Chapter 6
Communication Structure, Protocol and Data Model Toward Resilient Cities in Japan

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Abstract This chapter proposes a wider view of disaster risk reduction in local communities through structured communication and information exchange. Smart city planning shows that resilience toward disasters equates with confidence in efficient responses. Information collection, sharing and delivery are, therefore, the keys in local communities to providing effective disaster management operations and relief to citizens. Community members clearly demonstrate expectations in the organization of information and communication that would increase resilience. Multiple stakeholders such as local municipalities and communities, state and prefectural government, private industries, NPOs and civil volunteers should all be involved in disaster response. Required information at each organizational level varies in terms of information granularity and contents. Moreover, there is no prior understanding of who owns what information, a fact which hinders collecting and sharing it effectively in the event of a disaster. A standardized data model that can be shared by related organizations on an everyday basis is mandatory. In addition, a common structure must be in place for information delivery from a local municipality to its citizens. This chapter asks what the information needed in a disaster consists of and how we can structure it across different organizations and devise a communication protocol between local municipalities and their citizens.

Keywords Data model · Information sharing · Disaster management · Local municipalities · Communication protocol

6.1 Introduction

Natural disasters occur frequently in Japan and therefore require well thought-through responses premised on collaboration with various stakeholders. Many organizations, groups and individuals are involved in disaster response. At the forefront of coordination lie local municipalities, i.e., towns and villages. For them, the

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M. Sakurai and R. Shaw (eds.), *Emerging Technologies for Disaster Resilience*,
Disaster Risk Reduction,
https://doi.org/10.1007/978-981-16-0360-0_6

primary goal of disaster response is to save lives and ensure the safety of their citizens. Securing and operating evacuation shelters and managing relief supplies are on-going secondary missions (Sakurai et al. 2014). Local municipalities must also be prepared to respond to inquiries from citizens following a disaster. Information sharing with related organizations and communication with citizens are the keys to rapid disaster response operations. Specifically, effective communication is one of the major requirements of an organization aiming to bolster resilience (Horne and Orr 1998). Moreover, cross-sector collaboration is crucial in reducing disaster risks (Sakurai et al. 2017). Efficient communication strategies and coordinating activities in a disaster situation are found to enhance cross-sector and cross-organizational collaboration and consequently increase resilience.

According to a survey of mayors of the Japanese local government, which the author conducted in 2019, the following 10 items were listed as goals for disaster communication.

(1) Disaster mitigation
(2) Providing a sense of security to citizens and a safe environment
(3) Promptly grasping the situation, collecting accurate information and making appropriate decisions
(4) Fostering initiative and self-help, enabling citizens to act on their own accord
(5) Saving lives through community effort or individually
(6) Collaboration among citizens, local communities and city administration
(7) Rebuilding lives of victims
(8) Preventing secondary disasters
(9) Accurate transmission of support information to citizens
(10) Quick recovery and reconstruction

Although these goals sound general, emphasis is placed on encouraging self-help and mutual support on the basis of appropriate information from local communities.

The same survey enquired about important issues arising from adverse conditions negatively affecting the above goals. The following list was produced.

1. Lack of know-how of ICT tools in general
2. The need for a disaster response and information sharing tool that is standardized nationwide and actually in service (rather than kept for use-in-emergency)
3. Correct timing of evacuation advisories and instruction transmission
4. Dissemination of dangerous or vulnerable site information to citizens
5. Sharing knowledge and experience from lessons of past disasters
6. Spontaneously grasping a given situation in highly damaged areas
7. How to apply new technology to an already existing disaster prevention system
8. Information sharing with related organizations
9. Incompatibility of information systems among different stakeholders
10. Careful consideration of information-vulnerable people (e.g., the elderly)

