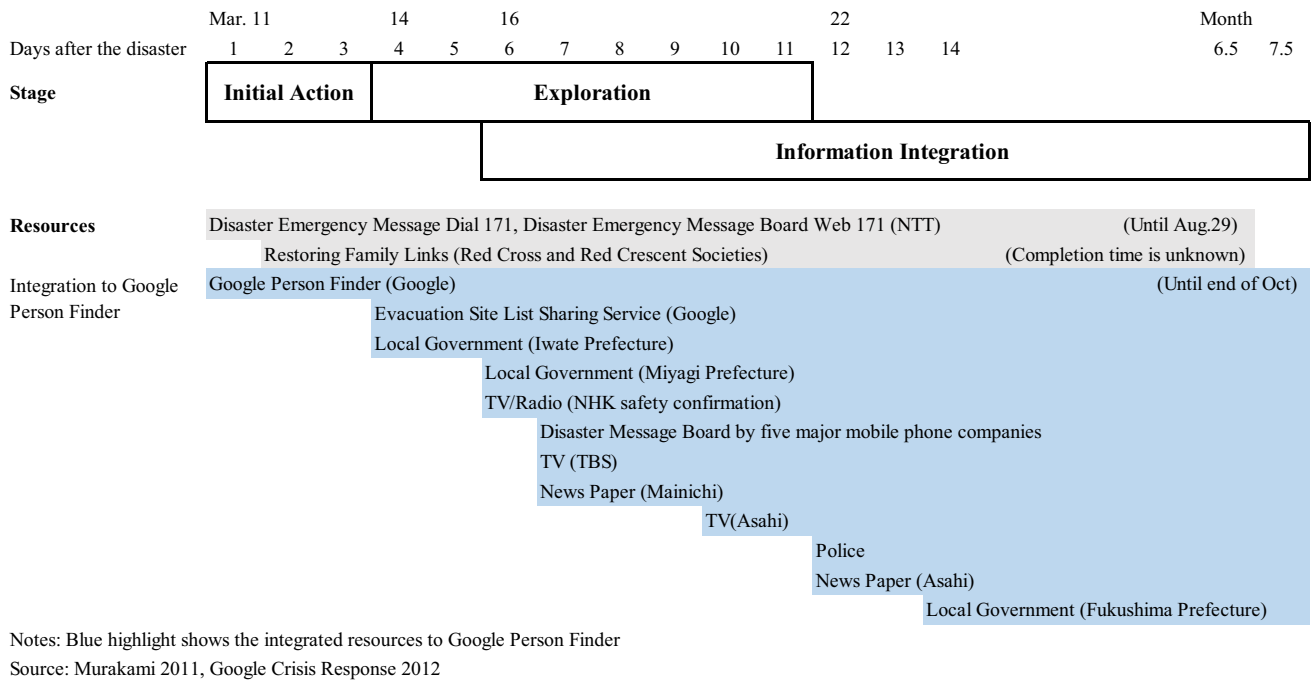
2.2.1 Great East Japan earthquake

The GEJE occurred on March 11, 2011. It was a wide area and complex disaster of Magnitude 9.0 earthquake, tsunami, and nuclear power plant accident, and the death toll and the missing were more than 22,000. The recovery of the electricity was about one week later, and the recovery of telecommunication was at the end of April [41]. In the emergency phase, 1.9 million communication lines for land phones were cut off (March 13 data), and 29,000 mobile phone base stations were shut down (March 12 data) [41] because of infrastructure collapse and depletion of power generation. On the other hand, Japanese society tried to overcome the safety confirmation issue by using multiple resources.

Figure 1 shows the stage of safety confirmation at the GEJE. Murakami [13] discovered three safe confirmation stages during the GEJE: initial action, exploration, and information integration. The initial action stage is three days after a disaster; the highest demand for safety confirmation was observed during this period. Right after the earthquake occurred, 80% of the people tried to notify others about their status and check the status of their loved ones. Mainly, they used voice calls on their mobile phones and called their family members and relatives [42]. After they evacuated to shelters, the face-to-face confirmation increased, and the target of safety confirmation expanded to coworkers in the workplace. Disaster Emergency Message Dial 171, Disaster Message Board Web 171, Disaster Message Board by five major mobile phone companies, and the safety confirmation by Japan Broadcasting Corporation (NHK) were provided from the day of the disaster [13]. In the initial action stage, the Disaster Emergency Message Dial and Boards are the most used resources for safety confirmation. Disaster Emergency Message Dial 171 recorded 1,568,000 messages and was played 339,400 times. Disaster Emergency Message Board Web 171 recorded 54,000 messages and were reviewed 81,900 times. Disaster Message Board by five major mobile phone companies recorded about 2,471,700 messages and were reviewed about 8,742,300 times. In the case of the web board, the review times increased compared with the number of records. In addition, the NHK of public broadcasting announced about 1770 people were safe, and Restoring Family Links by the Red Cross registered 1776 people in three days.

The exploration stage is from day 4 to day 11. The power outage continued, so people wrote the safety information by hand on paper and put it on the wall at the evacuation shelters. Similar behavior was observed at the Maui wildfire in the 2023 case. On day 4, Google established an evacuation center list-sharing service [43]. Google collected pictures of more than 10,000 with names, and volunteers typed them. Approximately 140,000 safety confirmation data were collected through this service. First responders also assisted in safety confirmation beyond their duty. NTT workers who worked to install special public telephones were entrusted with 2683 safety information from residents, and branch staff successfully confirmed 2017 by telephone from their office.

The information integration stage started on day 6. Although it was the first time the Google Person Finder was used in Japan, this system became the largest platform for safety confirmation data [13, 44–46]. From March 16, the NHK safety confirmation system information was integrated into the Google Person Finder. The information on safety, missing, and dead from other TV stations, the Disaster Message Board by five major mobile phone companies, the local governments, the newspapers, and the police were integrated into the Google Person Finder within two weeks after the disaster. The Google



Notes: Blue highlight shows the integrated resources to Google Person Finder
Source: Murakami 2011, Google Crisis Response 2012

Fig.1 The stage of safety confirmation at the GEJE

engineer's technical assistance helped remove duplication between different data resources. Finally, the Google Person Finder recorded 670,000 safety confirmation data until the service was closed at the end of October 2011.

Commissioned Welfare volunteers and Voluntary Disaster Prevention Organization staff also assisted in the safety confirmation and evacuation of socially vulnerable people, such as disabled people or seniors in their community. On the other hand, 55 Commissioned Welfare volunteers passed away, and 36 of them were recorded as a public affairs death associated with the assistance of evacuation or safety confirmation [47, 48]. Therefore, the security of the safety confirmation support staff was mentioned as a lesson learned.

