Study on BCP and BCM for Urban and Building Resilience to Withstand Earthquakes in Japan

Jichen Hu and Takehiro Tanaka
1 Toyo University, Japan
E-mail: hujichen0602@gmail.com; tanaka@toyo.jp

Abstract. The occurrence of the 2011 East Japan Earthquake prompted the country to accelerate the development of BCP/BCM-based communities aimed at establishing autonomous energy systems and implementing disaster management. This idea is also conceived to be a comprehensive concept for addressing the effects of climate change. In this case, flexible urban planning proposals were made and targets, measures and assessment procedures were tried and established in various areas such as urban planning, energy, transportation, health and welfare. According to the results, the corresponding measures and the emergency early warning treatment plan after the disaster are proposed to achieve the purpose of risk assessment.

1. Introduction
The occurrence of the 2011 Great East Japan Earthquake has prompted the nation to speed up BCP/BCM-based community development aiming at the establishment of autonomous energy systems and the implementation of disaster management. The idea is also conceived as a comprehensive concept to cope with the impact of climate change. Under these circumstances, a proposal of resilient city planning is brought up and its goals, measures and evaluation procedures are tried and established in various fields including city planning, energy, transportation, health and welfare. In this study, the concepts of resilience and BCP/BCM are defined: DCM/BCM-related risks remaining unsolved in the future of four districts on which the authors conducted surveys are examined: and visions and issuers of Japan’s future BCP/BCM-based resilient cities and buildings against earthquakes are proposed.

2. Resilience

2.1. Definition of “resilience”
The term “resilience” has been used originally to indicate political skill or scientific methodology. The term “resilience” is also used to give a psychological description and applied further widely to ecology, disaster management, climate change and other studies today in response to increasing needs for measures against environmental changes and major disasters.

2.2. Urban and architectural resilience
Urban and architectural resilience is regarded mostly as the ability to recover fast from a disaster in the context of risk mitigation and management. According to Bruneau (2007) [1], disaster resilience is defined as the ability of social units (e.g., organizations and communities) to (1) mitigate hazards, (2) contain the effects of disasters when they occur, and (3) carry out recovery activities in ways that minimize social disruption and mitigate the
effects of future disasters. He has advocated the R4 attributes to improve such ability: robustness, resourcefulness, redundancy and rapidity. Like the concept of BCP/BCM, this theory is considerably important in discussing urban and architectural resilience.

2.3. 100 Resilient Cities
In recent years, “resilience” has been grasped from a broader viewpoint. “100 Resilient Cities” [2] is a comprehensive framework established by the Rockefeller Foundation in the U.S. for the purpose of evaluating and improving urban resilience. From 2014 to 2016, a total of 100 cities were selected for excellence in resilience. Funded by the foundation, each of the selected cities works together with its own project leader called Chief Resilient Officer (CRO) and aims to attain a higher level of resilience. New Orleans of the U.S., for example, was acknowledged to be a resilient city as the city made a dramatic recovery from the devastation by hurricanes; implemented city planning schemes in response to climatic change; improved the quality of life by creating jobs and equaling opportunities; and set 50-year long-term strategic goals including the establishment of energy infrastructure available at both ordinary and emergency times. From Japan, the cities of Toyama and Kyoto were selected. Toyama was highly rated in the light of its compact and sustainable city planning while Kyoto in the light of its comprehensive disaster prevention efforts.

100 Resilient Cities defines resilience as the capacity of a city to withstand, respond to, and adapt more readily to shocks and stresses, which becomes more robust in the days of hardship and more fertile in the days of affluence. In this context, shocks are sudden, sharp events (e.g. disasters) whereas stresses are day-to-day strains (e.g. shortages). This particular term “stress” implies that a community entails external threats against enterprises and organizations in general. On these grounds, 100 Resilient Cities carries out evaluation and selection in consideration of the characteristic qualities listed in Table 1.

The 4R attributes, discussed in Section 2.2, put emphasis on the resources of comparative substances/procedures whereas 100 Resilient Cities provides definitions by referring more to terms related to “intention” and “awareness”. In this regard as well, 100 Resilient Cities is considered to be the source for flexible adaptability, explicitly presenting future visions to draw various stakeholders in and demonstrating capabilities in independently planning and forming the framework to put these visions into practice.