While mayors recognized information sharing through IT platforms is critical, they alsonoted the lack of IT literacy within municipalities. Getting the big picture of a situation and transmitting risk information and appropriate evacuation instructions to citizens become top priority. Resilient cities or communities should sustain their functions even when a disaster or an emergency downgrades people's everyday life. The Rockefeller Foundation expressed this requirement in its definition of urban resilience as follows: "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.[1]" This chapter focuses on disaster communication that helps a city to increase its capacity for resilience and calls for a common communication protocol for conducting smooth disaster relief operations. Disaster communication includes two types of activities: (1) information collection/sharing and (2) delivery. The former collects and shares information from related organizations, communities and citizens, aiming at smooth mutual collaboration. The latter primarily focuses on citizens by delivering risk and disaster information in order to reduce risks threatening the population at the time of a disaster.

The following section provides a systematic analysis to show how Japanese local municipalities collect and share information with other organizations and deliver information to citizens in a disaster response. The structure of the entire chapter relies on information system design theory stressing the following three characteristics (Markus et al. 2002): (1) working process, (2) work context and (3) information requirements. In addition, to get discussions to be grounded in social issues, this study employs design science methodology. First, a brief introduction of the methodology and data collection is given. Information requirements for disaster communication are specified followed by an illustration of a working process and context. Finally, a common communication protocol for information collection/sharing and delivery is discussed.

6.2 Methodology

Design science methodology aims to derive design requirements and systems features from practical observations. The design science approach begins with the notion of "the sciences of the artificial," advocated by Simon (1996). Design is defined as "the use of scientific principles, technical information and imagination in the definition of a structure, machine or system to perform pre-specified functions with the maximum economy and efficiency" (Walls et al. 1992). In an industry concerned with developing new products, the importance of careful observation is recognized as well. Direct observation and good understanding of people's needs and wants lead innovation activities following design principles to increase the value of a product (Brown 2008).

[1] https://100resilientcities.org/resources/#section-1, last accessed on May 25th, 2020.

The design science paradigm has its roots in engineering, and thus its aim is problem-solving (Hevner et al. 2004). Design science is concerned with creating artifacts to achieve certain goals while natural science is concerned with explaining how and why things are (Simon 1996). With regard to a product, then, its design refers to "a plan of something to be done," while the design process means "to plan the parts of the intended structure [so that] all requirements will be satisfied" (Walls et al. 1992). What this methodology aims to solve are particularly situated problems by providing new ways to develop or improve organizations through the design of artifacts. Design science methodology can produce concepts, constructs and models as well as artifact instantiations (March and Smith 1995). Previous research indicates that qualitative research methodologies are quite valuable when aiming to understand social settings (Myers 1997). In that sense, then, this study applies case study methodology to problem identification. Information requirements are derived from actual problems.

6.3 Data Collection

As part of this study, a series of workshops, motivated by the mayors' survey, were held with disaster management staff in a number of Japanese municipalities (Table 6.1). The overall objective was to get a handle on the issues involved in disaster communication, the processes of information collection/sharing and delivery. The participating towns and cities were: Muroran, Sendai, Joso, Chiba, Kamakura, Fujisawa, Higashishirakawa Village, Tanba, Kobe, Nishinomiya, Kochi, Genkai Town and Kumamoto.

In each workshop, a couple of municipalities shared their experiences and lessons learned from a past disaster. This was followed by discussions regarding communication, information sharing/delivery, the utilization of ICT and solutions applicable to future disasters. Specifically, our focus was on exploring the process of information collection/sharing and delivery as well as context, which would clarify the actors in that process.

Table 6.1 Workshop date and participants

Date of workshop	Number of participants
May 16, 2019	18
July 11, 2019	15
August 28, 2019	10
October 17, 2019	12
November 14, 2019	14
January 16, 2020	10

6.4 Process and Context Identification

6.4.1 Information Collection and Sharing

The Fig. 6.1 illustrates the process and context of information gathering before and during 72 h following a disaster. Local municipalities are located at the center. The figure shows what information is required by local municipalities and how to collect it. The asterisk refers to type of information, and italics denote tools that carry information.

