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Rethinking a Business Continuity Plan (BCP): What Should Companies Learn from the Great East Japan Earthquake?

—Visualizing disaster risks to reflect in risk dispersion strategies—

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Rethinking a Business Continuity Plan (BCP): What Should Companies Learn from the Great East Japan Earthquake?

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The Great East Japan Earthquake was the first ever instance of a highly networked modern society being struck by a major disaster, with the scale and extent of the damage being far greater than what would be expected. Its effects extended to areas that were not even directly struck by the earthquake.

However, there were many situations where measures taken based on lessons learned from previous earthquakes were effective in mitigating the effects of this disaster, which remind us that it is very important for us to have an attitude of "learning from disasters."

While the Great East Japan Earthquake was of a scale that occurs only once in every 1,000 years, the government has stated that there is an 87 percent probability of an earthquake striking the Tokai region within the next 30 years. In the past, massive multi-segment sequential earthquakes simultaneously striking the Tokai, Tonankai and Nankai regions had occurred every 100 to 150 years, indicating that there is a high probability of major sequential earthquakes occurring in the near future.

Any such sequential earthquakes would seriously affect Japan's pivotal areas supporting production activities. If the corridor connecting the eastern and western regions of the country were to be crippled, there is a good chance that the effects could far outstrip those of the Great East Japan Earthquake.

If these expected earthquakes strike, the disruption of the supply chain and basic infrastructure will present the risk of halting business operations over a wide area even if a company's own facilities are not directly hit.

To reduce such risks, it is necessary to define the regional blocks necessary to ensure business continuity by visualizing the risks involved and look into the way in which facility sites in Japan are rearranged and functions are shared among these blocks, including those in other countries.

I Facts Highlighted by the Great East Japan Earthquake

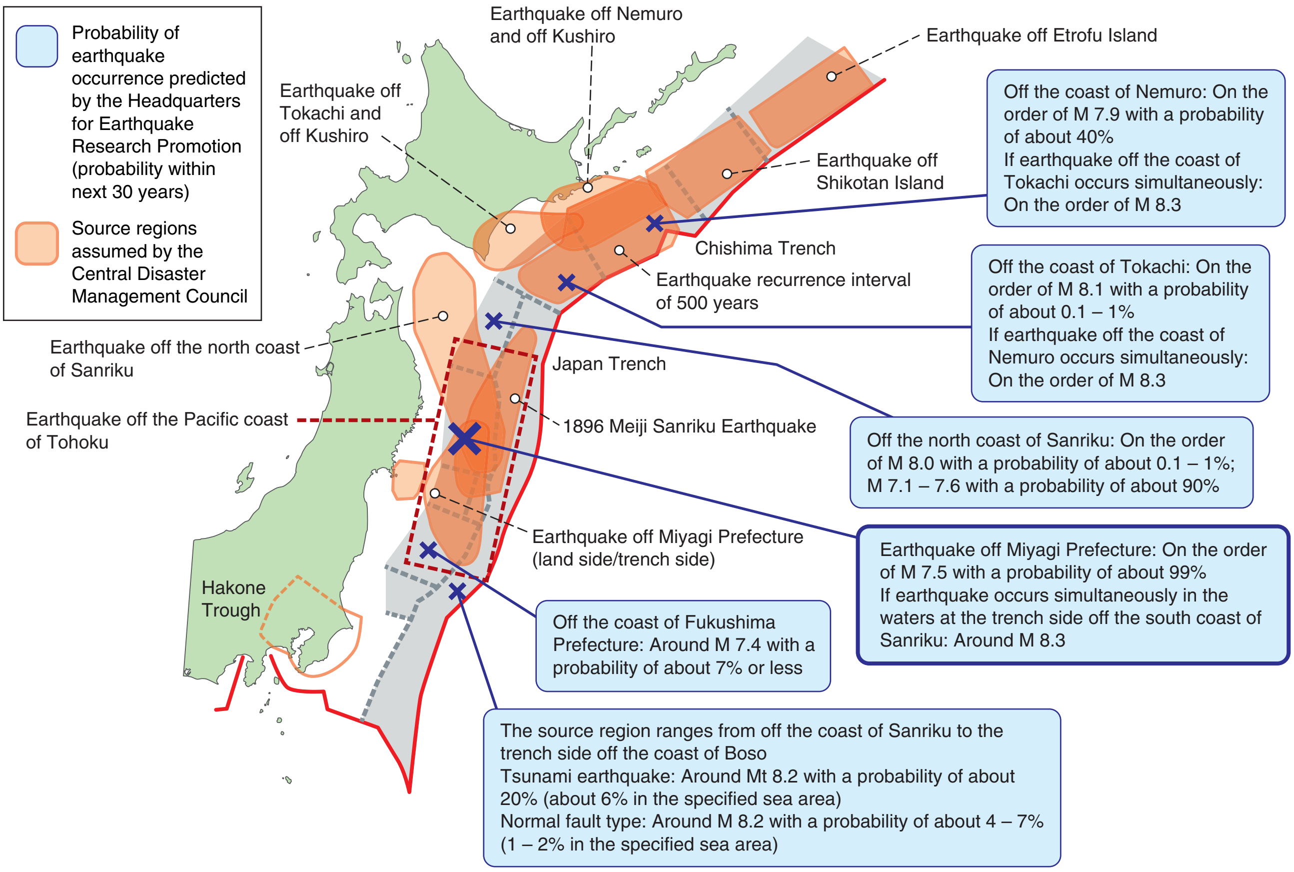
1 The Great East Japan Earthquake was not "unexpected"

The Great East Japan Earthquake, which occurred on March 11, 2011, was the most powerful earthquake to have ever been recorded in Japan, with a magnitude of 9.0. Given its wide-ranging effects such as widespread affected areas, enormous damage from the ensuing tsunami and the shortfall in electrical power caused by the accident at Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station, the term "unexpected" has often been used.

However, the reality was that both the Headquarters for Earthquake Research Promotion (under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology) and the Central Disaster Management Council (under the jurisdiction of the Cabinet Office) had pointed out the possibility of a massive subduction zone earthquake and subsequent tsunami off the Tohoku coastline (Figure 1). For example, prior to the occurrence of the Great East Japan Earthquake, the Headquarters for Earthquake Research Promotion had published a forecast stating a 99-percent probability of an offshore earthquake in Miyagi Prefecture within the next 30 years. Furthermore, within the Central Disaster Management Council, the Committee for Technical Investigation on Countermeasures for the Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches had conducted simulations of earthquake/tsunami scenarios assuming multiple seismic sources in the waters that were identical to those of the source region of the Great East Japan Earthquake. However, in view of the fact that there is no record of any great multi-segment sequential earthquakes similar to that which occurred this time along the Tohoku coastline over the last 1,000 years, the above-mentioned government agencies had not included the area in their studies.

Earthquakes are natural phenomena that have occurred repeatedly throughout our planet's 4.6-billion year history. However, only a tiny portion of this history has been recorded. As such, it must have been realized that there are possibilities for the occurrences of earthquakes that

Figure 1. Probability of earthquake occurrence predicted by the Headquarters for Earthquake Research Promotion and source regions assumed by the Central Disaster Management Council



Notes: M = magnitude, Mt = tsunami magnitude (magnitude is calculated based on the height of tsunami).
Source: Compiled based on "National Seismic Hazard Maps for Japan (2008)" published by the Headquarters for Earthquake Research Promotion and materials published by the Committee for Technical Investigation on Countermeasures for the Subduction Zone Earthquakes in the Vicinity of the Japan and Chishima Trenches, the Central Disaster Management Council.

might inflict damage that exceeds the assumptions made by experts and government officials.

"'Unexpected' has no place in a business strategy." Corporate executives need to recheck the facts revealed by the March 11 earthquake, heighten their awareness to prepare for the expected future large earthquakes and increase their efforts to reduce any related risks.

2 Vulnerability of the networked society is revealed

Even since the beginning of the 20th century, Japan has experienced many subduction zone earthquakes on the order of magnitude 8, not the least of which is the Great Kanto Earthquake of 1923. However, the subduction zone earthquakes that damaged wide areas mostly occurred during the first half of the century. In the second half of the century, near-field earthquakes that caused severe damage only to areas around the source regions were prevalent, as typified by the Great Hanshin-Awaji Earthquake of 1995 (Figure 2).

The Great East Japan Earthquake was Japan's first wide-area major disaster after the country went through its period of post-war high economic growth. This massive earthquake hit northeast Japan at a time when Japanese society has been equipped with modern infrastructure including highly networked transportation, information and communications systems, and supply chain management has gained momentum in pursuit of increasing the efficiency of industrial and economic activities.