2.4. Resilience advocated by OECD
100 Resilient Cities introduced in Section 2.3 is significant in that they select and support cities by the definite evaluation criteria of resilience, based on which the selected cities are reinforced further while the importance of resilience is put forward to the others. In view of “how to increase resilience” more practically and directly, OECD (2014) [3] issued ‘Guidelines for Resilience Systems Analysis - How to analyze risk and build a roadmap to resilience’. Apparently it takes the position that resilience contains not only characteristics or abilities but also processes to improve those elements.

In the OECD guidelines, the framework for strengthening resilience is conceptualized in the broad sense as Table 2[4] indicates. Rightward in the frame, the intensity of change increases. There are three different types of capacities to strengthen resilience: absorptive capacity for moderate change, transformative capacity for radical change, and adaptive capacity for in-between change. Resilience can be boosted by strengthening these three capacities. That is to say, in order to improve resilience, it is important to properly select and increase these capacities and necessary costs by analyzing kinds and impacts of stresses and shocks.
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Table 1. Evaluation criteria of 100 Resilient Cities

| Categories of preventive measures in the “Tokyo Metropolitan Area Disaster Prevention Plan” | DCM/BCM issues (risks) | Business district | Coastal district |
|---|---|---|---|
| Development and implementation of support systems to meet individual needs. | × | × | × |
| Continuous BCM-based individual approach. | × | × | × |
| Development of base isolation and seismic control structures, and preventive measures for furniture and fixtures from moving. | × | × | × |
| Development of an independent system within a community. | × | × | × |
| Development of a decentralized energy system to secure the amount necessary for emergency. | × | × | × |
| Development of a decentralized energy system (e.g. cogeneration, renewable energy, and hydrogen energy) are not available. | × | × | × |
| Establishment of an independent system to meet individual needs and situations. | × | × | × |
| Establishment of an independent system within a community. | × | × | × |
| Development and implementation of an emergency information gathering system about individual needs. | × | × | × |
| Preparation of the minimum stockpile in each community. | × | × | × |
| Preparation of the minimum stockpile in each community. | × | × | × |
| Development and implementation of an emergency information gathering system about individuals. | × | × | × |
| Examined and handled as new risks. | × | × | × |
| Examined and handled as new risks. | × | × | × |
| Examined and handled as new risks. | × | × | × |
| Examined and handled as new risks. | × | × | × |

| DCM/BCM-related risks changing with time | 2017 | 2030 | 2050 |
|---|---|---|---|
| Comfortable living is not secured for many Tokyo residents in an earthquake. | × | × | × |
| Secondary members such as the ceiling materials of a general structure collapse, causing many injuries and system malfunctions. | × | × | × |
| An elevator in a high-rise building often stops suddenly and traps people in, requiring much time for restoration. | × | × | × |
| Social system in which people can lead their lives without everyday transportation. | × | × | × |
| Establishment of an independent system to meet individual needs and situations. | × | × | × |
| Development of a decentralized energy system to secure the amount necessary for emergency. | × | × | × |
| Functions of some disaster prevention agencies are lost right after an earthquake, failing to share information for swift evacuation guidance and rescue activities. | × | × | × |
| Realtime earthquake information is too massive to conduct efficient measures. | × | × | × |
| Uncustomised to gathering appropriate information in an earthquake, leading to communication failure. | × | × | × |
| Sharp increase in communication traffic after an earthquake leads to communication failure. | × | × | × |
| A number of households without an emergency stockpile need to depend on public bodies and others in an earthquake, worsening a shortage of necessities. | × | × | × |
| Emergency goods are not distributed satisfactorily. | × | × | × |
| Cooperation between public organs and some private businesses ends in failure because of logistical changes in an earthquake, hindering the effective use of stockpiles. | × | × | × |
| Emergency goods are not properly delivered to all who need them. | × | × | × |
| Examined and handled as new risks. | × | × | × |
| Examined and handled as new risks. | × | × | × |
| Examined and handled as new risks. | × | × | × |