3 Social capital

3.1 The form of social capital

SC has cognitive and structural forms, and Sanyal and Routray [22] assess the importance of cognitive and structural SC for disaster risk reduction. Cognitive SC shapes the shared values, reciprocity of values, trust, attitude, or norms of behavior. Structure SC shows networks and includes the rules and guidelines for institutions, associations, and participation. In a structured SC concept, Narayan [49, 50] introduced bonding SC within a group and bridging SC between other groups through their poverty study. Using a network theory approach, Lin [51] stated that SC is an asset in networks and discussed the factors leading to inequality, capitalization, and effects as a return to society. The model shows the collective SC assets, such as trust and norms and the SC structure, identifying the network's accessibility to resources and its effect on social aspects. This network view affected Aldrich's definition of the bonding, bridging, and linking SC [52]. Bonding SC is a horizontal tie within similar groups and focuses on relationships with and between community members [53]. In this study, bonding SC members are families, relatives, and neighbors. Bridging SC connects members or groups to extra local networks and links to external assets and broader identities [54]. Bridging SC involves the activity in different locations, identities, cultures, and affiliations. In this study, bridging SC members are friends, colleagues, and acquaintances who live outside neighborhoods. Linking SC is the relationships between people and formal, institutional, or authority in society [55]. The interaction with nongovernmental organizations (NGOs) and international agencies is also included. In this study, linking SC members are local governmental agencies, governmental agencies, NGOs, and volunteers from in and out of regions, nationally and internationally. Sanyal and Routray [22] also showed how bonding, bridging, and linking SC works within each

stage of a disaster. They introduced in the response stage that bonding SC provides mutual cooperation and offering support; in the relief stage, bridging SC provides information by using connections. Fraser [56] measured bonding, bridging, and linking SC in Japan and showed the value of bonding SC to be high, followed by bridging and linking.

3.2 The social background formed social capital in the U.S. and Japan

The U.S. is a highly civil society with formal and informal participation. Participation in the case of formal network membership affiliations through civic associations, churches, unions, and political parties provides the trans-local and cross-class environment and promotes civil participation [57]. Historically, U.S. associations linked many local groups into organized networks. Membership associations have upgraded common citizenship across persistent ethnic and class issues in history; however, in the middle of the 1960s, cross-class membership associations were replaced by political advocacy groups. These new associations are more exclusive because they are less likely to bridge different social groups and decline in social trust.

Participation in the case of informal networks in the U.S. is less organized, less purposeful, and more flexible [54]. Informal activities include having dinner parties or barbecues, hanging out with friends, talking in the bars, visiting relatives, and sending greeting cards. Putnum [54] mentioned that Americans did informal activities more than formal ones from 1986 to 1990. The average American was not isolated socially; however, the time spent building neighbor relationships and informal socializing decreased from 1960 to 2000, and people's activities have transferred to solo activities such as eating dinner alone. In contrast, helping others with time and money is a tradition in American society. Americans are more engaged in philanthropy and volunteerism than people in other countries [58]. Philanthropy and volunteerism have recently become more organized and professionalized. Although the number of working on community projects decreased, volunteering increased in the U.S. from 1975 to 1999. The majority of new volunteers are 60 and over.

In Japan, social capital tendencies are more determined by the peculiarities of national history [59]. Japanese political culture has transitioned from honorific individualism to honorific collectivism over the last five centuries. Inoguchi [60] described that good traditions in civil society lead to high levels of participation and redistribution of resources to reduce inequality. The collectiveness culture related to tradition helped recover from the GEJE in 2011. In the emergency phase, high norms were shown in the disaster area. Survivors did not have enough food but followed the social order, waited quietly for long hours in the supermarket lines, and only purchased the necessary amount of food with less looting [61]. In the recovery phase, solidarity for the entire Japan was shown voluntarily through social pressure. Many power plants stopped producing electricity because of tsunamis and earthquakes, so the disaster area faced a severe electricity shortage. The government and electricity companies decided to send electricity from other regions. The entire Japanese society voluntarily turned off flashing neon signs or digital displays to save energy, reduce rolling blackouts, and avoid enjoying the recreational environment. Commercial events, seasonal festivals, recreational media programs, and celebration ceremonies were voluntarily canceled or postponed for several months. Although there were opposing opinions among the people, "voluntary self-restraint" [62] was a large social movement because society requested that the entire Japan share the feelings of people in the disaster areas and show solidarity.

On the other hand, Japanese society has always adapted quickly to the new environment, such as industrialization and economic growth. Japan is in the early transitional stage of SC because participatory values and freedoms have changed to more open forms through civil society and internationalization.

3.3 Trust in the U.S. and Japan

Grzegorczyk [23] described the difference in trust between the U.S. and Asia for a technical transfer process. Trust in the U.S. is delivering on promises and results, shared beliefs, and financial commitment. Trust in Asia is investing in relationships, benefits extended by one person to another, and mutual benefits. Inoguchi [60] introduced the difference in trust in social institutions between the U.S. and Japan. The U.S. has higher trust for social institutions than Japan, and the radius of social trust in Japan is narrow. In the U.S., trust in the military, religious, police, and educational institutions is identified as high trust at 60–79 percent. Trust in political institutions such as executive, judicial, and legislative are 50–59 percent. In Japan, trust in the judiciary and police is high trust at 60–69 percent. Trust in the military, executive, and legislative is low, at 30–39 percent. The trust in nongovernmental institutions such as labor unions, business firms, and religious organizations was the lowest, at 10–29 percent.

The expression of trust is one factor that explains the difference in trust. U.S. society has ethnic and cultural diversity, but Japanese society is relatively homogeneous. Therefore, U.S. society demands a positive and trusting attitude toward an unknown person. In contrast, Japanese society shows strong cohesion in intimate circles, and this trend is higher than in Western countries [59]. This tendency of Japanese SC can be connected to safety confirmation in Japan. Safety confirmation by community members such as Voluntary Disaster Prevention Organizations or Commissioned Welfare Volunteers has been developed through trust and mutual assistance in intimate circles. Inoguchi [60] also points out the negative side of Japanese SC in that volunteer assistance with a stranger is lower in Japan than in the U.S.