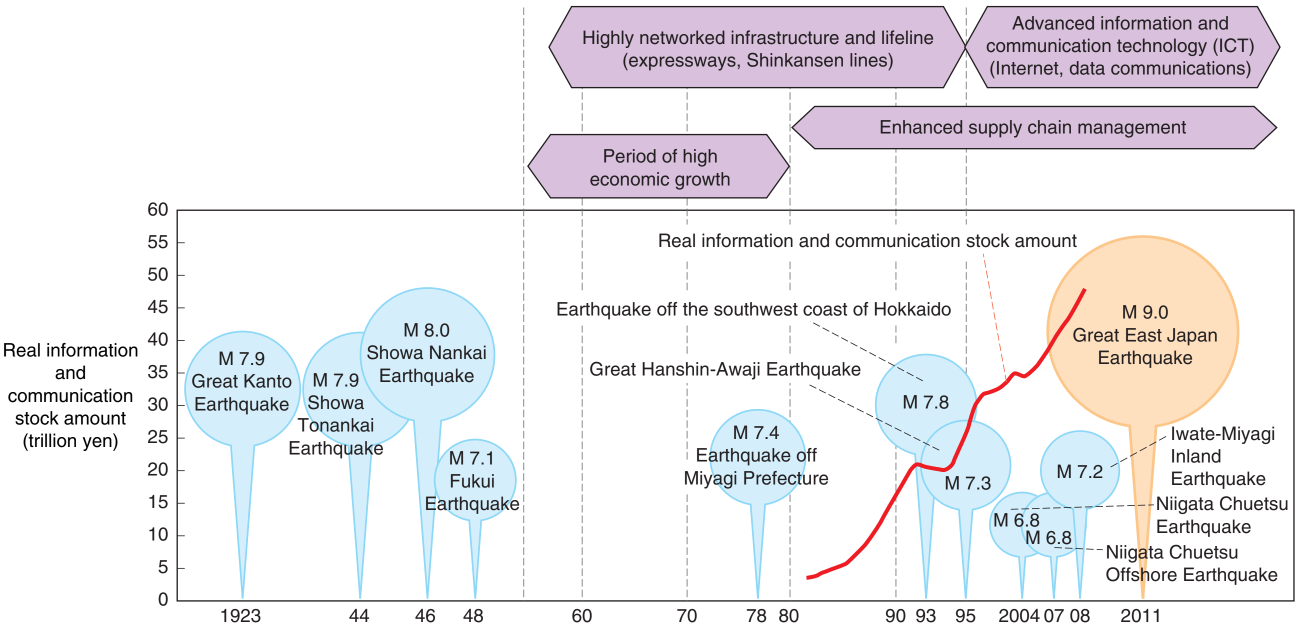
For this reason, large corporations that had been developing their supply chains on a nationwide scale have come to realize the magnitude of the spillover effect that any disaster would have on a highly networked society. The disaster has taught a new lesson that could never be learned from previous major earthquakes.

In particular, the disaster revealed that the Tohoku region has become an important base as part of a vast supply chain because many suppliers of parts and components are located in this region and that any interruption of their supplies could have an influence all over the world. It was also revealed that the structure of the supply chain was not a "mountain type" in which suppliers are located evenly throughout the country. Rather, the supply chain consisted of many "barrels" where suppliers of important parts and components are concentrated in specific locations. One typical example is the case of Renesas Electronics Corporation, which is a manufacturer of automotive semiconductors including microcontrollers. Because of damage inflicted on the company's factories as well as on parts suppliers that are clustered in the Tohoku region, car production in Japan and around the world came to a standstill (Figures 3 and 4).

Particularly hard hit by the effects of the post-disaster production stoppage were those companies characterized by the following four elements, typical examples of which include the automotive and transportation machinery industries.

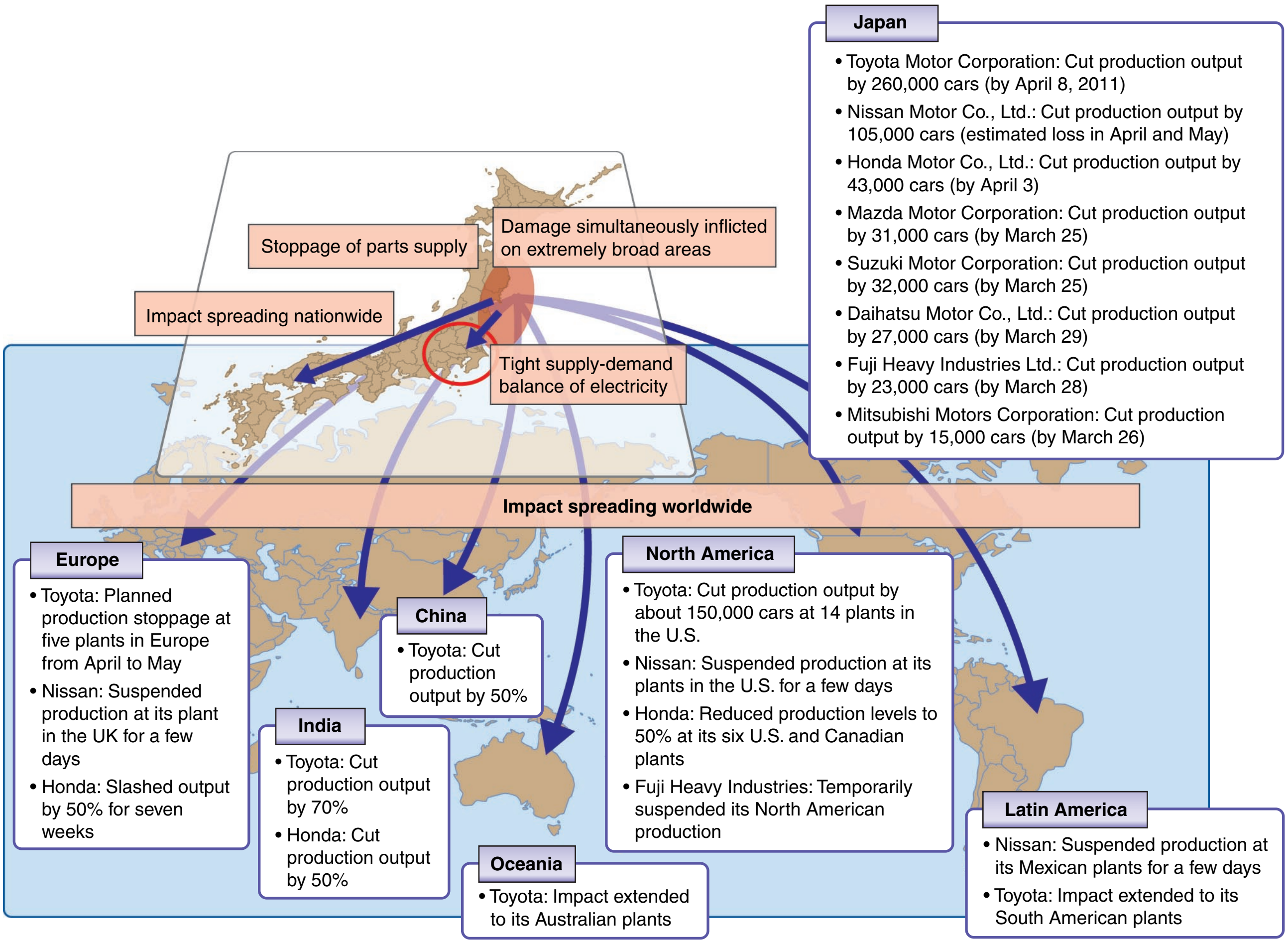
(1) There are no alternative production facilities
(2) Inventories are reduced to a bare minimum through "just in time" supply systems
(3) The supply chain hierarchy is deep and complex, with second- and even third-tier subcontractors
(4) There is a high degree of dependence on suppliers producing special parts and having special technologies

Figure 2. Major destructive earthquakes in Japan during and after the 20th Century



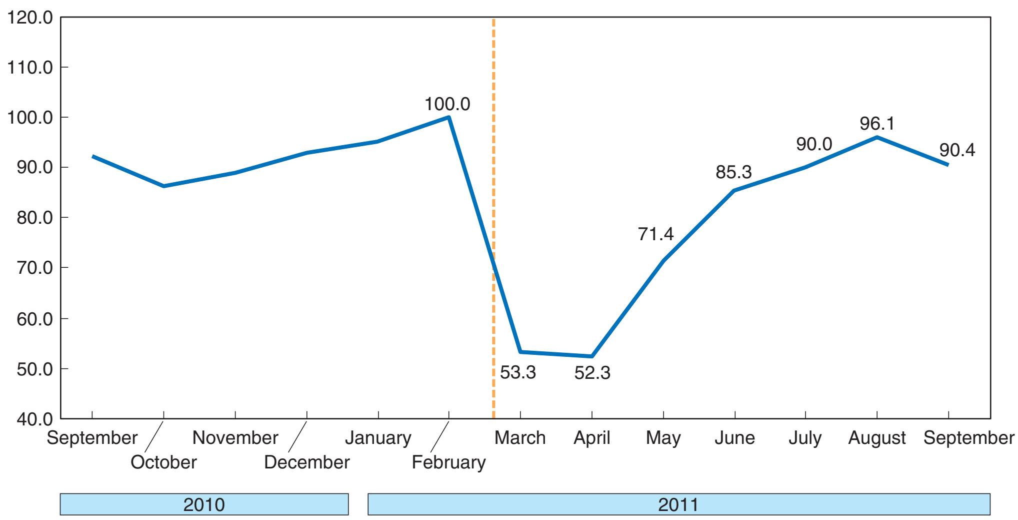
Source: Compiled based on Usami, T., "*Saishinban Nihon Higai Jishin Soran 416 – 2001* (Comprehensive List of Destructive Earthquakes in Japan 416 – 2001)," University of Tokyo Press, 2003.