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Table 2. Intensity of external change and resilience

| DCM/BCM-related risks changing with time | DCM/BCM issues (risks) | 2017 | 2020 | 2050 | Additional measures | 2017 | 2020 | 2050 | Additional measures |
|------------------------------------------|------------------------|------|------|------|---------------------|------|------|------|---------------------|
| City Planning                           | Comfortable living is not secured for many Tokyo residents in an earthquake. | △ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
|                                 | Functions of private businesses cannot be maintained or restored earlier. | △ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
| Promotion of Earthquake Resilient Buildings and Safety Measures | Secondary members such as the ceiling materials of a general structure collapse, causing many injuries and system malfunctions. | △ | ○ | ○ | n/a | △ | ○ | ○ | n/a |
|                                         | An elevator in a high-rise building often stops suddenly and traps people in, requiring much time for restoration. | △ | △ | △ | Advanced IT control systems in response to Earthquake Early Warning. | △ | △ | △ | Advanced IT control systems in response to Earthquake Early Warning. |
| Reincorporation of Risk City Planning   | Liquefaction causes damage not only to buildings but also to urban infrastructure such as roads, reticulums and common ducts, subduing daily life. | ○ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
| Ground Motion                           | Skyscrapers and high-rise buildings suffer functional disorders due to long-period earthquake ground motion, which adversely affects business continuity. | × | △ | Measures for maintaining functions against long-period earthquake ground motion | ○ | ○ | ○ | n/a |
| Prevention of Fire Break-out and Spread  | Fire spreads out into urban districts because of oil infusing from Tokyo waterfront plants. | -- | -- | -- | -- | -- | -- | -- | -- |
| Assured Safety of Transportation Facilities | Roads, railways, reticulums and other facilities fail to function, requiring human-wave tactics for restoration. | △ | △ | △ | Social system in which people can lead their lives without everyday transportation. | △ | △ | △ | Social system in which people can lead their lives without everyday transportation. |
| Assurance of Sustainable Utilities      | Power, gas, water supply and sewer services are disconnected, requiring a long time for restoration. | △ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
| Sacred Energies                         | A bulk power system is not operable in a wide range. | × | △ | Development of a decentralized energy system to secure the amount necessary for emergency | × | △ | △ | n/a (energy supply independent of a bulk power system) |
| Demolition and Deconstruction Electrolines | Decentralized energy systems (e.g. cogeneration, renewable energy, and hydrogen energy) are not workable. | △ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
| Development of Information and Communication Systems between Disaster Prevention Agencies | Functions of some disaster prevention agencies are lost right after an earthquake, failing to share information for swift evacuation guidance and rescue activities. | △ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
|                                          | Realtime earthquake information is too massive to conduct efficient measures. | × | △ | ○ | n/a | △ | △ | ○ | n/a |
| Development of Information Providing System for Residents | Proper information cannot be provided to meet the emergency situation. | × | △ | At expert systems capable of responding flexibly to various situations | × | △ | △ | At expert systems capable of responding flexibly to various situations |
| Development of Information Sharing and Communication Systems among Residents | Unaccustomed to gathering appropriate information in an earthquake, users fall into a panic. | △ | △ | Provision of practical information to meet individual needs and situations | △ | △ | △ | Provision of practical information to meet individual needs and situations |
| Stockpiles of Water/Food/Living Necessities | Sharp increase in communication traffic after an earthquake leads to communication failure | × | △ | ○ | n/a | × | △ | ○ | n/a |
|                                          | GPS and navigation systems for daily use become unavailable, throwing users into a panic. | × | △ | ○ | n/a | × | △ | ○ | n/a |
| Environmental Management of Living-Related Management | A number of households with no emergency stockpile need to depend on public bodies and others in an earthquake, worsening a shortage of necessities. | △ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
|                                          | Emergency goods are not distributed satisfactorily. | ○ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
| Improvement of Stockpile Warehouses, Transportation Bases and Transportation Systems | Cooperation between public organs and some private businesses end in failure because of situational changes in an earthquake, hindering the effective use of stockpiles. | ○ | ○ | ○ | n/a | ○ | ○ | ○ | n/a |
|                                          | Emergency goods are not properly delivered to all who need them. | △ | △ | △ | Utilization of ICT-based allocation system | △ | △ | △ | Utilization of ICT-based allocation system |
| Automated Operations for IoT and Self-driving Vehicles | ICT, IoT and self-driving vehicles, which public utilities, transportation and logistics heavily depend on, cannot be operated efficiently in an earthquake, requiring a long time for restoration in the absence of experts. | -- | × | △ | Handled as new risks: security reinforcement and redundant cloud storage | -- | × | △ | Handled as new risks: security reinforcement and redundant cloud storage |
| Hydrogen-based Society                   | A hydrogen fuel station may bring a dangerous threat in an earthquake, and a hydrogen supply chain malfunctions. | -- | × | △ | Examined and handled as new risks. | -- | × | △ | Examined and handled as new risks. |
3. Persistent risks in the future DCM/BCM of each district