In recent years, social ties have declined in the U.S. and Japan; however, social connections are not disappearing. There are positive relations between SC and citizen's activity, and the existing SC transformed with the new SC. Burt [63] introduced the structural hole theory and weak ties with less redundancy networks. In particular, weak ties allow access to more diverse information and provide advantages as a broker of information [64].

4 Methodology

4.1 Study area

The metropolitan areas are high-density with population, urban infrastructures, and economic activities; therefore, the impacts of natural disasters are large. When a disaster occurs, the metropolitan areas will be the high-demand areas for safety confirmation. This study chose two metropolitan areas, Honolulu County, Hawaii, and Aichi Prefecture, Japan, with natural hazard risks and different social backgrounds forming social capital.

Honolulu County is the capital of the State of Hawaii. Honolulu County encompasses the entire island of Oahu and is a metropolis in the center of the Pacific region. The main natural hazards are floods and hurricanes, and preparation is conducted for distant-generated tsunamis. The population is 1,016,508 (2020 U.S. Census), and the ethnic diversity is high [65]. The ethnic proportion is Asian (42.6%), White (21.2%), Native Hawaiian and Other Pacific Islander (9.9%), Black (2.8%), American Indian and Alaska Native (0.3%), and more than one races include Hispanic and Latino (23.2%). According to the estimation by the American Community Survey, the contents for Asians are Filipino (34.9%), Japanese (32.6%), and Chinese (11.9%) [66]. The aging rate is increasing, and the rate of 65 years and over in 2020 is 19.6% [65]. This study divided Honolulu County into six districts and was classified into three urbanization levels following the development and sustainable community plans [67]. The core area is the Primary Urban Center, and the sub-core area is East Honolulu, Koolauloa and Koolaupoko, and Central Oahu. The ring area is Ewa and Rural Oahu (Fig. 2).

Aichi prefecture belongs to the Chubu region, one of Japan's three major metropolitan regions, and the capital city is Nagoya. Four other prefectures and the ocean border Aichi prefecture. The main natural hazards are floods, typhoons, and earthquakes. The Japanese government predicts that a large earthquake with M8 or M9 class, the Nankai Trough earthquake, will occur with high probability [68]. The national government designates the entire Aichi prefecture as a region to promote preparations for the Nankai Trough earthquake [69]. The population is 7,542,415 people (2020), and the ethnic diversity is low [70]. The ethnic proportion is Japanese (96.4%), other Asian (2.6%), South American (0.9%), and others. It includes Brazilians (0.8%), Chinese (0.6%), and Vietnamese (0.6%). The aging rate is increasing, and the rate of 65 years and over in 2020 is 25%. This study divided Aichi prefecture into six districts and classified them into three urbanization levels based on the development plans [71]. The core area is Nagoya, and the sub-core area is North-East Owari, Center-West Owari and Ama, and Chita. The ring area is West Mikawa and East Mikawa (Fig. 3).

4.2 Data collection

A web-based survey was conducted in October 2019 using web survey companies, and 1,324 valid samples were collected from residents. The sample size for Honolulu County was 488, and Aichi Prefecture was 836. Each district sample contains the same proportion of five age groups (20s, 30s, 40s, 50s, and 60s). The five components (demographic, residence, socioeconomic, media use for communication, and SC) were collected to clarify the personal characteristics that affect the safety confirmation network. Each component was measured by using proxy indicators (Table 2). In this study, the ethnicity category was designed utilizing the race proportion of the Census, and a higher category number indicates minority groups. The value associated with the safety confirmation network was measured by determining the number of people that individual residents would inform regarding their situation during a natural disaster within and between the

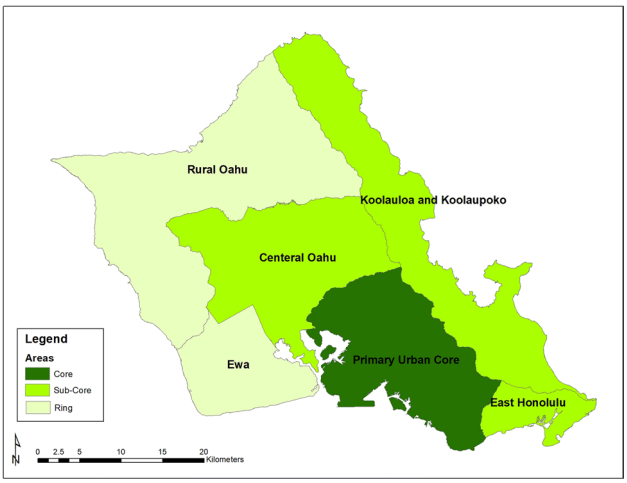


Fig. 2 Study area (Honolulu County)

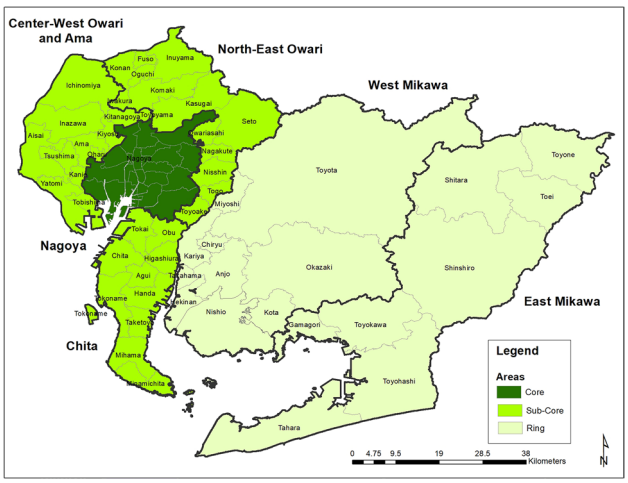


Fig. 3 Study area (Aichi prefecture)

districts. The network size becomes larger if individuals inform more people in their network. The larger network means that individuals provide and collect safety information more often. Therefore, a large network is a more resilient network.

This study defined the networks in the districts where individuals live as intra-network. The networks between the districts where individuals live and other districts were defined as inter-network, and the average value among six districts was used. The intra-safety confirmation network in Aichi had a greater value than in Honolulu (Honolulu: 2.564, Aichi: 2.834). The average value of the inter-safety confirmation network between the six districts in Honolulu was greater than in Aichi (Honolulu: 2.152, Aichi: 1.688). This result supported Putnum's idea that Japanese society shows strong cohesion in intimate circles [59]. Lee et al. [72] showed that online bonding communication (bonding SC) influences a sense of belonging and offline communication. Moreover, Kim and Kim [73] mentioned that social media use affects social capital and well-being through network heterogeneity. Therefore, this study asked about the length of media use for weekday communication.