Figure 3. Major impact of supply chain disruptions on the automotive industry



Source: Compiled based on various news articles and the website of each company.

Figure 4. Change in output of the transport machinery industry



Note: Monthly output was calculated by regarding the base year (2005) average as 100.
Source: "Current Survey of Production" published by the Ministry of Economy, Trade and Industry.

Furthermore, it took a full two weeks to simply attempt to understand the structure of the supply chain after the disaster, which further delayed recovery efforts. Because of this, the corporate executives of large companies have become deeply aware of the importance of fully and deeply understanding the structures of their supply chains. In order to prepare for major sequential earthquakes that are expected to occur, they are making efforts to understand the structures of their supply chains and are strengthening their database management during normal times before any disaster occurs.

3 Importance of learning from past disasters is re-recognized

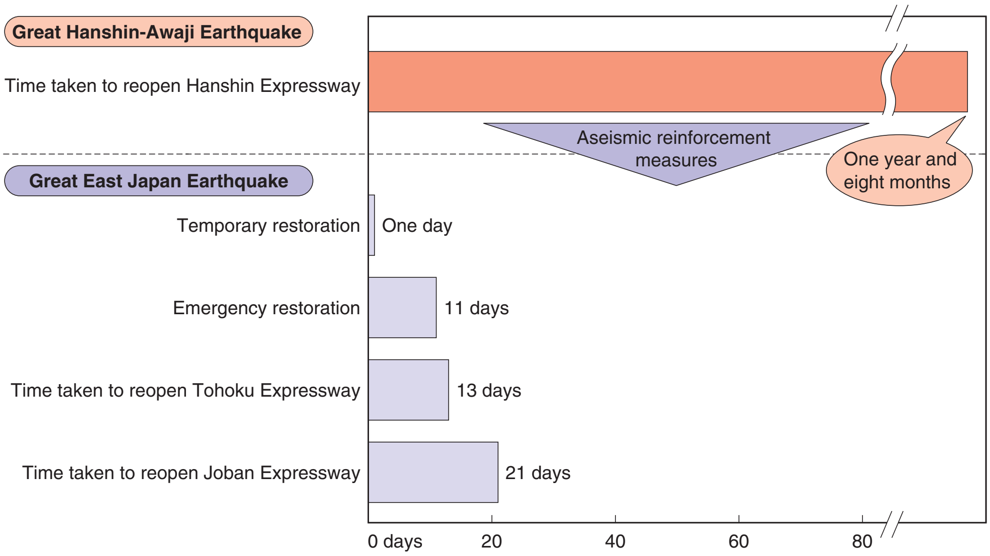
The Great East Japan Earthquake also revealed cases in which damage was minimized thanks to the improved seismic resistance of buildings and facilities as well as steady progress in hardware technologies that had come about based on the experience gained from the Great Hanshin-Awaji Earthquake and the 2004 Niigata Chuetsu Earthquake. At the same time, there were also many cases where the improved genba-ryoku (the strengths of field sites) was effective in reducing damage.

For example, a look at transportation infrastructure and facilities shows that the Tohoku Expressway suffered no major damage such as collapsing bridges, and was reopened to the public 13 days after the earthquake (Figure 5). All trains running on the Tohoku Shinkansen lines were safely brought to a stop, without a single train derailment.

Kurihara Central Hospital is located in Kurihara City, Miyagi Prefecture, where a seismic intensity of 7 was observed. However, thanks to the building's seismically isolated structure, the hospital suffered no damage and was able to continue operation in the same way as it did when it survived the 2008 Iwate-Miyagi Inland Earthquake.

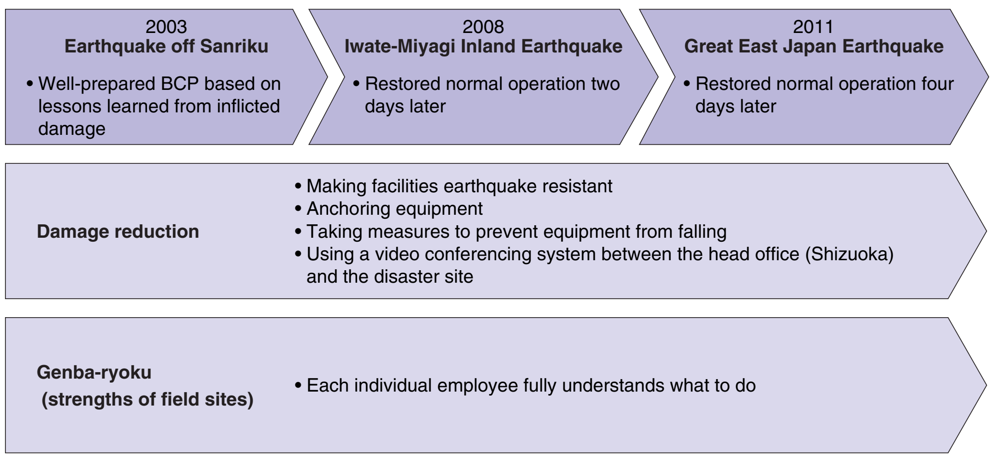
Company A, which is a manufacturer that has its final assembly plant in Iwate Prefecture, had taken its past experience with earthquakes to devise various ideas and strengthen its employee training so as to hasten its recovery. Because of this preparedness, the company was able to restore its production environment on March 15, a mere four days after the earthquake struck (Figure 6).

Figure 5. Comparison of speed at which expressways were restored



Source: Compiled based on materials published by the Road Bureau of the Ministry of Land, Infrastructure, Transport and Tourism and various sources of information such as Nikkei newspapers.

Figure 6. Manufacturer A's efforts to reduce damage and recovery results



Note: BCP = business continuity plan.

However, because the supply of parts had dried up, it was not actually able to restart production until April 18.

As well as the safety, disaster preparedness and resilience of Japan's social infrastructure and facilities once again being internationally recognized, the importance of learning from past earthquakes has been reconfirmed.

On the other hand, the wide-ranging impact of infrastructure failures, as typified by supply chain disruptions and a shortfall in electrical power, points to the inadequacy of conventional business continuity plans (BCP) that have aimed at making a company's important management resources earthquake resistant and at enhancing genba-ryoku (the strengths of field sites).

II Impact of Expected Major Multi-segment Sequential Earthquakes

1 Major sequential earthquakes are sure to occur in the near future

The Great East Japan Earthquake is said to be an unprecedented event that happens only once every 1,000 years. On the Pacific side of western Japan, however, series of sequential earthquakes similar to this massive earthquake have occurred every 100 to 150 years (Figure 7).

There have been no major sequential earthquakes in this region since the Showa Tonankai Earthquake of 1944 and the Showa Nankai Earthquake of 1946, almost 70 years ago. Given that there has been no major subduction zone earthquake in Suruga Bay in 157 years (as of 2011), since the Ansei Tokai Earthquake of 1854, it is said that major sequential earthquakes can happen at any time in the near future. According to the Headquarters for Earthquake Research Promotion, the probability of a major earthquake occurring during the next 30 years is 87 percent for the Tokai region, 60 – 70 percent for the Tonankai region and 60 percent for the Nankai region.

Against this background, in 2001, the Central Disaster Management Council established the Committee for Technical Investigation on Countermeasures for the Tokai Earthquake and the Committee for Technical Investigation on Countermeasures for the Tonankai and Nankai Earthquakes to strengthen measures to be taken in preparation for major sequential earthquakes by estimating the damage likely to be caused. Based on the lessons learned from the Great East Japan Earthquake, studies have also been started that extend the range of the potential source of any such earthquake in the direction of Hyuganada off the coast of Miyazaki Prefecture. By around the spring of 2012, the distribution of seismic intensities and tsunami height data are scheduled for review.

2 Damage will affect extremely broad areas and sever Japan's main corridor

(1) Broad areas will be simultaneously affected by shaking, liquefaction and tsunami

A characteristic of major sequential earthquakes such as a Tokai earthquake is that they inflict massive damage over very wide areas.

The size of the affected areas would be so large as to include the Chubu region, which is Japan's largest production center, as well as the entire Pacific Ocean belt zone (Figure 8).