Stakeholders, who are important when collecting information, are first infrastructure operators of utilities such as electricity and gas, which are indispensable for sustaining people's everyday life. At the same time, information on the operating status of railways and buses from transportation companies is also essential, especially in urban areas. Local municipalities exchange information on type and degree of damage and confirm the safety status of residents with fire departments and the police. Traditional communication tools such as phones and faxes are used to collect that information. Some municipalities have hotlines with infrastructure providers. For information such as weather warnings, local officials check the Japan Meteorological Agency (JMA) website or emergency bulletins. The officials also compile people's requirements of relief materials at an evacuation center. This is often done by analog means using pen and paper. In some cases, residents may send information about damage incurred directly through social media such as Twitter and other smartphone applications. Figure 6.1 shows that information which a municipal government should collect does not automatically collect at disaster management headquarters, but city officials take it there by themselves. It is indeed a labor-intensive operation.

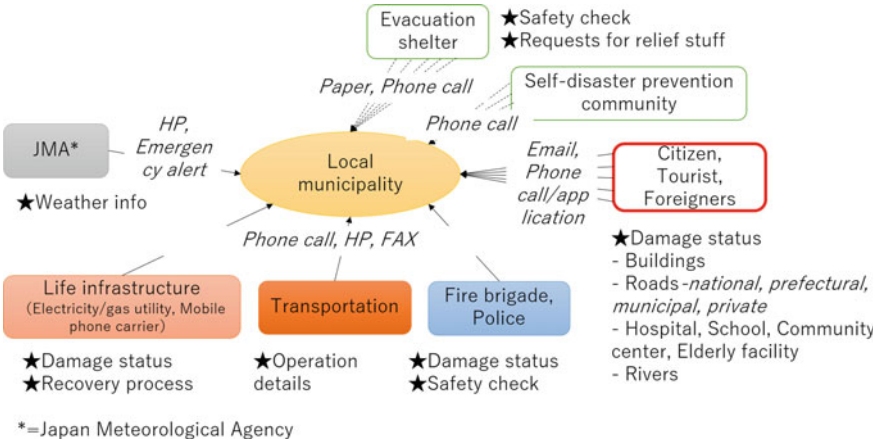

Fig. 6.1 Structure of information collection and sharing in Japanese municipality

6.4.2 *Information Delivery*

The Fig. 6.2 illustrates the structure of information delivery centered on local municipality. It shows that the ultimate purpose of information delivery for a local government is to deliver life support information to its citizens. As in Fig. 6.1, the asterisk and the italics refer to type of information and information delivery tools, respectively.

Compared with the process of information collection/sharing, that of information delivery is rather limited. Essential information is about evacuation centers, restoration status of lifeline infrastructure, emergency alerts and disaster support that helps people protect their own or their family's lives. Information delivery tools are diversifying with emails and smartphone applications. These days, even the development of disaster management applications for a smartphone has become quite popular. Also, AI speakers are now available as a means of information delivery to those who do not possess or are unable to use a smartphone or disaster radio.