Regarding SC measurement, this study used six SC indicators, "group and networks," "trust and solidarity," "collective action and cooperation," "information and communication," "social chosen and inclusion," and "empowerment and political action," by Grootaert et al. [74]. Table 3 shows the measurement of SC for natural disaster resilience in this study. "Group and networking" was measured by the degree of emergency assistance, and "trust and solidarity" was measured by general trust. "Collective action and cooperation" was measured by the frequency of participation

Table 2 Proxy indicator of personal characteristics

Component	Proxy indicator	Scale	Type	Honolulu		Aichi	
				Mean	SD	Mean	SD
Safety confirmation network	The number of people whom you would inform about your situation during a natural disaster in the district/between the districts (average)	5: 10 and more people 4: 5–9 people 3: 2–4 people 2: 1 person 1: 0 person	Intra-network	2.564	1.330	2.834	1.365
			Inter-network	2.152	0.943	1.688	0.672
Demographic	Age	5: 60's and more 4: 50's 3: 40's 2: 30's 1: 20's		3.357	1.466	3.395	1.403
	Gender	2: Female 1: Male		1.590	0.492	1.500	0.500
	Ethnicity	7: Hawaiian, 6: Black, 5: Latino, Hispanic, and Pacific Islander, 4: Caucasian, 3: Other Asian, 2: Japanese, 1: More than one		3.590	2.154	2.019	0.201
Residence	Urbanization: Distance (Km) from the core area (City hall)	Km		16.738	9.914	25.756	19.154
	Local Attachment: The number of years you live in your current district	18: More than 80 years 17: 76–80 years, …… 2: 1–5 years 1: Less than 1 year		5.678	3.740	7.268	3.812
Socioeconomic	The number of generations live with you	4: Four generations 3: Three generations 2: Two generations 1: One generation		1.578	0.718	1.673	0.623
	Annual household income in 2018	12: $210 K/ ¥21 M and more 11: $190 K/ ¥19 M-less than $210 K/ ¥21 M …… 2: $10 K/ ¥1 M-less than $30 K/ ¥3 M 1: Less than $10 K/ ¥1 M		5.192	2.590	2.701	1.429
Media use for communication	The number of minutes of media use in a day (weekdays) for communication with others	5. 60 min and more 4. 11–59 min 3. 6–10 min 2: 5 and less minutes 1: I do not use	Telephone/Cellphone (Voice)	3.217	1.306	1.797	0.827
			Telephone/Cellphone (Text)	3.287	1.318	1.776	0.770
			Internet (Email)	3.447	1.312	1.858	0.932
			Internet (Social Media)	2.895	1.588	2.249	1.234
SC	The average values of "groups and networks," "trust and solidarity," "collective action and cooperation," "information and communication," "social cohesion and inclusion," and "empowerment and political action."	5: High …… 1: Low	Bonding SC index	3.078	0.855	2.705	0.739
			Bridging SC index	2.804	0.777	2.284	0.602
			Linking SC index	2.285	0.709	2.076	0.551

Table 3 Measurement of SC

Members of structural SC	Bonding SC (ex: Family, relatives, or neighbors who live in your community) Bridging SC (ex: Friends or acquaintances living outside of your community) Linking SC (ex: Local government, governmental agencies, or NGOs)						
SC indicator	Questions	The case of structural SC	Answers	Honolulu		Aichi	
				Mean	SD	Mean	SD
Groups and networks	(1) During a natural disaster, if you suddenly need to borrow some amount of money (equivalent to one week's household income), how much will each of the following individuals/groups assist you?	Bonding SC Bridging SC Linking SC	5: Much assistance 4: Some assistance 3: Neutral 2: Very little assistance 1: No assistance	2.561	1.412	2.882	1.150
Trust and solidarity	(2) How much do you think you could trust each of the following individuals/groups?	Bonding SC Bridging SC Linking SC	5: Strongly trust 4: Somewhat trust 3: Neutral 2: Do not somewhat trust 1: Do not trust at all	3.579	1.190	3.400	1.052
Collective action and cooperation	(3) How often do you participate in community/regional activities (example: community planning, disaster prevention or environmental conservation) with the following people/groups?	Bonding SC Bridging SC Linking SC	5: Once or more a week 4: 2 or 3 times a month 3: One time a month 2: Several times a year 1: No interaction	1.845	1.181	1.384	0.738
Information and communication	(4) How often do you interact with the following individuals/groups?	Bonding SC Bridging SC Linking SC	5: Once or more a week 4: 2 or 3 times a month 3: One time a month 2: Several times a year 1: No interaction	2.800	1.533	2.135	1.326
Social cohesion and inclusion	(5) How many family members and friends of a different ethnicity do you have in internal and external districts?	Bonding SC Bridging SC (average of 5 districts)	5: 10 and more people 4: 5–9 people 3: 2–4 people 2: 1 person 1: 0 person	2.521	1.338	1.534	1.071
Empowerment and political action	(6) How strongly do you agree or disagree that your opinions are considered in the decision making of the following individuals/groups?	Bonding SC Bridging SC Linking SC	5: Strongly agree 4: Agree 3: Neutral 2: Disagree 1: Strongly disagree	3.106	1.079	2.135	1.326

in community activities, and "information and communication" was measured by the frequency of interaction with others. "Social chosen and inclusion" was measured by the number of acquaintances with different ethnicities in internal and external districts, and "empowerment and political action" were measured by residents' influence on decision-making. As each SC indicator, bonding, bridging, and linking SC were measured with a 5-level scale. The linking SC of social cohesion and inclusion was not measured because the ethnic diversity of all governmental agencies and NGOs that individual access is unclear. In addition, the bonding SC index, bridging SC index, and linking SC index were analyzed using the average values of six SC indicators.

4.3 The analysis of safety confirmation network resilience

This research used ordinal logistic regression [75, 76]. Let Y be an ordinal outcome with category i. Then $P(Y \leq i)$ is the cumulative probability of Y less than or equal to a specific category $i = 1, \ldots, k+1$. The logistic regression model is given by k equations if Y has $k+1$ categories and there is one logistic coefficient β_{ij} for each category/covariate combination. These quantities are then defined by:

$$P(Y \leq i) = p_1 + \cdots + p_i \tag{1}$$

$$odds(Y \leq i) = \frac{P(Y \leq i)}{1 - P(Y \leq i)} = \frac{p_1 + \cdots + p_i}{p_{i+1} + \cdots + p_{k+1}} \tag{2}$$

$$logit(Y \leq i) = \ln\left(\frac{P(Y \leq i)}{1 - P(Y \leq i)}\right), i = 1, \ldots, k \tag{3}$$

The cumulative logistic regression model is parametrized as

$$logit(Y \leq i) = \alpha_i + \beta_{i1}X_1 + \cdots + \beta_{im}X_m, i = 1, \ldots, k \tag{4}$$

It follows that the cumulative odds are given by

$$odds(Y \leq i) = exp(\alpha_i)exp(\beta_1 X_1 + \cdots + \beta_m X_m), i = 1, \ldots, k \tag{5}$$

Hence, the odds are proportional because the k odds for each cut-off category i differ only in terms of the intercepts α_i.