Relative to the Great East Japan Earthquake, seismic sources would be very close to land areas and catastrophic damage would be caused by shaking, liquefaction and tsunami occurring simultaneously over broad areas primarily in the Pacific coastal regions.

In addition, tsunami could reach land very quickly. Based on a simulation by the Central Disaster Management Council, in some areas, the first tsunami waves would make landfall only a few minutes after an earthquake occurred.

(2) Production facilities would be severely damaged

The Chubu region, which is Japan's largest production center, is expected to be seriously affected.

The four fields of the manufacturing industry in the Chubu region, which are transport equipment, iron and steel products, precision machinery and petroleum and coal products, together generate about 26 trillion yen annually (about 26 percent of the nationwide total), or about ten times that of the Tohoku region (about 2.6 trillion yen) (Figure 9).

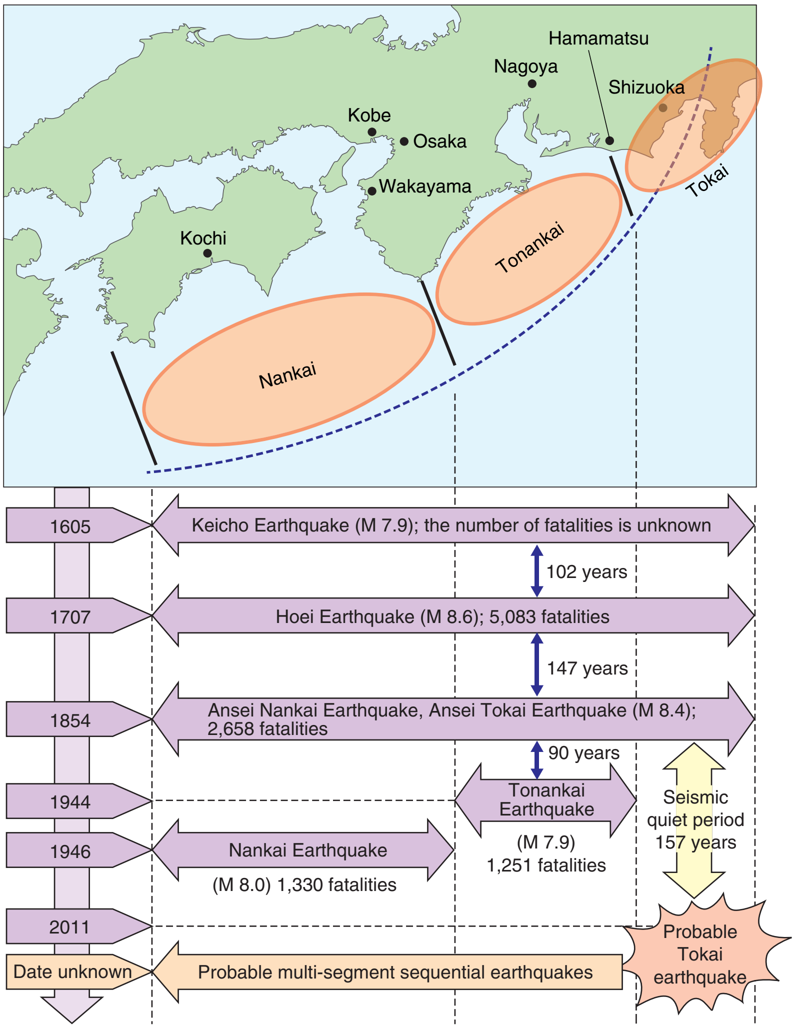
In particular, in the case of the automotive industry (which falls in the field of transport equipment), a large company's head office, its production facilities and diverse suppliers that support its production are clustered in this region. The Great East Japan Earthquake was characterized by the knock-on effects of supply chain disruptions. However, major sequential earthquakes such as a Tokai earthquake could well cripple a head office, production facilities and the supply chain simultaneously, with an impact that would far outweigh that of the Great East Japan Earthquake.

(3) Disruption of the core functions of Tokyo, Osaka and Nagoya

It has also been predicted that long-period ground motions more than twice those observed in the Great East Japan Earthquake would likely occur.

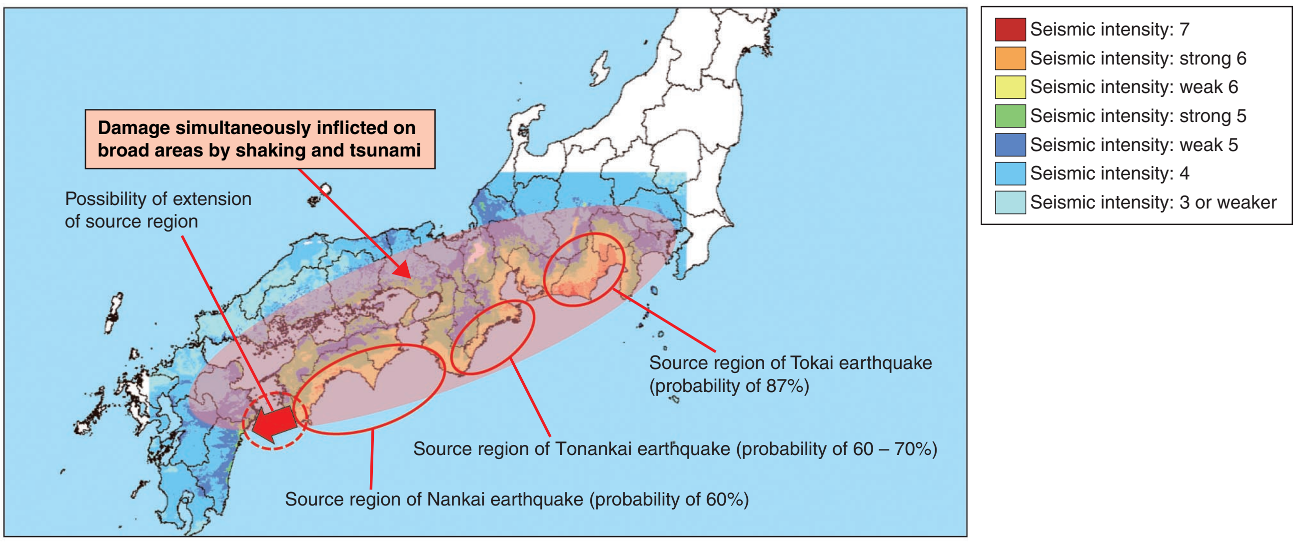
Long-period ground motions are slow shakings with a period of 2 to 20 seconds and are characterized by large amplitudes and long durations. This kind of shaking travels much further than usual primary waves (P waves) and secondary waves (S waves) that have an effect on ordinary low-rise buildings such as houses, penetrating into the thick sedimentary layers, where it

Figure 7. History of earthquakes in the Tokai, Tonankai and Nankai regions



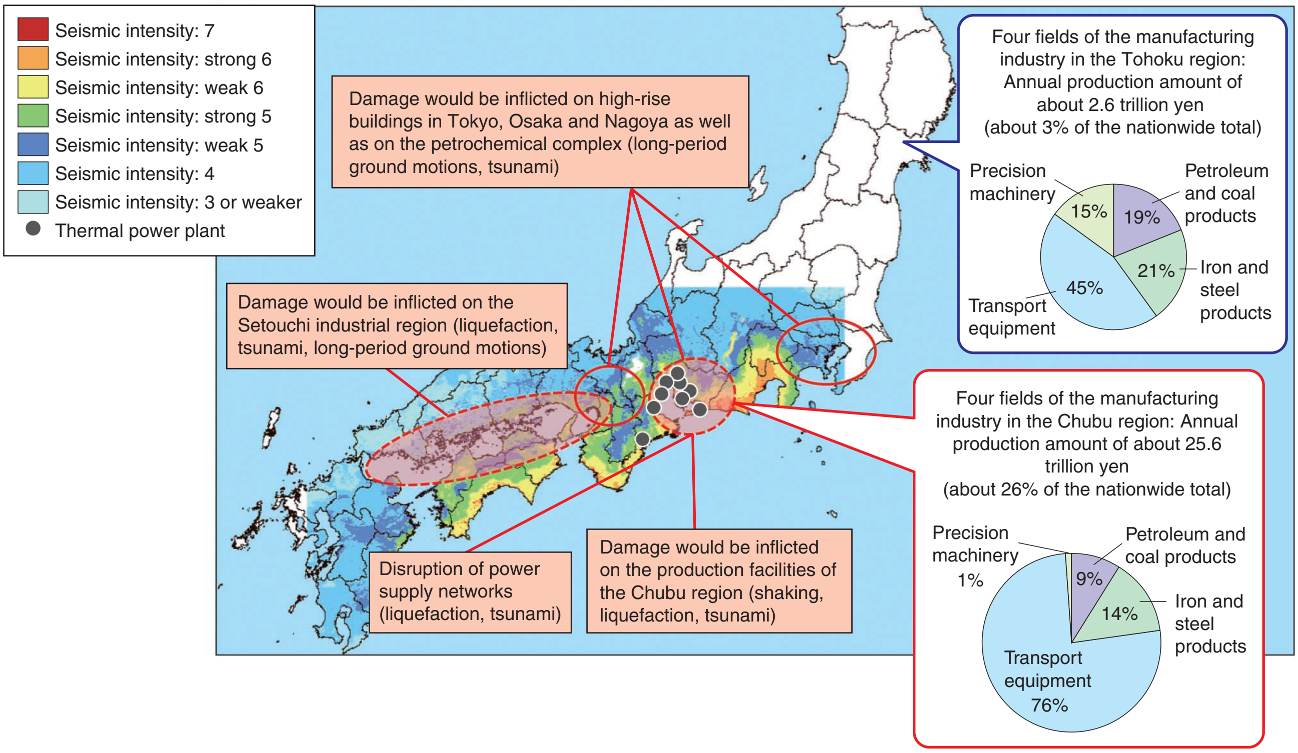
Source: Compiled based on Usami, T., "*Saishinban Nihon Higai Jishin Soran 416 – 2001* (Comprehensive List of Destructive Earthquakes in Japan 416 – 2001)," University of Tokyo Press, 2003.