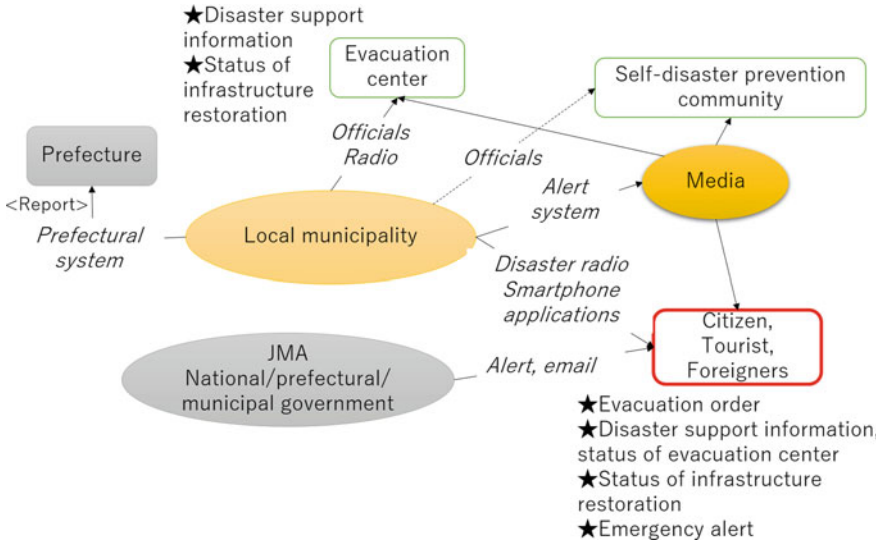

Fig. 6.2 Structure of information delivery in Japanese municipality

6.5 Issues and Requirements

This section identifies problems in information sharing and delivery and guides us to consider what is required for future disaster communication.

6.5.1 Information Collection and Sharing

The workshop pointed to the following seven issues in information collection and sharing, which were shared in all participating localities. Quotations made at the workshop are in italics.

(1) Townships collect information in a labor-intensive manner using phone call, FAX, media sources and scrolling websites. Although there is no difference among municipalities in the types of information gathered at the time of a disaster, there is no common system or guideline to effectively collect them.
As an official says: *(Looking back on the past earthquake), the sources of information from which to grasp the situation were TV, Yahoo, and aerial Google photographs. From these sources, we learned about gas supply interruption and water pipe rupture. Safety confirmation is the responsibility of self-help disaster prevention communities and residents' associations. However, systematic methods of collecting information from these groups have not been established.*

(2) Local municipalities receive various information from citizens through a number of tools and channels including phone call, email, SNS, fax and so on. However, a method of organized use within municipal governments has not been established.

(3) Inadequate information collaboration with a prefectural government.
An official comments: *When the gas supply was restored, our city received no advance information and we suddenly got a phone call from a utility company asking us to specify the location for a recovery unit. (Prefectural government might have known the supply resumption in advance, but) no information was passed between prefectural and municipal governments.*

(4) Since the granularity of information that a municipality needs to collect differs from that of prefectures, information sharing becomes complicated and duplicated in some cases.
An official says: *The city needs an individual's name to confirm its safety, but a prefectural government requires information on where and how many people are affected.*

(5) Each stakeholder has a different information management system. Information is not shared on daily basis.
An official says: *The fire department has one information system for managing daily emergency work. Construction and civil engineering departments have another to record daily malfunctions such as water leaks in gutters.*

(6) It is difficult to correctly interpret collected information and grasp the full picture which would guide mayors to make appropriate decisions.
An official says: *Unable to get any information, a staff member took a tablet and patrolled the site in the middle of the night. Photos and videos convey the situation, but I could not see exactly how bad the situation really was. It was difficult to judge.*
Another official says: *For storm and flood damage, the information we can check in advance is the weather forecast and the webcam. Since live cameras were not installed along all rivers, it was difficult to know the place where the water level was rising. It is hard to grasp the situation from information coming in by telephone from nearby citizens.*

(7) There are many residents who require support when evacuating. But there are not enough people to support them and confirm their safety.
These issues can be broadly divided into three categories: (a) how to collect information, (b) how to organize and share collected information and (c) how to use collected information for decision-making.

Based on these findings, fundamental requirements for information collection and sharing are:

(1) A common information structure or data model for organizing collected and/or required information and
(2) The managing and sharing of such information with stakeholders on a daily basis.

In addition to gathering information on the big picture of a disaster, municipal government officials are busy in responding to inquiries from residents. Human resources are not necessarily sufficient when organizing inquiries. Inquiries are often duplicated. For example, the most frequently asked questions are "where are evacuation shelters," "is my house subject to evacuation instructions," "what should I do now that my house is heavily damaged," including also complaints about gas/water leaks, and a washed away road or collapsed bridge, and queries such as "when will relief goods arrive," "when are roadblocks removed," "when are electricity, gas and water restored," "when will a disaster victim certificate be issued," "what happened to city hall," and so on. Citizens need a status update on the situation, while officials move about trying to collect that information on foot.