This study used ordinal logistic regression with the selection probability of the safety confirmation network as a dependent variable, and individual characters and SC as an independent variable were used. The size of the safety confirmation network was classified into five categories: Category 1 is 0 people, 2 is one person, 3 is two to four people, 4 is five to nine people, and 5 is ten or more people, and this category is a continuous variable. The parameter represents the influence of each characteristic and SC on the selection probability of the safety confirmation network.

5 Results

5.1 The association with demographic characteristics

Tables 4 and 5 show the effect of personal characteristics on the safety confirmation network. The dependent variable is the safety confirmation network. The effects of demographic, residence, socioeconomic, media use for communication, and SC were analyzed. Model 1 shows the effect of personal attribution, Model 2 shows the effect of personal attribution and media use behavior for communication, and Model 3 shows the effect of personal attribution and behavior. When we compared all three models, the coefficient β of SC was significantly higher in both intra and inter-networks. Therefore, it was determined that SC strongly influences the safety confirmation network.

In the Honolulu intra-network case, the year in residence and generations in the household were positively significant in all models. In Model 3, the bonding SC index ($\beta = 0.651$, $\rho < 0.01$) and the bridging SC index ($\beta = 0.648$, $\rho < 0.01$) were significant. In the inter-network case, age was negatively significant, and generations in the household were positively significant in all models. Telephone text use was positively significant (Model 2: $\beta = 0.324$, $\rho < 0.01$, Model 3: $\beta = 0.233$, $\rho < 0.05$). In Model 3, the bridging SC index ($\beta = 1.018$, $\rho < 0.01$) and the linking SC index ($\beta = 0.685$, $\rho < 0.01$) were significant. Bridging SC is especially affected strongly. It was recognized that living with multiple generations affects both intra and inter-networks. The local attachment to the community, living with multiple generations, bonding SC, and bridging SC are factors that improve the intra-safety confirmation network. In the inter-safety confirmation case, young people living with multiple generations have high network resilience. Telephone text use behavior, bridging SC, and linking SC improve network resilience. Gender, ethnicity, and household income did not affect intra and inter-safety confirmation networks. It means the network size does not change between socially vulnerable people and others in Honolulu.

In the Aichi intra-network case, the distance, the year in residence, and household income are positively significant in all models. Email use was negatively significant (Model 2: $\beta = -0.363$, $\rho < 0.05$. Model 3: $\beta = -0.186$, $\rho < 0.05$), but social media use was positively significant (Model 2: $\beta = 0.342$, $\rho < 0.01$. Model 3: $\beta = 0.221$, $\rho < 0.01$). In Model 3, the bonding SC index ($\beta = 0.804$, $\rho < 0.01$), bridging SC index ($\beta = 0.528$, $\rho < 0.01$), and linking SC index ($\beta = -0.503$, $\rho < 0.01$) were significant. Linking SC had a negative effect on the safety confirmation networks. In the inter-network case, age ($\beta = 0.210$, $\rho < 0.01$), distance ($\beta = -0.007$, $\rho < 0.1$), and year in residence ($\beta = -0.051$, $\rho < 0.05$) were significant only in Model 3. Distance and the year in residence had negative effects. Social media use was positively significant (Model 2: $\beta = 0.256$, $\rho < 0.05$.

Table 4 The effect of personal characteristics (Honolulu)

		Honolulu (N = 488)											
		Intra-network						Inter-network					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|	Coef.	P > |z|
Demographic	Age	− 0.130	0.054*	− 0.091	0.203	− 0.076	0.302	− 0.335	0.000***	− 0.267	0.001***	− 0.234	0.003***
	Gender	0.249	0.143	0.090	0.604	0.238	0.185	0.030	0.866	− 0.165	0.366	− 0.053	0.778
	Ethnicity	− 0.004	0.915	− 0.015	0.724	− 0.025	0.561	− 0.027	0.531	− 0.040	0.365	− 0.054	0.239
Residence	Distance (km)	0.013	0.109	0.012	0.153	0.011	0.191	0.017	0.052*	0.013	0.132	0.016	0.098*
	Year in residence	0.060	0.018**	0.072	0.006***	0.065	0.015**	0.020	0.450	0.027	0.312	0.006	0.818
Socioeconomic	Generations in household	0.365	0.003***	0.292	0.022**	0.225	0.076*	0.368	0.005***	0.347	0.009***	0.302	0.025**
	Household income	0.036	0.258	0.029	0.371	− 0.027	0.425	0.021	0.539	0.010	0.770	− 0.022	0.543
Media use for communication	Telephone (voice)			0.092	0.267	0.049	0.559			− 0.107	0.212	− 0.223	0.012**
	Telephone (text)			0.293	0.002***	0.153	0.118			0.324	0.001***	0.233	0.024**
	Internet (email)			− 0.033	0.693	− 0.105	0.225			0.069	0.414	0.003	0.970
	Internet (social media)			0.012	0.862	− 0.040	0.568			0.090	0.202	0.021	0.780
SC	Bonding SC index					0.651	0.000***					0.128	0.413
	Bridging SC index					0.648	0.000***					1.018	0.000***
	Linking SC index					− 0.141	0.333					0.685	0.000***
	LR χ^2	29.270		54.970		143.810		48.810		77.040		210.510	
	Prob > χ^2	0.000		0.000		0.000		0.000		0.000		0.000	
	Log likelihood	− 723.125		− 710.273		− 665.854		− 601.725		− 587.608		− 520.876	
	Pseudo R^2	0.020		0.037		0.098		0.039		0.062		0.168	

***ρ < 0.01

**ρ < 0.05

*ρ < 0.1

Table 5 The effect of personal characteristics (Aichi)