Figure 8. Source regions of and areas to be affected by Tokai, Tonankai and Nankai earthquakes—damage to be simultaneously inflicted on broad areas by shaking, liquefaction and tsunami



Source: Seismic intensities are based on material published by the Central Disaster Management Council and probabilities are based on material published by the Headquarters for Earthquake Research Promotion.

Figure 9. Production facilities clustered in the Pacific Ocean belt zone would be simultaneously affected



Source: Material published on the website of the Federation of Electric Power Companies of Japan (FEPC) was used to indicate the locations of thermal power plants and "2005 Inter-Regional Input-Output Table" published by the Ministry of Economy, Trade and Industry was used for annual production amounts.

causes large back and forth motions that continue for a long time.

The three major cities of Tokyo, Osaka and Nagoya are all located on top of these sedimentary layers, and feature dense concentrations of skyscrapers and condominiums, with large-scale petrochemical complexes built along the coastline.

Because the natural period of these large-scale structures is relatively long compared to that of ordinary buildings, the structures are very susceptible to resonating with long-period ground motions. The motions that occurred during the Great East Japan Earthquake bent the uppermost part of Tokyo Tower, while fires broke out in oil tanks. Furthermore, Kogakuin University in Shinjuku, Tokyo and the Sakishima Building of the Osaka Prefectural Government suffered damage such as cracks in their walls and stalled elevators.

The Great East Japan Earthquake, the seismic source of which was several hundred kilometers from Tokyo and Osaka, did not cause any serious long-period ground motions. Nevertheless, Tokyo's transportation infrastructure came to a standstill on the day of the earthquake, leading to major confusion on the roads and massive traffic jams (Figure 10).

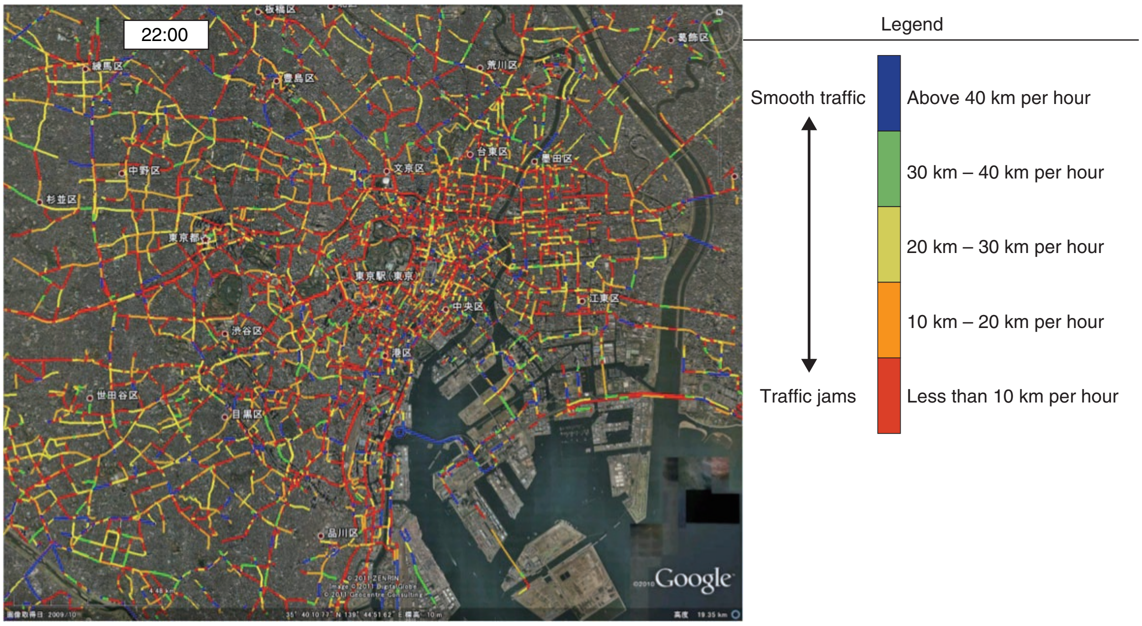
Because the source regions of major sequential earthquakes such as a Tokai earthquake are no more than 100 km from Tokyo, Nagoya and Osaka, any serious, long-period ground motions will not only affect high-rise buildings in these large cities, but could also damage other large-scale structures such as the petrochemical complexes scattered along the coast and the thermal power plants that are concentrated in the coastal areas of Ise Bay.

(4) Severing of the country's main corridor

The coastal areas of Shizuoka Prefecture are located directly above the source region of a Tokai earthquake. Therefore, in all these areas, the strength of the earthquake is likely to reach an intensity of strong 6 or 7 while the ensuing tsunami would probably be at least 10 m high. The Tomei Expressway and the Tokaido Shinkansen line, which together constitute the main arterial corridor of the country, run through these areas that would be severely affected by an earthquake and across major rivers such as the Tenryu River, Oi River and Fuji River (Figure 11).

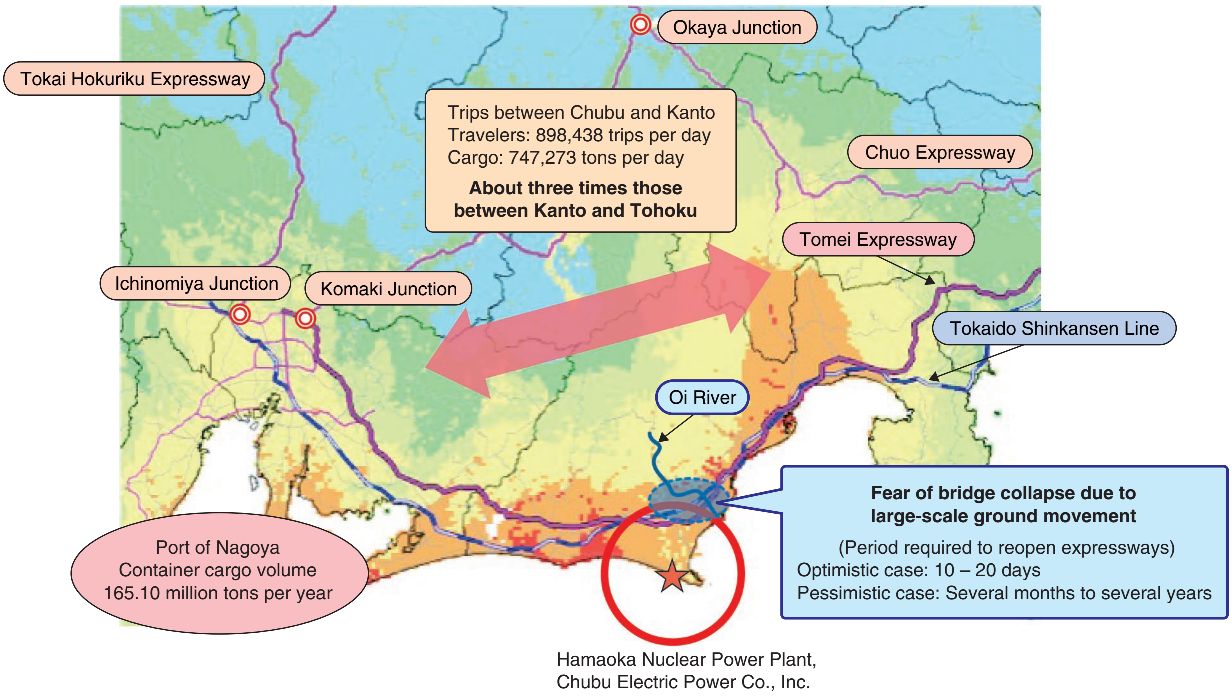
Since the Great Hanshin-Awaji Earthquake, bridges have been seismically retrofitted and have not suffered any major damage by subsequent earthquakes. However, if there were large-scale movement of the ground in and around the estuary zones, bridges could be displaced or even collapse, leading to the possibility of long-term closures. In addition, because both the road and rail lines are no more than 20 km from the Hamaoka nuclear power plant of Chubu Electric Power Co., Inc. in Omaezaki, an accident similar to that at the Fukushima Dai-Ichi and Dai-Ni nuclear plants could lead to long-term closures of these transport links.