This was the case in Kamakura, where city officials received 1,153 inquiries when Typhoon Faxai hit the area in September 2019. There were also 924 enquiries when Typhoon Hagibis struck Japan a month later. The city appointed 20 officials to answer the phone. However, it became impossible to catch up with all inquiries as their number increased rapidly. Consequently, the city organized an information team with six officials. The team members recorded inquiry information onto a PC, eliminated duplication and organized content. While there was an enormous increase of information and tasks, which are mandatory following a disaster, the number of officials that could handle it remained about the same as it was before the disaster.

This points to the need for more efficient organization of incoming information, rather than the need for adding personnel in an ad hoc fashion.

6.5.2 Information Delivery

Issues in information delivery are also common to local communities. (Statements made at the workshop are again in italics.)

(1) How to deliver information to tourists, foreigners and business travelers who are temporarily staying in an affected area.
One official says: *We need to consider what people are looking for when they move beyond the (geographical) boundary of the local area.*
Another official says: *Information required for individual travelers and business travelers should be differentiated. We also need to prepare different types of information in different locations, i.e., at a tourist information site and at a general information center in the municipal office.*

(2) How to promote multilingual support and how to transmit multilingual information to those who do not understand Japanese.

(3) How should information be personalized and customized? It is necessary to consider the status of the recipient in terms of age, family composition and mental or physical challenges, before contacting those who need to evacuate immediately or require support in evacuation.
An official comments: *In heavy rain, city officials made a phone call to elderly people living alone in the evacuation areas and requiring evacuation support, and [merely] informed them that an evacuation advisory had been issued.*
Another official says: *It is important to have an arrangement and a system for sharing information among local welfare officers and care workers who will provide necessary support to those who need it.*

(4) What are desirable tools and what is the best timing for the delivery of information facilitating evacuation?
An official says: *In some cases, the mayor himself urged people to evacuate via disaster prevention radio, and the residents started to feel a sense of great urgency.*

(5) How to balance information delivery in normal times and during a crisis.
An official comments: *A tool that is not used during normal times cannot be used during a disaster.*
Another official says: *If we oversupply information during normal times, citizens will hesitate to look at essential information during a disaster.*

The workshops summarized the requirements in information delivery into proper timing of dissemination, personalized information delivery, multilingualization and appropriate balance between normal and critical times of information delivery. It was also pointed out that while delivery tools were diversifying, consideration would have to be given to people who are not readily familiar with digital technology.

Basic requirements for information delivery are:

(1) Organization of collected information allowing efficient access and
(2) Personalized information delivery to those who need immediate action for saving their lives.

6.5.3 Bottlenecks of Information Systems

Somewhat different issues also arose from the workshop discussions and revealed a bottleneck due to the differentiation of information systems. One example is the daily use of incompatible information systems by different organizations. Police, fire departments and other related agencies use different systems for disaster management. Differentiation of daily use systems hinders interoperability of information integration which results in additional trouble in information sharing. City officials are forced to extract data from their own disaster management system in CSV format and input them into another system, which is used for sending emergency alerts to citizens' cellphones and smartphones. The same thing happens when a local government reports its damage status to a prefectural government. Duplication emerges due to different systems of data management.

Another example comes from Kumamoto city. The city drew up a disaster information triage form on paper, instead of employing an information system when responding to phone calls from citizens. Officials filled out the triage form based on what they heard on the phone and faxed it to the related department within local government. Such information collection/sharing is performed by human resources. It means officials may not necessarily be familiar with aspects of information technology. In the event of a disaster, they tend to use what they already know and are familiar with. Disaster risk reduction is, therefore, not only always achieved with high-tech solutions but also with methods people are comfortable with.