		Aichi (N = 836)											
		Intra-network						Inter-network					
		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
		Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
Demographic	Age	0.329	0.185	0.590	0.022**	− 0.073	0.239	− 0.154	0.557	0.028	0.917	0.210	0.002***
	Gender	0.825	0.001***	0.583	0.023**	0.154	0.287	0.654	0.012**	0.576	0.037**	0.097	0.544
	Ethnicity	− 1.347	0.182	− 1.237	0.221	− 0.326	0.340	− 0.888	0.386	− 0.706	0.503	0.098	0.775
Residence	Distance (km)	0.011	0.071*	0.010	0.090*	0.014	0.000***	− 0.009	0.147	− 0.008	0.193	− 0.007	0.066*
	Year in residence	0.172	0.000***	0.166	0.000***	0.113	0.000***	− 0.053	0.264	− 0.063	0.198	− 0.051	0.028**
Socioeconomic	Generations in household	0.223	0.291	0.215	0.315	0.093	0.399	0.024	0.911	− 0.008	0.970	0.011	0.925
	Household income	0.245	0.014**	0.221	0.032**	0.148	0.003***	0.088	0.406	0.057	0.602	0.041	0.459
Media use for communication	Telephone (voice)			0.235	0.067*	− 0.042	0.639			0.367	0.012**	0.102	0.303
	Telephone (text)			0.076	0.615	0.147	0.124			0.177	0.270	0.094	0.376
	Internet (email)			− 0.363	0.016**	− 0.186	0.025**			− 0.146	0.370	− 0.086	0.352
	Internet (social media)			0.342	0.000***	0.221	0.000***			0.256	0.016**	0.252	0.000***
SC	Bonding SC index					0.804	0.000***					0.355	0.006***
	Bridging SC index					0.528	0.001***					0.674	0.000***
	Linking SC index					− 0.503	0.001***					0.261	0.116
	LR $\chi^2(14)$	38.340		57.100		222.700		13.880		31.830		143.950	
	Prob > χ^2	0.000		0.000		0.000		0.053		0.001		0.000	
	Log likelihood	− 390.136		− 380.782		− 1163.989		− 263.258		− 254.281		− 730.409	
	Pseudo R^2	0.047		0.070		0.087		0.026		0.059		0.090	

***ρ < 0.01

**ρ < 0.05

*ρ < 0.1

Model 3: $\beta = 0.252$, $\rho < 0.01$). In Model 3, the bonding SC index ($\beta = 0.355$, $\rho < 0.01$) and the bridging SC index ($\beta = 0.674$, $\rho < 0.01$) were significant. It was determined that urbanization, local attachment to the community, household income, email use, social media use, and all types of SC were significant for the intra-safety confirmation network. On the other hand, linking SC reduces people's self-safety confirmation. It is assumed that the people who interact frequently with formal institutions rely on formal institutions' safety confirmation services rather than the safety confirmation by themselves. High-income groups have a high resilience of the intra-safety confirmation network. In the inter-network case, urbanization and local attachment reduced the inter-safety confirmation network for seniors. On the other hand, social media use, bonding SC, and bridging SC improves network resilience. Although women have high network resilience in Model 1 and Model 2, this tendency cannot be seen in Model 3.

5.2 The association with social capital

The analysis of personal characteristics showed that SC is the critical factor for safety confirmation networks, and inter-networks were affected by age factors. Therefore, this study analyzed SC effects by age group in detail. Tables 6 and 7 show the effect of SC on the safety confirmation network.

In Honolulu's case, the bridging SC of "social cohesion and inclusion" affected all age groups' intra- and inter-safety confirmation networks. Especially, those in the 20'–30's age group strongly affected the inter-safety confirmation network ($\beta = 0.946$, $\rho < 0.01$), but as ages increased, its influence diminished (40'–50's: $\beta = 0.542$, $\rho < 0.5$, 60's and greater: $\beta = 0.434$, $\rho < 0.1$). On the other hand, the opposite tendency was seen for intra-safety confirmation. The effect of those in the 20'-30's age group on the intra-safety confirmation network ($\beta = 0.526$, $\rho < 0.05$) was smaller than other age groups, and with aging populations, its influence increased (40'–50's: $\beta = 0.576$, $\rho < 0.01$, 60's and greater: $\beta = 0.639$, $\rho < 0.01$). The "groups and networks" impacted especially the inter-safety confirmation positively (20–30's: $\beta = 0.398$, $\rho < 0.05$, 40–50's: $\beta = 0.387$, $\rho < 0.01$, 60's and greater: $\beta = 0.360$, $\rho < 0.05$). The linking SC of "information and communication" affected the inter-safety confirmation network positively in the 20'–30's ($\beta = 0.601$, $\rho < 0.01$) and 40'–50's ($\beta = 0.348$, $\rho < 0.1$) age groups. "Trust" only affects the intra-safety confirmation networks. With aging, the bonding SC of "trust" changed from positive to negative (20'–30's: $\beta = 0.365$, $\rho < 0.1$, 40'–50's: β = -0.457, $\rho < 0.1$, 60's and greater: $\beta = -0.537$ and $\rho < 0.05$.) Honolulu's results identified that a diverse ethnical network beyond the community promotes the resilience of the safety confirmation network. In intra-network cases, this effect increases with aging, but in inter-network cases, it decreases. Economic networks, which allow the borrowing of emergency funds from acquaintances living in other communities, connect with safety confirmation networks. Therefore, people's economic networks improve the safety confirmation network. For young and middle-aged people, the opportunity to interact with external governmental institutions or NGOs promotes the resilience of the inter-safety confirmation network. Bonding trust provides different sizes of intra-safety confirmation networks depending on age group. It decreases with aging, and middle-aged and seniors' bonding trust reduces the size of safety confirmation networks. The strong trust for middle-aged and seniors in the community transfers to strong ties and does not expand to others.