Figure 10. Traffic congestion in central Tokyo on the day of the Great East Japan Earthquake



Source: Compiled based on probe traffic information gathered by NRI's Ubiqlink Department.

Figure 11. Severing of the country's main corridor



Source: Compiled based on "2005 Inter-regional Travel Survey," "2005 Survey on the National Net Cargo Flow" and "Annual Report on Port Statistics 2009" published by the Ministry of Land, Infrastructure, Transport and Tourism.

Furthermore, if aftershocks were to continue for many weeks as they did after the Great East Japan Earthquake, presenting the risk of tsunami, there is the danger that the ports of Nagoya and Osaka could suffer long-term closures.

As such, if this land and sea transport corridor were to be severed for a long time, the country would essentially be separated into several broad blocks and these blocks would be isolated from each other.

III Promoting the Relocation of Facilities by Visualizing Risks

1 Awareness of risks changes management's crisis responsiveness

According to the Nihon Keizai Shimbun (Nikkei) newspaper of July 11, 2011, Suzuki Motor Corporation is planning to move its Motorcycle Technical Center, which is engaged in the development and design of motorcycles and is currently located in Iwata City, Shizuoka, as well as its head-office departments related to electric car development and motorcycle engine production, which are currently located in the lowlands of Hamamatsu, to a high elevation north of Hamamatsu. Given that the current facilities are located on the Pacific coast, Suzuki has long worried about the possibility of damage that would be caused by tsunami triggered by a Tokai earthquake.

Since the occurrence of the Great East Japan Earthquake, company stakeholders including customers and shareholders have become much more concerned with a company's BCP. Because of such increased interest, on occasions such as at annual shareholders meetings, corporate executives are required to give clear explanations of their plans for dealing with major disasters. It is very likely that those suppliers that make up the supply chain will also be required by a customer company to strengthen their risk mitigation measures as a prerequisite for continuing business transactions with the customer company. Actually, some companies have already begun to evaluate the risks associated with supplier facilities. As a result of this risk assessment, they are creating guidelines on disaster preparedness measures that are found to be necessary for each supplier facility.

As such, the author believes that corporate executives have come to a point where they cannot avoid making decisions for investing in disaster preparedness measures in order to ensure business continuity.

2 Expected major multi-segment sequential earthquakes will bring about a paradigm shift

Expected major multi-segment sequential earthquakes such as a Tokai earthquake will bring about a paradigm shift in a company's conventional thinking related to risk mitigation measures (Table 1).

(1) Strengthening virtual functions that do not rely on a prerequisite of assembling personnel

In the case of earthquakes that occurred in the past, head-office functions in Tokyo, Osaka and Nagoya remained unaffected. Therefore, it was possible to assemble personnel in the head office, where recovery measures were taken for local disaster-hit companies under the supervision of the headquarters for disaster response. However, major sequential earthquakes will present the first ever instance of a head office being struck by an earthquake. Stalled transportation will mean that it is difficult for personnel to reach their offices. Even in such a situation, recovery measures must be taken for disaster-stricken production facilities and business continuity must be ensured. In such a case, virtual response strategies that make effective use of information and communications infrastructure will become more important, which do not necessarily require personnel to physically reach the head office.

(2) Ultra-wide area dispersion

The steel, machinery and petrochemical industries that have supported Japan's high economic growth are all characterized by large-scale production facilities clustered along the Pacific Ocean belt zone. However, expected major sequential earthquakes including a Tokai earthquake could easily strike the Chubu, Kinki and Setuchi regions simultaneously.

Major financial institutions often have their head offices and data centers in Tokyo, with backup facilities in Osaka. With the occurrence of any long-period ground motions or liquefaction, however, it can be assumed that Tokyo and Osaka would be affected simultaneously.

Considering the possibility of a disaster striking such very broad areas on the Pacific Ocean side, causing major damage to both Tokyo and Osaka, there is a need to consider the Japan Sea side of the country and even overseas as possible sites for ultra-wide area dispersion.

Table 1. A paradigm shift to be brought about by expected major sequential earthquakes such as a Tokai earthquake

	Conventional paradigm	Paradigm assuming major sequential earthquakes		
Head office	Head office (in Tokyo) where personnel are assembled provides supervision for recovery activities (in Tohoku)	An earthquake strikes the head office and it is difficult to assemble personnel there; the head office will no longer be able to function as planned	▶	Strengthening virtual functions that do not rely on assembling personnel
Space	Production facilities are dispersed along the Pacific Ocean belt zone	Damage would be inflicted on ultra-wide areas	▶	Ultra-wide area dispersion (including overseas sites)
	A data center and a backup data center are located at two different sites (Tokyo and Osaka)	Both Tokyo and Osaka would be affected simultaneously; network disruption	▶	
Network	A supply chain stretches out along the length of the country	The country's main corridor would be severed	▶	Functional integration to achieve self-reliance and independence in each regional block

(3) Functional integration to achieve self-reliance and independence in each regional block

Japan's production functions were developed in regions where there was vast and inexpensive land and where a workforce was available. As a result, Japan created a massive supply chain that stretched out along the length of the country. However, this configuration would be easily disrupted by any partitioning of the country. To minimize the impact if the country were to be partitioned, individual regional blocks might have to be self-reliant in the future.

In fact, in light of Tokyo's transportation infrastructure being crippled in the wake of the Great East Japan Earthquake, Company B, a manufacturer with its head office in Tokyo and production facilities located throughout the country, has started to look into the following measures in order to steer away from assembling personnel in its Tokyo head office for the supervision of recovery activities and to ensure business continuity.

(1) Maintaining secondary and tertiary head-office functions and facilities
(2) Establishing a virtual disaster response headquarters by making greater use of video conferencing systems
(3) Installing radio equipment and satellite mobile phones in the homes of key personnel
(4) Delegating considerable authority to each of the production sites

Similarly, in preparation for a major earthquake in the Tokai region, Company C, a financial institution with its head office in the Chubu region, has set up separate data centers in the Chubu and Kanto regions. However, because large-scale liquefaction occurred in Urayasu, Chiba Prefecture, about 400 km away from the source area of the Great East Japan Earthquake, the company has started to look into the possibility of moving the data center located in Kanto to another region.

3 Defining blocks to ensure business continuity

(1) Limitations of conventional BCPs in which a company's own offices are positioned as main locations for recovery activities

① Strengthening earthquake resistance and enhancing genba-ryoku (the strengths of field production sites)

In the case of a near-field earthquake with a focus directly under a populated area (as happened in the case of the Hanshin-Awaji Earthquake), as symbolized by the term "zone of seismic intensity 7," extremely severe damage is inflicted on a relatively small area. For example, Kobe Steel, Ltd. completely lost its head office in Kobe and suffered major damage to its blast furnaces, leading to major losses for the company. The most valuable lesson learned from the Hanshin-Awaji Earthquake was the importance of clearly identifying a company's most important resources such as its head office and core factories and making such facilities earthquake resistant. Based on the experience gained from this earthquake, the Japanese government reviewed the seismic design criteria for important structures. At the same time, progress has been made in earthquake resistance, seismic isolation and damping technologies.

The Niigata Chuetsu Earthquake of 2004 and the Niigata Chuetsu Offshore Earthquake of 2007 have provided manufacturing industries with the opportunity to introduce a BCP. The Niigata Chuetsu Earthquake caused damage exceeding 50 billion yen to the semiconductor factory of a subsidiary of Sanyo Electric Co., Ltd, Niigata Sanyo Electric Co., Ltd. (now Sanyo Semiconductor Manufacturing Co., Ltd.). The Niigata Chuetsu Offshore Earthquake that struck three years later featured extremely severe tremors in Kashiwazaki, where Riken Corporation had two factories, both of which were affected by the earthquake, leading to the halting of the manufacture of piston rings that are indispensable in the production of automobiles. This time, however, immediately after the earthquake, the automotive industry collectively rallied to make an all-out effort to provide support for restoring the facilities so that production was only stopped for four days. This event again caused companies to realize the importance of genba-ryoku (the strengths of field production sites) to the early recovery from a disaster.

② Factories of secondary suppliers were in a blind spot

The effects of the Great East Japan Earthquake far eclipsed the damage done by the two above-mentioned earthquakes, with many of the factories that produced parts and components for the manufacturing industry being simultaneously affected. Given that a car is an assembly of about 30,000 parts and components, it is easy to understand that the automotive industry features huge, complex and multi-layered supply chains. The Great East Japan Earthquake affected somewhere between several hundred to more than a thousand component factories. In particular, the factories producing microcomputers, rubber for brakes, paint pigments and chemical materials used for secondary materials (consumables used in the manufacturing process such as lubricating oil) often constitute a single source with no alternative factories available. The lack of alternative factories became a bottleneck and prevented the resumption of car production for about one month, with full recovery taking about two more months. This situation clearly exposed the limitations of a conventional BCP that considers a company's own offices as principal locations for recovery activities.