According to the fact-finding survey conducted for the four districts regarding DCM/BCM related risks, issues (marked with × or △) which are considered to still remain unresolved in the future (2050) are shown below. [5] Table 3 indicates comparative risk management among six districts including the business and coastal districts.

3.1. Risks and countermeasures common among the four districts
(a) An elevator in a high-rise building often stops suddenly and traps people in, requiring much time for restoration.
(b) Roads, railroads, revetments and other facilities fail to function, requiring human-wave tactics for restoration.
(c) A bulk power system is not operable in a wide range.
(d) Unaccustomed to gathering appropriate information in an earthquake, users fall into a panic.
(e) Emergency goods are not properly delivered to all who need them.
(f) ICT, IoT and self-driving vehicles, which public utilities, transportation and logistics heavily depend on, cannot be operated efficiently in an earthquake, requiring a long time for restoration in the absence of experts.
(g) A hydrogen fuel station may bring a dangerous threat in an earthquake, and a hydrogen supply chain malfunctions.

3.2. Risks and countermeasures common among the Daimaruyu district, the district around Tamachi Station Higashiguchi, and the Kashiwanoha Smart City
(a) Proper information cannot be provided to meet the emergency situation.

3.3. Risks and countermeasures for the Nagaoka central district (Aô-re Nagaoka)
(a) Comfortable living is not secured for many residents in an earthquake.
(b) Functions of private businesses cannot be maintained or restored earlier.
(c) Secondary members such as the ceiling materials of a general structure collapse, causing many injuries and system malfunctions.
(d) Liquefaction causes damage not only to buildings but also to urban infrastructure such as roads, revetments and common ducts, obstructing daily life.
(e) Roads, railroads, revetments and other facilities fail to function, requiring human-wave tactics for restoration.
(f) Power, gas, water supply and sewer services are disconnected, requiring a long time for restoration.
(g) A bulk power system is not operable in a wide range.
(h) Decentralized energy systems (e.g. cogeneration, renewable energy, and hydrogen energy) are not workable.
(i) A number of households with no emergency stockpile need to depend on public bodies and others in an earthquake, worsening a shortage of necessities.
(j) Emergency goods are not distributed satisfactorily.
(k) Cooperation between public organs and some private businesses ends in failure because of situational changes in an earthquake, hindering the effective use of stockpiles.
## Table 3. Comparative risk management among six districts including the business and coastal districts