In Aichi's case, the bonding SC of "social cohesion and inclusion" positively affected the intra-safety confirmation network (20'–30's: $\beta = 0.438$, $\rho < 0.01$, 40'–50's: $\beta = 0.483$, $\rho < 0.01$, 60's and greater: $\beta = 0.415$, $\rho < 0.01$). The bridging SC of "social cohesion and inclusion" strongly affected the inter-safety confirmation network (20'-30's: $\beta = 1.869$, $\rho < 0.01$, 40'–50's: $\beta = 1.278$, $\rho < 0.01$, 60's and greater: $\beta = 1.642$, $\rho < 0.01$). Trust is also essential for safety confirmation. In the intra-network case, the bridging "trust" for 20'–30's ($\beta = 0.271$, $\rho < 0.1$), the bonding and linking "trust" for 40'–50's (bonding: $\beta = 0.387$, $\rho < 0.05$, linking: $\beta = 0.292$, $\rho < 0.1$), and the bridging "trust" for 60' and greater ($\beta = 0.492$, $\rho < 0.01$) positively affected the safety confirmation network. In the inter-network case, the bridging "trust" for 40'–50's ($\beta = 0.331$, $\rho < 0.1$), the bonding "trust" for 60' and greater ($\beta = 0.371$, $\rho < 0.05$) affected the safety confirmation network. In the case of "information and communication," the bridging SC for 20'-30's affected the safety confirmation networks (intra-network: $\beta = 0.268$, $\rho < 0.1$, inter-network: $\beta = 0.280$, $\rho < 0.1$). On the other hand, 60' and greater used their bonding SC to improve the safety confirmation network (intra-network: $\beta = 0.185$, $\rho < 0.1$, inter-network: $\beta = 0.190$, $\rho < 0.1$). In the "collectiveness and cooperation" case, only the linking SC affected the intra-safety confirmation network for those 20'–30's ($\beta = -0.637$, $\rho < 0.1$) and 40'–50's ($\beta = 1.002$, $\rho < 0.05$). Aichi's results determined that an ethnically diverse network in the community promotes the resilience of the intra-safety confirmation network, and an ethnically diverse network beyond the community strongly promotes the resilience of the inter-network. All types of trust promote the intra and inter-safety confirmation network. Communication within the bridging network improves the safety confirmation network for young people. In the senior's case, the communication within the bonding network promotes the resilience of the safety confirmation network.

Table 6 The effect of social capital (Honolulu)

		Honolulu											
		Age 20′–30′				Age 40′–50′				Age 60′+			
		Intra-network		Inter-network		Intra-network		Inter-network		Intra-network		Inter-network	
		Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
Groups and networks	Bonding	− 0.046	0.755	− 0.211	0.151	0.239	0.095*	0.387	0.007***	0.042	0.762	0.016	0.912
	Bridging	0.087	0.627	0.398	0.036**	0.001	0.997	0.131	0.433	0.283	0.067*	0.360	0.035**
	Linking	0.083	0.634	0.164	0.326	0.281	0.096*	0.009	0.956	− 0.006	0.969	0.097	0.591
Trust	Bonding	0.365	0.061*	− 0.231	0.241	− 0.457	0.059*	− 0.383	0.120	− 0.537	0.030**	0.088	0.722
	Bridging	0.279	0.197	0.171	0.426	0.059	0.796	0.115	0.616	0.664	0.009***	− 0.032	0.897
	Linking	− 0.252	0.180	− 0.073	0.696	0.166	0.420	0.187	0.376	0.097	0.655	− 0.187	0.417
Collective action and cooperation	Bonding	− 0.069	0.706	0.267	0.168	− 0.073	0.778	0.047	0.861	− 0.074	0.750	− 0.383	0.151
	Bridging	0.049	0.834	− 0.089	0.720	0.175	0.514	0.008	0.976	− 0.291	0.234	− 0.040	0.886
	Linking	0.387	0.088*	− 0.103	0.663	− 0.095	0.733	0.267	0.315	0.326	0.300	0.598	0.101
Information and communication	Bonding	0.140	0.458	0.439	0.025**	0.430	0.017**	0.130	0.474	0.256	0.104	0.026	0.874
	Bridging	0.093	0.616	− 0.306	0.099*	− 0.204	0.254	− 0.028	0.876	− 0.028	0.869	− 0.019	0.912
	Linking	− 0.053	0.779	0.601	0.003***	− 0.074	0.728	0.348	0.091*	0.167	0.459	0.073	0.771
Social cohesion and inclusion	Bonding	0.233	0.150	0.171	0.295	0.276	0.095*	0.024	0.882	− 0.016	0.902	0.275	0.065*
	Bridging	0.526	0.012**	0.946	0.000***	0.576	0.005***	0.542	0.010**	0.639	0.002***	0.434	0.055*
Empowerment and political action	Bonding	− 0.112	0.632	− 0.263	0.258	0.454	0.061*	− 0.240	0.346	0.793	0.002***	0.087	0.741
	Bridging	− 0.279	0.290	0.305	0.220	− 0.385	0.152	0.293	0.283	− 0.350	0.192	0.149	0.596
	Linking	− 0.045	0.817	0.386	0.052*	− 0.563	0.006***	− 0.127	0.544	− 0.147	0.493	0.274	0.238
	N	165.000		165.000		165.000		163.000		160.000		160.000	
	LR χ^2	70.290		135.020		92.060		67.310		69.340		45.880	
	Prob > χ^2	0.000		0.000		0.000		0.000		0.000		0.000	
	Log likelihood	− 224.073		− 171.175		− 198.381		− 176.848		− 189.015		− 121.061	
	Pseudo R^2	0.136		0.283		0.188		0.160		0.155		0.159	

***ρ < 0.01

**ρ < 0.05

*ρ < 0.1

Table 7 The effect of social capital (Aichi)