(2) Visualizing risks in the supply chain in defining blocks to ensure business continuity

To prepare for future disasters that are expected to have wide-ranging effects, it is not sufficient merely to understand the makeup of the supply chain. Rather, the diverse impacts that an earthquake would have on the production facility sites of suppliers must be analyzed and evaluated. These impacts include the shaking, liquefaction and tsunami that accompany an earthquake, the severing of social infrastructure such as utility supplies (electricity, gas and water) and the transportation network, and any accidents involving nuclear power plants and other facilities where toxic gas and hazardous materials are stored and handled. Through such assessment, it is important to estimate the risks of fragmenting the entire supply chain and visualize where bottlenecks are likely to occur before creating any plan or strategy (Table 2). For risk visualization, the use of the Geographic Information System (GIS) is effective (Figure 12).

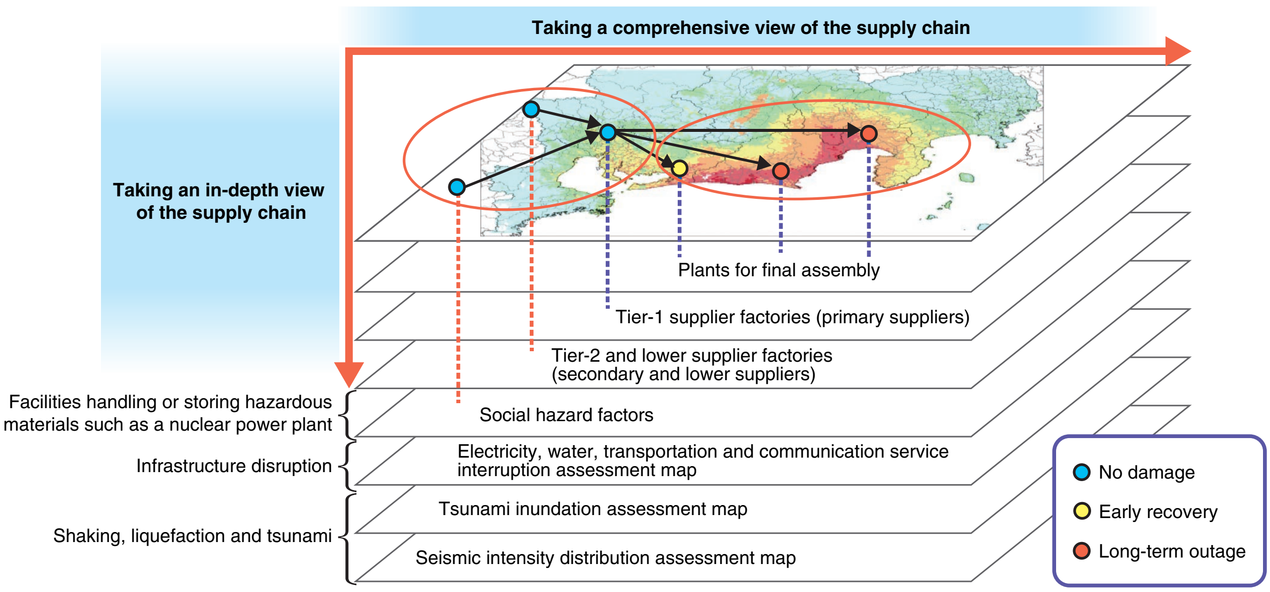
In creating a multi-layer database containing a wide range of information, such information is overlaid to assess the risks facing each supplier production site. Such a database makes it possible to visualize risks, distinguish between those areas that will be affected by a disaster and those which will escape, and define blocks that are appropriate to ensure business continuity (Figure 13).

In the past, it had been assumed that it was impossible to fully understand the structure of the supply chain, given that it has so many layers. In the wake of the Great East Japan Earthquake, however, many automobile and precision machinery manufacturers have started their efforts to identify the structure of the supply chain and visualize the risks involved. Their efforts are considered to be prompted by recognition of the fact that after the Great East Japan Earthquake, it took about two weeks to identify the bottlenecks in the supply chain, which expanded the range of affected business activities. In addition, because major sequential earthquakes such as a Tokai earthquake are expected to strike a company's head office and factories, response measures that rely on genba-ryoku (the strengths of field production sites), which were effective for recovery from the Great East Japan Earthquake, will likely no longer be effective.

Table 2. Viewpoints involved in visualizing risks facing the supply chain

	Viewpoints that have not yet been fully examined
Identifying SCM (supply chain management) resources	Identifying the resources involved in the entire supply chain, ranging from the procurement of materials and parts to manufacture, logistics and sales
	▼
Damage inflicted on SCM resources	Selecting a seismic hazard scenario and determining the range of resources that would be affected by shaking and tsunami
Social infrastructure	Analyzing and assessing the range of social infrastructure (electricity, water and sewage, roads, ports, airports, etc.) that would be affected and the time required for restoration
Location environment	Evaluating the location environment to see if there are facilities where hazardous materials are handled or stored, such as a nuclear power plant, that might influence business activities, and determining the range of influence

Figure 12. Using the geographic information system (GIS) to overlay information on risks facing the supply chain



(3) Making use of visualized risks in establishing a location strategy

If it is possible to identify the areas that would not be affected by a disaster through the visualization of risks involved in the supply chain, a company would be able to devise a specific location strategy that would allow the company to continue its operation even if the country were to be split into separate blocks as a result of major sequential earthquakes.

Although the direction of any location strategy depends on the characteristics of each industry and each company, there are basically two approaches, as follows.

(1) Promoting functional integration to achieve complete self-reliance and independence in each block
(2) Spreading redundant functions among blocks and improving cooperation among them

① Promoting functional integration to achieve complete self-reliance and independence in each block

This approach aims to promote functional integration to achieve complete self-reliance and independence in each regional block so that business continuity can be ensured even if the country were to be essentially split into separate blocks by a major disaster (Figure 14).

Manufacturer D, in order to have its third domestic production site in Tohoku in addition to its production facilities in Chubu and Kyushu, has started talks with its two affiliates that have production facilities in Tohoku to make them the company's wholly owned subsidiaries. The company made this decision based on its belief that further strengthening a trilateral domestic production system and increasing the degree of self-reliance within each regional block would eventually further improve Japan's manufacturing competitiveness. At the same time, in light of the experience gained from the Great East Japan Earthquake, the company's decision is assumed to reflect its intention to prepare for expected massive sequential earthquakes.

Since before the Great East Japan Earthquake, Company E, a major beverage manufacturer, has adopted a business strategy that stresses the freshness of its products by locating production factories very close to the markets where they are consumed. Based on this strategy, production facilities have been dispersed throughout the country, such that the recent earthquake had very

Figure 13. Concept of the definition of blocks to ensure business continuity based on visualized supply chain risks