| DCM/BCM-related risks changing with time | Nagoya central district (Air-re Nagoya) | Kashiwana Smart City |
|-----------------------------------------|----------------------------------------|----------------------|
| Categories of preventive measures in the “Tokyo Metropolitan Area Disaster Prevention Plan” | Risk management level | Additional measures | Risk management level | Additional measures |
|                                           | 20  | 2030 | 2050 |                                           | 20  | 2030 | 2050 |                                           |
| City Planning for Secured Livelihood      |     |      |      | Comfortable living is not secured for many Tokyo residents in an earthquake. | ×   | △   | △   | Development and implementation of support systems to meet individual needs. | ○   | ○   | n/a |
|                                           |     |      |      | Functions of private businesses cannot be maintained or restored earlier. | ×   | △   | △   | Continuation of business and individual approach and business collaboration | ○   | ○   | n/a |
| Promotion of Earthquake Resilient Buildings and Safety Measures |     |      |      | Secondary members such as the ceiling materials of a general structure collapse, causing many injuries and system malfunctions. | ×   | △   | △   | Development of base isolation and seismic control structures, and preventive measures for furniture and fixtures from moving. | △   | ○   | n/a |
| Reassurance of Secured Metropolitan Area  |     |      |      | An elevator in a high-rise building often stops suddenly and traps people in, requiring much time for restoration. | ×   | △   | △   | Advanced EV control systems in response to Earthquake Early Warning. | △   | △   | Advanced EV control systems in response to Earthquake Early Warning |
| Prevention of Fire Break-out and Spread   |     |      |      | Liquefaction causes damage not only to buildings but also to urban infrastructure such as roads, revetments and common ducts, obstructing daily life. | △   | △   | △   | Examination and promotion of measures for local liquefaction risks. | ○   | ○   | n/a |
|                                           |     |      |      | Skycrapers and high-rise buildings suffer functional disorders due to long-period earthquake ground motion, which adversely affects business continuity. | --  | --   | --   | -- | -- | -- | n/a |
| Assertiveness of Secured Transportation Networks and Public Utilities |     |      |      | A bulk power system is not operable in a wide range. | ×   | ×   | ×   | Establishment of an independent system within a community. | △   | △   | n/a |
| Assured Safety of Transportation Facilities |     |      |      | Power, gas, water supply and sewer services are disconnected, requiring a long time for restoration. | ×   | ×   | ×   | Development of a decentralized energy system to secure the amount necessary for emergency. | ×   | △   | n/a (energy supply independent of a bulk power system) |
| Secured Energies                          |     |      |      | A logistics system is not operable in a wide range. | ×   | ×   | ×   | New local power projects initiated by municipal authorities. | ○   | ○   | n/a |
| Development of Information and Communication on Systems between Disaster Prevention Agencies |     |      |      | Functions of some disaster prevention agencies are lost right after an earthquake, failing to share information for swift evacuation guidance and rescue activities. | △   | △   | ○   | n/a | ○ | ○ | n/a |
| Assured Stabilization of Public Utilities |     |      |      | Realtime earthquake information is too massive to conduct efficient measures. | △   | △   | ○   | n/a | ○ | ○ | n/a |
| Development of Information Providing System for Residents |     |      |      | Proper information cannot be provided to meet the emergency situation. | △   | △   | ○   | n/a | ○ | ○ | n/a |
| Development of Information Sharing and Communication on Systems among Residents |     |      |      | Unaccustomed to gathering appropriate information in an earthquake, users fall into a panic. | △   | △   | ○   | n/a | ○ | ○ | n/a |
| Stockpiles of Drinking Water/Food/Living Necessities |     |      |      | Sharp increase in communication traffic after an earthquake leads to communication failure. | ×   | ○   | n/a | -- | ○ | ○ | n/a |
| Improvement of Stockpile Warehouses, Transportation Bases and Transportation Systems |     |      |      | A number of households with no emergency stockpile need to depend on public bodies and others in an earthquake, worsening a shortage of necessities. | △   | △   | △   | Introduction of ICT-based efficient re-allocation of goods | ○   | ○   | n/a |
| Enhancement of ICT-based Logistical Measure |     |      |      | Emergency goods are not distributed satisfactorily. | △   | △   | △   | Development and implementation of an emergency information gathering system about individual needs. | ○   | ○   | n/a |
| Promotion of Logistics/Storage/Transportation Networks and Public Utilities |     |      |      | Cooperation between public organs and some private businesses ends in failure because of situational changes in an earthquake, hindering the effective use of stockpiles. | ×   | △   | △   | A logistics system switched over swiftly into an emergency mode. | ○   | ○   | n/a |
| Realization of DCM/BCM-based Allocation System |     |      |      | Emergency goods are not properly delivered to all who need them. | ×   | △   | △   | Utilization of ICT-based allocation system | △   | △   | Utilization of ICT-based allocation system |
4. Future issues regarding BCP and BCM for urban and building resilience to withstand earthquakes in Japan

As future issues regarding BCP and BCM for urban and building resilience to withstand earthquakes in Japan, it is inevitable to establish smart technologies to meet social needs and develop methods for their effective utilization in terms of risk management [6]. Specifically, the following smart technologies and their effective application methods are suggested. 