6.6 Discussion: Solution Proposition

As mentioned previously, a single shared structure for organizing information collection and delivery can contribute to disaster risk reduction effectively. The fundamental issue of current disaster communication in local municipalities is that information is not shared among stakeholders on an everyday basis. The inefficiency of information gathering by human trial and error is due to the fact that municipal officials have no advance knowledge of the stakeholders who have the required information. In addition, in the event of a disaster, various industries and civil organizations will begin to support the affected area. Because information sharing by newly joined organizations is done ad-hoc, a relief organization will not know when a disaster-affected municipality is in trouble and what their needs may be, and vice versa. An official in municipal government cannot tell what a relief organization can do to support

them. Indeed, there exists a gap in communication between different stakeholders. Therefore, it is necessary to establish a common data model that enables continuous information sharing beyond any particular municipal government office. It is also important to share a common communication protocol for smooth and quick information delivery to citizens.

6.6.1 Common Structure for Information Collection and Sharing

Chen et al. (2013) developed an emergency data model for a fire department in the USA based on the activity theory. Chen et al. (2013) produced an ununified information-sharing format for all the different regions the fire department belongs to. They developed an emergency data model for smooth information sharing among the different fire departments. It categorizes necessary information for emergency response into threat assessment and incident command.

Following the Great East Japan Earthquake in 2011, the Ministry of Internal Affairs and Communications in Japan classified the information required at the time of a disaster into the specific information categories (Ministry of Internal Affairs and Communications 2013).

They include information and instructions on evacuation, evacuee safety, victims and injuries, fire, earthquake, tsunami, evacuation center locations, missing person notifications, temporary accommodation, transportation, roads, electricity and gas restoration, medical institutions, administrative service, school and public facilities, financial institutions, shops, volunteers, relief supplies, volunteer application and recruitment, temporary housing, disaster victim certificates, subsidies donations and house reconstruction.

Based on discussions in our series of workshops and on an earlier study of disaster information categories and appropriate data model, this chapter proposes the following model for information collection and sharing (Fig. 6.3).

The model consists of three categories: (1) threat assessment, (2) service restoration and (3) response command. The first category specifies the event. It includes hazard risk information that gives detailed information on different types of crises; earthquake, tsunami, flooding and so on. Threat information for property, population and environment needs to be collected under this category. The second category shows the restoration status of public/private services, which are necessary to recover people's everyday lives. Major items under this category are transportation, lifeline infrastructure and public/private facilities such as hospitals and schools. The final category aims to organize internal command operations. This includes the details of response teams, available resources and organizations/individuals who are involved in relief activities. The status of relief operations also needs to be recorded. The most complicated and critical operations might be the opening of evacuation

Fig. 6.3 Common data model for information collection and sharing in a disaster (*data source* Chen et al. 2013; Ministry of Internal Affairs and Communications 2013 and our workshops)

centers, counting the number of evacuees and other related tasks. Therefore, careful information collection and sharing are important.

Each category requires different stakeholders to collaborate with. There are a small number of cases where a local government itself acts as an information source. For instance, the first category requires weather and risk information from JMA, casualty and damage information from police and a fire department, and hazard information from an expert in the area. It might be possible to extract sensor information through IoT devices throughout a city, which could show the real-time water level of a river. The second category obviously needs collaboration with transportation and utility companies. Stakeholders managing schools, hospitals, retail shops are also essential partners. Sharing such information in every day, year-round operations can strengthen the immediate response after a disaster and thus contribute to disaster risk reduction. The third category is focusing on internal operations and administrative information. When compared to the other categories, far fewer stakeholders are involved.

However, internal information sharing and collaboration with volunteers and NPOs, who participate in relief operations, become crucial.

The proposed data model covers most of the frequently asked questions from citizens. If a local municipality stored information according to that structure, they would be able to respond smoothly to inquiries. Suitable information technology is readily available to develop data storage supporting comprehensive information collection and sharing for everyday use.