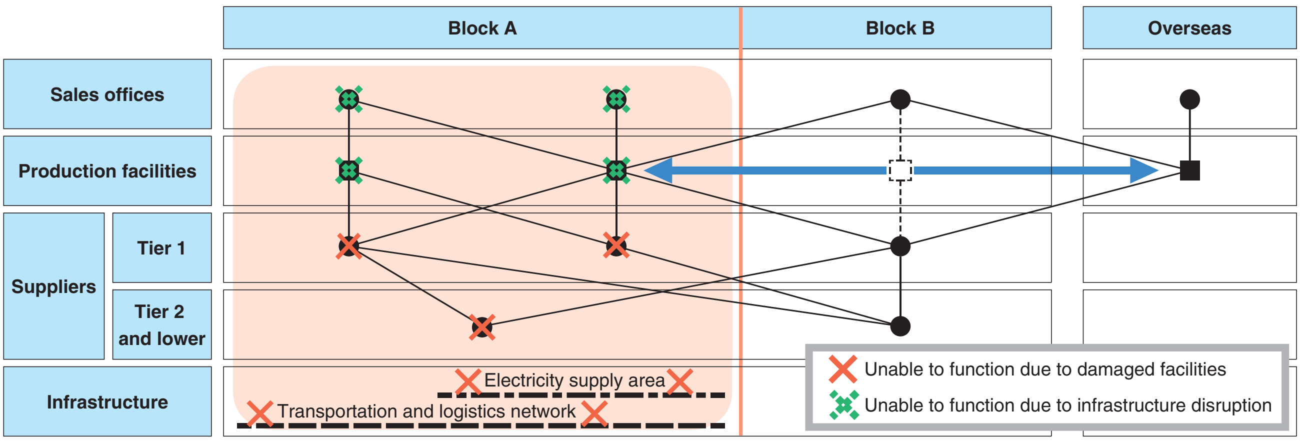
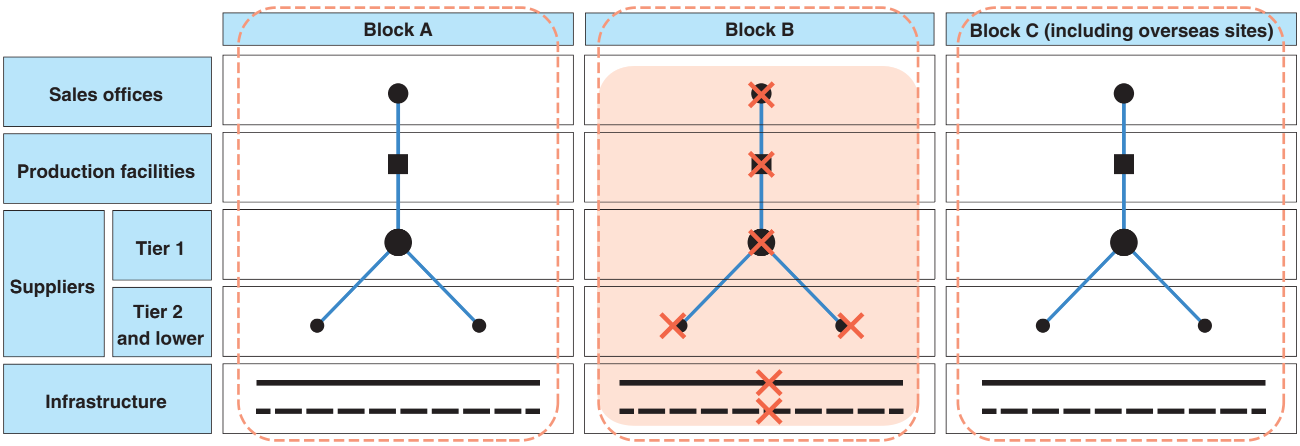


Figure 14. Supply chain risk mitigation pattern through functional integration to achieve complete self-reliance



limited effect on the company's business operations. A similar trend can be seen in the entire grocery industry. Statistical data clearly show that the effect of the earthquake on this industry was relatively minor (Figure 15).

② Spreading redundant functions among blocks and improving cooperation among them

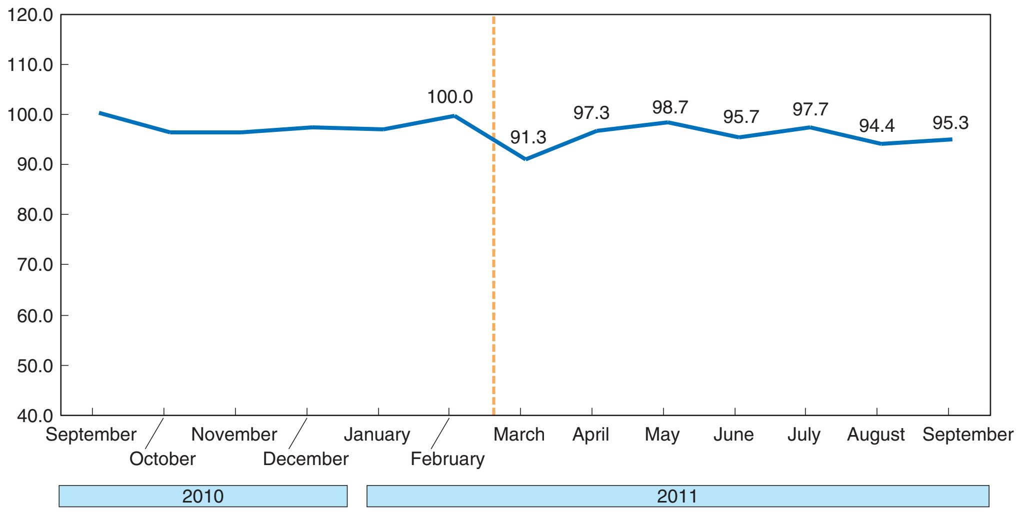
While an approach of promoting functional integration to achieve complete self-reliance in each block is seen as an ideal way of dispersing the risks associated with earthquakes, this approach requires a certain degree of demand in order to justify production levels. Similarly, to establish local production facilities in the same way as Beverage Manufacturer E, there must be sufficient demand from the local market. Therefore, many companies are seeking to diversify their risks by promoting the sharing of redundant functions and cooperation among blocks including overseas sites (Figure 16).

Having learned from the Great East Japan Earthquake, Manufacturer F has been acting to establish a complementary relationship for production with an overseas company so that Manufacturer F can continue production even if its production facilities are affected. Furthermore, in addition to its component factory located in the Kanto region, the company has a plan to open a factory in the Kinki region to supply the same parts.

Since the occurrence of the Hanshin-Awaji Earthquake, Manufacturer G has been promoting domestic and overseas dispersion of its production facilities. At the same time, the company has been reviewing parts inventories, increasing its stocks of general-purpose parts and standardizing special-order parts from the design stage to the maximum extent possible in order to enable switching production to a domestic factory in another block or to an overseas factory.

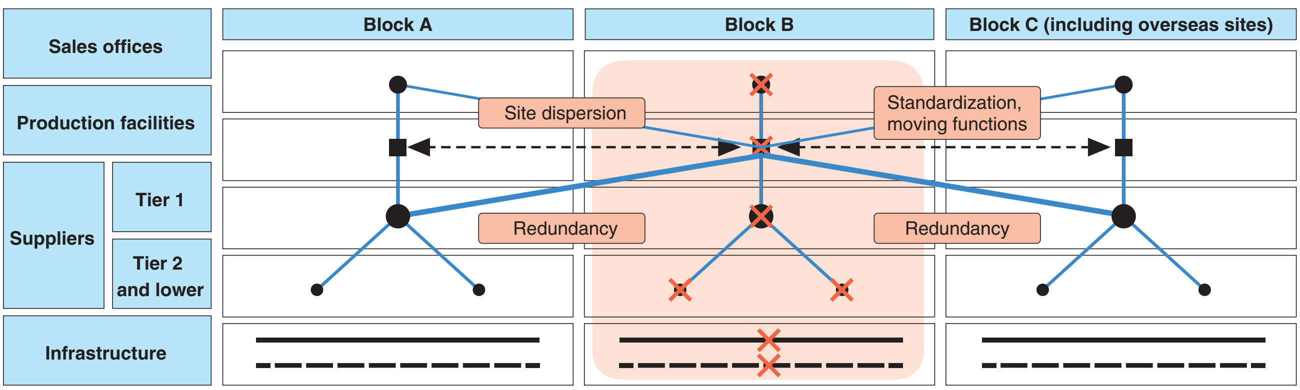
Manufacturer H has a string of large-scale production factories along the Pacific Ocean belt zone. Because the necessary investment associated with relocating its facilities or establishing new sites is huge and this solution is impracticable, the company has been improving the earthquake-and flood-resistance of its factory buildings and production equipment. The company has also started to look into the possibility of sharing functions between its existing sites.

Figure 15. Change in production output in the grocery industry



Note: Monthly production output is calculated by regarding the output in the base year (2005) as 100.
Source: "Current Survey of Production" published by the Ministry of Economy, Trade and Industry.

Figure 16. Risk mitigation pattern through the sharing of redundant functions among blocks and cooperation among them



A director who is responsible for procurement at Manufacturer I, whose production volume is not so large, considers that rather than pursuing wide-area site dispersion within Japan or contracting with multiple suppliers for the same parts, there will be an increasing trend to seek out suppliers that can supply parts and components to both domestic and overseas sites including those in other Asian countries and to train these suppliers to meet a company's requirements. He has pointed out that doing so, however, requires the implementation of measures that go back as far as the stages of development and design such as the standardization of parts and components.

IV Future Efforts Required of Enterprises

Since the occurrence of the Great East Japan Earthquake, social awareness of the need to prepare for major earthquakes has been increasing. The government has warned that there is a major risk of giant multi-segment sequential earthquakes occurring in the near future, one of which is forecast for the Tokai segment. Companies that have a high level of risk awareness have been embarking on efforts to reduce the risks they face such as improving earthquake resistance and rearranging site locations by relocating and dispersing their facilities.

Of course, the implementation of measures to mitigate the risks associated with massive sequential earthquakes will incur enormous cost. A company must continue to remain successful in a globally competitive society. However, it will not be easy to relocate production facilities or provide redundant functions. For this reason, a company must choose the most appropriate decision from the perspective of business management by accurately identifying the balance between the loss that would be incurred if business were to be halted by an earthquake and the cost for risk mitigation measures, which constitute trade-off relationships.

For business owners, the most important tasks they currently face are defining blocks that will ensure business continuity by visualizing the risks involved and planning a strategy that indicates what amounts of resources can be put into what activities so as to ensure a company's survival.

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