(1) Social needs and risk management

It is difficult to foretell what technologies will be realized by 2050, but prospective technologies and methods for future SBCM should be considered by looking into social needs which can be the mother of technological development and by looking over current technologies, development goals and latest trends. That is to say, even if a risk event breaks out within the scope of assumptions, businesses are still sustainable as facilities are continuously operated and used as usual. For instance, base isolation is one of the construction methods to protect building structures. However, because utility services including power, water supply and gas are controlled mostly outside such structures, these services are not necessarily kept fully operated or provided as usual. As a practical matter, when a risk event occurs, interim measures are taken by supplying power for a short time to avoid an immediate power cut, for the purpose of protecting human lives and preventing functional failures and suspensions which may lead to secondary disasters. In addition, when utility services are disconnected for a long period, it is necessary to take such a risk control that gives selective areas long-hour access to the utilities or to follow a soft-landing process by executing temporary service suspension so that minimum preparation can be made for businesses to be able to resume.

(2) Realization of safe city planning -- city planning for secured livelihood, promotion of earthquake-resistant construction and safety measures, reinforcement of measures against liquefaction and long-period earthquake ground motion, and prevention of fire break-out/spreading -- Aboveground utility poles and power lines which collapse in time of disaster are likely to block roads and throw obstacles in the way of traffic. The Act to Boost the Disappearance of Utility Poles was promulgated in December, 2016, with the expectation of forestalling those risks. With the aim of preventing disasters, securing safe and smooth traffic, and offering clear views, the aboveground installation of utility poles and power lines will be restricted by embedding power lines under the ground or by other measures, and at the same time the removal of aboveground utility poles and power lines will be promoted.

(3) Sustainable safe transportation networks and utility services -- safety of transportation facilities, functions of transportation networks, public utility services, and energies -- Public transportation facilities such as roads, bridges, tunnels, tide walls and sluices, of which safety and functionality must be ensured all the time, enhance their security and reliability through maintenance, inspection, repair and technological renewal. In the case of Tokyo Gate Bridge which was opened to traffic over Tokyo Bay in February, 2012, a bridge monitoring system has been introduced to save labor for maintenance, reduce life cycle costs and analyze deterioration mechanism[7]. On the basis of those data, it is expected to improve management, safety and reliability of other bridges.

(4) Accessible information and communications -- establishment of information exchange systems among disaster prevention agencies (e.g. availability of emergency facilities and personnel), information provision for local residents (e.g. disaster information and evacuation information), and information networks among local residents (e.g. safety confirmation) -- Development and advancement of IoT, ICT and other Internet technologies facilitate information gathering, provision and utilization in an emergency, and increase their reliability. Safety confirmation, which has been done mostly by using a mobile phone individually, tends to be made by e-mail today with lighter communication load. The trend is now shifting toward the use of Internet-based applications and
solutions like message boards and SNS which allow users to make most of immediate one-to-many information sharing.

(5) Promotion of strategic distribution, storage and transportation systems (drinking water/foods/living necessities in reserve, and improvement of stockpile warehouses, transportation bases and transportation systems) Through private-public collaborative campaigns as seen in the distribution of disaster prevention handbooks in Tokyo, awareness of disaster prevention is expected to develop in households and businesses, promoting the storage of emergency stockpiles including drinking water, foods and portable toilets. A suspension of water supply in time of disaster results in shortages of not only drinking water but also water for miscellaneous use necessary for maintaining hygiene. As a large volume of water is required to keep a healthy environment, it is inevitable to make the best possible use of proper water sources such as nearby swimming pools and fire protection water tanks. In this context, water purification technologies like seawater desalination offer hope of turning various types of water sources to practical use, particularly for drinking. In order to provide information about locations and amounts of water sources available in time of emergency, the accessibility to information and communications discussed above in Section (4) is a crucial issue. For transportation strategies to be carried out effectively, the accessibility to information and communications mentioned in (4) is also indispensable.

5. Summary and future issues
Considering the problems encountered, the current situation of Tokyo is analyzed according to the OECD’s Guidelines for Resilience Systems Analysis - How to analyze risk and build a roadmap to resilience, and evaluates and analyses the potential DCM/BCM related continuing risks in future Tokyo, and puts forward corresponding countermeasures and emergency plans. A plenty of detailed information is required in figuring out what needed where, making transportation planning, comprehending transportation routes, and selecting optimum routes. As the post-disaster situation changes with the passage of time, realtime information gathering, analysis and provision are particularly important. A plenty of detailed information is required in figuring out what needed where, making transportation planning, comprehending transportation routes, and selecting optimum routes.

As the post-disaster situation changes with the passage of time, realtime information gathering, analysis and provision are particularly important.

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