6.6.2 Common Structure for Information Delivery

In order to effect the quick organization of collected information as well as personalized and multilingual information delivery, having a common communication protocol is required. As shown previously, information from municipal governments to citizens is delivered through various IT tools. While delivery tools are differentiated, there is no standardized form of information delivery except emergency alert and evacuation advisory.

Based on the workshop sessions discussed above and the report by the Ministry of Internal Affairs and Communications (2013), this chapter proposes the following structure for information delivery (Fig. 6.4). Items in italics indicate information that can be personalized according to the condition of citizens or residential location. For instance, weather forecast and hazard prediction can be delivered to groups or

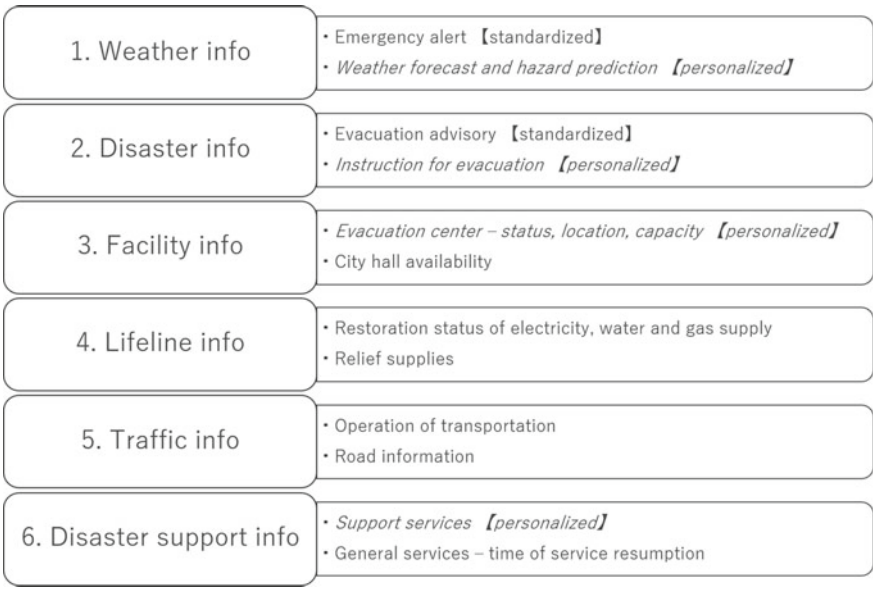

Fig. 6.4 Common information structure for information delivery in a disaster

individuals who live in disaster vulnerable areas. It promotes situation awareness of those groups and enhances immediate actions to save their lives. Instruction for evacuation is also demanded by foreign tourists who are not familiar with Japanese evacuation practices, and people who need special support for evacuation. Location of the evacuation center, its opening status and capacity are also necessary to those who are living nearby. Finally, disaster support information can be customized according to the level of damage and household composition.

Preferably, just as for emergency alerts and evacuation advisories that possess a standardized format of alert level and message, other items are also supposed to follow a standardized protocol when delivered to citizens. Information technology can support multilingualization much more conveniently if each information item follows a common communication protocol. It enables the coding of information data such that it is smoothly and quickly transacted throughout the technological platform.

6.6.3 Policy Implications at the National Level

The Japanese National Government has developed various programs for enhancing resilience of municipal government. Most of them aim to create a shared platform between itself and local municipalities, private companies, universities and national ministries. This platform provides for appropriate and stream-lined matching between needs and solutions in the shape of a hub-and-spokes network. Special interest groups are organized under such a program and platform in order to provide space for coordinated discussions on specific topics. A municipality submits its needs to be resolved, and the shared platform enhances public–private collaboration. Stakeholders who are interested in accessing and providing topics or problems can contact and collaborate with the local government. As of early 2020, collaboration platforms around smart city, SDGs and green infrastructure are active and each of them appeals to hundreds of members from government, enterprise and research sectors.