		Aichi											
		Age 20′–30′				Age 40′–50′				Age 60′+			
		Intra-network		Inter-network		Intra-network		Inter-network		Intra-network		Inter-network	
		Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
Groups and networks	Bonding	0.085	0.515	− 0.025	0.858	0.078	0.546	0.070	0.627	0.125	0.354	− 0.310	0.045**
	Bridging	− 0.008	0.962	− 0.001	0.994	− 0.049	0.743	− 0.280	0.087*	− 0.240	0.147	0.633	0.001***
	Linking	0.080	0.641	0.141	0.469	0.037	0.823	0.178	0.320	− 0.008	0.962	− 0.369	0.070*
Trust	Bonding	0.155	0.356	0.205	0.258	0.387	0.017**	0.100	0.570	0.121	0.428	0.371	0.037**
	Bridging	0.271	0.084*	0.240	0.163	− 0.091	0.572	0.331	0.056*	0.492	0.004***	− 0.049	0.797
	Linking	− 0.071	0.652	0.126	0.476	0.292	0.091*	0.126	0.514	− 0.117	0.518	0.005	0.980
Collective action and cooperation	Bonding	0.125	0.582	− 0.042	0.855	− 0.095	0.614	0.140	0.497	0.148	0.350	0.086	0.653
	Bridging	0.065	0.840	− 0.353	0.312	− 0.432	0.102	− 0.191	0.514	0.260	0.191	0.166	0.485
	Linking	− 0.637	0.073*	− 0.059	0.882	1.002	0.011**	− 0.027	0.952	− 0.380	0.165	0.293	0.356
Information and communication	Bonding	0.156	0.160	0.125	0.290	0.112	0.311	0.009	0.939	0.185	0.059*	0.190	0.091*
	Bridging	0.268	0.051*	0.280	0.054*	0.259	0.067*	0.216	0.164	0.094	0.402	0.112	0.373
	Linking	0.362	0.173	0.493	0.096*	− 0.246	0.378	0.833	0.007***	0.157	0.446	0.417	0.100
Social cohesion and inclusion	Bonding	0.438	0.000***	− 0.503	0.000***	0.483	0.000***	− 0.103	0.381	0.415	0.000***	− 0.310	0.007***
	Bridging	− 0.324	0.322	1.869	0.000***	− 0.103	0.711	1.278	0.000***	− 0.439	0.180	1.642	0.000***
Empowerment and political action	Bonding	0.389	0.015**	0.192	0.251	− 0.081	0.654	0.206	0.277	0.064	0.687	0.038	0.842
	Bridging	0.052	0.781	− 0.070	0.725	0.151	0.447	− 0.115	0.582	− 0.264	0.160	− 0.082	0.702
	Linking	− 0.452	0.006***	− 0.138	0.426	− 0.416	0.008***	− 0.132	0.443	− 0.029	0.846	− 0.152	0.364
	N	278.000		278.000		278.000		278.000		280.000		280.000	
	LR χ^2	99.050		89.970		81.900		82.240		61.170		66.400	
	Prob > χ^2	0.000		0.000		0.000		0.000		0.000		0.000	
	Log likelihood	− 359.805		− 225.212		− 381.701		− 226.338		− 404.132		− 223.255	
	Pseudo R^2	0.121		0.167		0.097		0.154		0.070		0.130	

***ρ < 0.01

**ρ < 0.05

*ρ < 0.1

Although participation with formal institutions expands the intra-safety confirmation network for middle-aged people, this action makes the intra-safety confirmation network smaller for young people.

6 Conclusion

This study clarified how SC and personal characteristics affect the resilience of the safety confirmation network for natural disasters in the U.S. and Japanese society. Honolulu and Aichi cases were analyzed by examining the difference between the U.S. and Japanese SC. The safety confirmation network reflects each country's social and SC structure [59]. Aichi has a larger intra-safety confirmation network than Honolulu. Honolulu has a larger inter-network than Aichi. There are no differences in the safety confirmation network size between socially vulnerable people and others. The difference in the safety confirmation network comes from the SC of individuals and society.

Honolulu's network is more open beyond the community and connects more with others. Bridging SC strongly affects the inter-safety confirmation network. Living with multiple generations is still a local custom in Hawaii to save on housing costs and support seniors. This local custom significantly promotes the resilience of the safety confirmation network. Young people in multi-generation households expand their inter-safety confirmation network through family networks. Communication by text is useful to maintain the safety confirmation network. Ethnic diversity connections beyond the community promote the resilience of the safety confirmation network. Moreover, people's economic networks, which allow the borrowing of emergency funds, link with the inter-safety confirmation network. For young and middle-aged people, the opportunity to interact with formal institutions promotes the resilience of the inter-safety confirmation network. In the "trust" case, young people use bonding trust to improve their intra-safety confirmation network, but seniors use bridging trust.

Aichi's network is more closed in the community and connects with kinship or neighbor ties. Bonding SC strongly affects the intra-safety confirmation network. SC, residence factor, and social media use were key factors that affected the safety confirmation network. Especially, SC is a vital factor in promoting the resilience of the safety confirmation network. Urbanization and local attachment expand the safety confirmation network in the community. Controversy, urbanization and local attachment reduce the network beyond the community for seniors. The income factor promotes only the intra-safety confirmation network. Although the Japanese community has less ethnic diversity than the U.S. community, the ethnic diversity of the network is essential for safety confirmation during the disaster period. Ethnic diversity transfers connections to other networks and increases access to safety information. All types of trust and interaction with others shape the foundation of the safety confirmation network. Young people maintain the safety confirmation network through interaction with bridging members, and seniors maintain it with bonding members. Participation in formal institutions' activity positively affects expanding the safety confirmation network for middle-aged people.

Sustainable disaster management requires an integrated safety confirmation system. An integrated safety confirmation system optimizes collecting trustable information, informing society, and connecting people [13]. Under chaotic and threatened situations, people still trust their loved ones, family, relatives, and close friends. This network always exists in our society, and the safety information through SC networks is trustable. There are three essential safety information: safety, missing, and death. All people in the disaster areas should be categorized as one of them. The U.S. approach focuses on those directly missing and dead, and how to identify who they are is the primary concern. The Japanese approach focuses on the survivors and tries to define whether the remaining people are missing or dead. The point to highlight is that much of the primary safety information comes from survivors during a disaster, and this is not different from country to country. A disaster resilience plan should focus more on the role of survivors as providers of safety confirmation. In the GEJE, the lists for safety confirmation were developed with individual and institutional volunteers outside the community. These volunteer actions are bridging SC, and bridging SC is the key to improving network resilience for safety confirmation.

If there are multiple ways to identify safety confirmation, this redundancy improves the resilience of the safety confirmation system. In addition, the collected safety information by multiple agencies, such as the government, police, cellphone companies, broadcasters, newspapers, and people, should be integrated into a common platform. An alliance to share data, data formats, and a common platform should be prepared before the disaster. This preparation provides more opportunity to collect and inform on safety confirmation. NGOs and informal groups will assist in connecting people again. This system integrates safety information, multi-institutional resources, and SC. The appropriate operational form of the system differs depending on the social structure based on SC. Collectivistic countries would allow voluntary cooperation with the private sectors and people, but countries with individualist ideas might focus on cooperation

with economic incentives using government subsidies. This study analyzed the safety confirmation network from the perspective of SC; however, an integrated safety confirmation system needs interdisciplinary approaches for adoption by society. The safety confirmation data includes private information, and handling the disclosure and protection should be considered with appropriate security and laws before the disaster. How to adopt the integrated safety confirmation system to society is a future research.

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Data availability As part of the informed consent obtained from the participants of this study and under the conditions of the project's ethics clearances, we cannot make the data available because the data has the individual's home address information for the location analysis.

Code availability Not applicable.

Declarations

Ethics approval and consent to participate The study was performed in accordance with the Toyo University Research Ethics Code of 2015 by Toyo University Research Ethics Committee.

Competing interests The authors declare no competing interests.

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