This chapter's proposition on communication structure might fit well into these initiatives. First, the present study started with identifying problems in disaster communication. There is a commonality in taking the problem-oriented approach. Second, as stated previously, disaster communication requires collaboration with various stakeholders. Common communication structure can help such collaboration in the field. Third, even though recognizing that the proposed structure cannot be entirely fixed, but will be changing in association with future disaster situations, a public–private collaboration platform will be useful.

While noticing similarities and the fit of this study into national government initiatives, there are some policy implications, which should be acknowledged.

(1) A research organization or other-related institutions that can identify problems based on what happened in past events ought to play an essential role on the given platform.

Local government possesses lessons from past disasters, though without always being aware of all problems and their interconnectedness. So, when a local municipality submits its aspirations to a given national platform they are commonly translated into an idealized strategy such as "protect people's safety and save lives" rather than being oriented toward the actual problems encountered at disaster sites. Specific desires or needs that came up in those lessons learned from past emergencies are not taken into account. It is in this area that a research organization can help clarify and organize what is necessary for future submissions.

(2) Practical implications based on empirical research should be reflected in national policy-making.
A process of national policy-making involves various external experts or experts committee. These experts provide their domain knowledge. If a policy theme relates to local municipalities, such as disasters, a few representative officials from a municipality may be invited to provide insights from their experiences. However, local perspectives are hardly considered when discussing a national policy. This generates a gap between a municipal and national policy. Evidence-based policy-making should be more encouraged in order to reflect critical requirements in the field.

(3) Horizontal learning platform for local municipality can enhance a city's resilience.
This study organized a series of workshops to identify information requirements in disaster communication. Participants were officials from local governments. Research activities can record lessons learned from a past event, but it would be better to have a national repository, which cares to store past disaster lessons such as to allow communication and information exchange laterally among all local communities. However, any given national collaboration platform aims to connect a municipality and other stakeholders hierarchically, top to bottom, therefore horizontal connections between municipalities are lost in such initiatives. In general, even though prefectural government takes a role in organizing its municipalities, it too creates mostly vertical connections. Based on this chapter's empirical research, we could benefit from sharing knowledge beyond the prefectural boundary, resulting in a strong horizontally spaced structure between municipalities.

6.7 Conclusion

Almost every year in recent Japan, we experience a disaster usually referred to as "once every few decades." Those disasters are quite large-scale and require the dispatch of self-defense forces to act as a disaster relief agency. Despite our experience and knowledge accumulated over time, we have not yet developed the best practice for efficient communication among a local municipality, stakeholders and citizens in such times. On the other hand, with the widespread of IT tools, disaster

support at the individual level is also being actively mobilized, and more players are joining disaster response sites.

Resilient cities require the ability to survive, adapt and grow in any unexpected calamity. A municipal government stands at the forefront of disaster response and it requires to have the ability to rapidly coordinate with various organizations and individuals up to the national level. Information and communication are the keys in the process of gaining such ability, as decisions by mayors are made on information collected through communication activities. Whereas the amount of information exchanged online is increasing year by year, the progress of developing the ability to select and organize information is still open to debate. Standardized, structured management of information will help us strengthen such ability. We note that there are obvious limitations on human resources at the local level when responding to a disaster. Appropriate communal support must be developed for the management of future disasters. The timely provision of information to citizens is essential for enhancing mutual support among individuals and civil communities.

This chapter tries to sublimate lessons and knowledge gained from past disasters into solutions. Specifically, this chapter focuses on a common, shared structure for comprehensive disaster communication in Japanese local governments. The proposed solution includes a standardized communication protocol, which will enable information sharing both in everyday use and in times of crisis across various stakeholders. It will enable personalized information delivery to all citizens in a form of society benefiting from emerging technologies characteristic of Industry 4.0. This, in turn, will strengthen individual capacity for self-help, raise the maturity level of personal resilience and thereby contribute to future disaster risk reduction.

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